Comparative Effectiveness Review
Number 266

Cervical Degenerative Disease Treatment: A Systematic Review

AHRQ
Agency for Healthcare
Research and Quality

Comparative Effectiveness Review

Number 266

Cervical Degenerative Disease Treatment: A Systematic Review

Prepared for:
Agency for Healthcare Research and Quality
U.S. Department of Health and Human Services
5600 Fishers Lane
Rockville, MD 20857
www.ahrq.gov

Contract No. 75Q80120D00006

Prepared by:
Pacific Northwest Evidence-based Practice Center
Portland, OR

Investigators:
Shelley S. Selph, M.D., M.P.H.
Andrea C. Skelly, Ph.D., M.P.H.
Rebecca M. Jungbauer, Dr.P.H., M.A.
Erika Brodt, B.S.
Ian Blazina, M.P.H.
Travis C. Philipp, M.D.
Kimberly M. Mauer, M.D.
Joseph Dettori, Ph.D., M.P.H., M.P.T.
Chandler Atchison, M.P.H.
Dakota Riopelle, M.P.H.
Shay Stabler-Morris, M.S.
Rochelle Fu, Ph.D.
Yun Yu, M.S.
Roger Chou, M.D.

AHRQ Publication No. 24-EHC001
November 2023

This report is based on research conducted by the Pacific Northwest Evidence-based Practice Center (EPC) under contract to the Agency for Healthcare Research and Quality (AHRQ), Rockville, MD (Contract No. 75Q80120D00006). The findings and conclusions in this document are those of the authors, who are responsible for its contents; the findings and conclusions do not necessarily represent the views of AHRQ. Therefore, no statement in this report should be construed as an official position of AHRQ or of the U.S. Department of Health and Human Services.

None of the investigators have any affiliations or financial involvement that conflicts with the material presented in this report.

The information in this report is intended to help healthcare decision makers—patients and clinicians, health system leaders, and policymakers, among others—make well-informed decisions and thereby improve the quality of healthcare services. This report is not intended to be a substitute for the application of clinical judgment. Anyone who makes decisions concerning the provision of clinical care should consider this report in the same way as any medical reference and in conjunction with all other pertinent information, i.e., in the context of available resources and circumstances presented by individual patients.

A representative from AHRQ served as a Contracting Officer's Representative and reviewed the contract deliverables for adherence to contract requirements and quality. AHRQ did not directly participate in the literature search, determination of study eligibility criteria, data analysis, interpretation of data, or preparation or drafting of this report.

Suggested citation: Selph SS, Skelly AC, Jungbauer RM, Brodt E, Blazina I, Philipp TC, Mauer KM, Dettori J, Atchison C, Riopelle D, Stabler-Morris S, Fu R, Yu Y, Chou R. Cervical Degenerative Disease Treatment: A Systematic Review. Comparative Effectiveness Review No.

266. (Prepared by the Pacific Northwest Evidence-based Practice Center under Contract No. 75Q80120D00006.) AHRQ Publication No. 24-EHC001. Rockville, MD: Agency for Healthcare Research and Quality; November 2023. DOI: https://doi.org/10.23970/AHRQEPCCER266. Posted final reports are located on the Effective Health Care Program search page.

Preface

The Agency for Healthcare Research and Quality (AHRQ), through its Evidence-based Practice Centers (EPCs), sponsors the development of systematic reviews to assist public- and private-sector organizations in their efforts to improve the quality of healthcare in the United States. These reviews provide comprehensive, science-based information on common, costly medical conditions, and new healthcare technologies and strategies.

Systematic reviews are the building blocks underlying evidence-based practice; they focus attention on the strength and limits of evidence from research studies about the effectiveness and safety of a clinical intervention. In the context of developing recommendations for practice, systematic reviews can help clarify whether assertions about the value of the intervention are based on strong evidence from clinical studies. For more information about AHRQ EPC systematic reviews, see https://effectivehealthcare.ahrq.gov/about/epc/evidence-synthesis.

AHRQ expects that these systematic reviews will be helpful to health plans, providers, purchasers, government programs, and the healthcare system as a whole. Transparency and stakeholder input are essential to the Effective Health Care Program. Please visit the website (www.effectivehealthcare.ahrq.gov) to see draft research questions and reports or to join an email list to learn about new program products and opportunities for input.

If you have comments on this systematic review, they may be sent by mail to the Task Order Officer named below at: Agency for Healthcare Research and Quality, 5600 Fishers Lane, Rockville, MD 20857, or by email to epc@ahrq.hhs.gov.

Robert Otto Valdez, Ph.D., M.H.S.A.
Director
Agency for Healthcare Research and Quality

Therese Miller, Dr.P.H.
Director
Center for Evidence and Practice Improvement
Agency for Healthcare Research and Quality

Craig A. Umscheid, M.D., M.S.
Director
Evidence-based Practice Center Program
Center for Evidence and Practice Improvement
Agency for Healthcare Research and Quality

Kim Wittenberg, M.A.
Task Order Officer
Center for Evidence and Practice Improvement
Agency for Healthcare Research and Quality

Acknowledgments

The authors gratefully acknowledge the following individuals for their contributions to this project: Tracy Dana, M.L.S., Tamara Cheney, M.D., Jessica Griffin, M.S., and Tosha Zaback, M.P.H., from the Pacific Northwest Evidence-based Practice Center; Trish Rehring, M.P.H., from the Congress of Neurological Surgeons; Associate Editor Jaya K. Rao, M.D., M.S., at the Scientific Resource Center, Pacific Northwest EPC; and Task Order Officer Kim Wittenberg, M.A., at AHRQ.

Key Informants

In designing the study questions, the EPC consulted several Key Informants who represent the end-users of research. The EPC sought the Key Informant input on the priority areas for research and synthesis. Key Informants are not involved in the analysis of the evidence or the writing of the report. Therefore, in the end, study questions, design, methodological approaches, and/or conclusions do not necessarily represent the views of individual Key Informants.

Key Informants must disclose any financial conflicts of interest greater than $5,000 and any other relevant business or professional conflicts of interest. Because of their role as end-users, individuals with potential conflicts may be retained. The TOO and the EPC work to balance, manage, or mitigate any conflicts of interest.

The list of Key Informants who provided input to this report follows:

Erica Bisson, M.D., M.P.H.
University of Utah
Salt Lake City, UT

Sanjay Dhall, M.D.*
University of California-San Francisco
San Francisco, CA

James Harrop, M.D.
Jefferson University Hospitals
Philadelphia, PA

Daniel Hoh, M.D.*
University of Florida
Gainesville, FL

Josiah Orina, M.D.
Oregon Health & Science University
Portland, OR

John O'Toole, M.D., M.S.
Rush University
Chicago, IL

Marjorie Wang, M.D., M.P.H.
Medical College of Wisconsin
Menomonee Falls, WI

*Also participated as the non-sponsoring partner (Congress of Neurological Surgeons).

Technical Expert Panel

In designing the study questions and methodology at the outset of this report, the EPC consulted several technical and content experts. Broad expertise and perspectives were sought. Divergent and conflicted opinions are common and perceived as healthy scientific discourse that results in a thoughtful, relevant systematic review. Therefore, in the end, study questions, design, methodologic approaches, and/or conclusions do not necessarily represent the views of individual technical and content experts.

Technical Experts must disclose any financial conflicts of interest greater than $5,000 and any other relevant business or professional conflicts of interest. Because of their unique clinical or content expertise, individuals with potential conflicts may be retained. The TOO and the EPC work to balance, manage, or mitigate any potential conflicts of interest identified.

The list of Technical Experts who provided input to this report follows:

Erik Ensrud, M.D.†
University of Missouri-Columbia
Columbia, MO

John Loeser, M.D.†
University of Washington
Seattle, WA

Daniel Hoh, M.D.*†
University of Florida
Gainesville, FL

Sean Rundell, P.T., D.P.T., Ph.D.†
University of Washington
Seattle, WA

*Also participated as the non-sponsoring partner (Congress of Neurological Surgeons)
†Provided input on Draft Report.

Peer Reviewers

Prior to publication of the final evidence report, EPCs sought input from independent Peer Reviewers without financial conflicts of interest. However, the conclusions and synthesis of the scientific literature presented in this report do not necessarily represent the views of individual reviewers. AHRQ may also seek comments from other Federal agencies when appropriate.

Peer Reviewers must disclose any financial conflicts of interest greater than $5,000 and any other relevant business or professional conflicts of interest. Because of their unique clinical or content expertise, individuals with potential nonfinancial conflicts may be retained. The TOO and the EPC work to balance, manage, or mitigate any potential nonfinancial conflicts of interest identified.

The list of Peer Reviewers follows:

Ali Bydon, M.D.
Johns Hopkins University
Baltimore, MD

Joshua Mergos, M.S., CNIM, FASNM
University of Michigan
Ann Arbor, MI

Cervical Degenerative Disease Treatment: A Systematic Review

Abstract

Objectives. Cervical degenerative disease (CDD) is common, becomes more prevalent with age, and is managed with surgical and nonoperative treatments to alleviate pain, improve function, and prevent progression or recurrence. This systematic review summarizes the evidence on treatments for CDD.

Data sources. We searched Ovid MEDLINE®, Embase®, and Cochrane CENTRAL from 1980 to February 15, 2023; reference lists; and clinical trial registries.

Review methods. Predefined criteria were used to identify studies; prespecified methods were used to assess study quality and strength of evidence for key outcomes. Effects were analyzed qualitatively and quantitatively where appropriate.

Results. We included 57 randomized controlled trials, 56 nonrandomized studies, and 1 systematic review. Studies enrolled patients with radiculopathy and/or myelopathy with disease at one or more levels. A variety of surgical approaches were used; there were few comparative studies of nonoperative treatments. Most studies were rated moderate risk of bias, while the majority of evidence was rated low or insufficient strength to draw conclusions on comparative benefits and harms.

Cervical arthroplasty versus anterior cervical discectomy and fusion (ACDF): In single-level disease, there were no important differences between cervical arthroplasty and ACDF in pain or function. Cervical arthroplasty was associated with a lower likelihood of reoperation and slightly lower likelihood of any serious adverse event (SAE) in the short term, with no difference between cervical arthroplasty and ACDF in SAEs longer term. In patients with 2-level disease, pain, function, and likelihood of reoperation at the index level were similar, but the likelihood of an adverse event was slightly lower at 24 months with cervical arthroplasty, with no difference at 120 months.

Anterior versus posterior approach: There was no difference between these approaches in pain, function, quality of life, and reoperation in patients with fewer than three operated levels. Limited evidence suggests that a posterior approach is associated with a greater likelihood of experiencing any SAE in patients with procedures at three or more levels.

Standalone cage versus plate and cage in ACDF: Fusion rates were similar between standalone cage versus plate and cage; there were no differences between treatments in postoperative arm pain, function, quality of life, or adjacent-level ossification.

Laminoplasty versus laminectomy and fusion. There was little difference between surgical techniques in postoperative function, but the risk of experiencing a complication was lower with laminoplasty, with no difference in reoperation rates.

Conclusions. There were few differences in benefits between surgical approaches and techniques for the treatment of CDD. However, there were some differences in the frequency of adverse events for some comparisons.

Contents

Tables

Figures

Appendixes

Executive Summary

Main Points

- ***Cervical arthroplasty versus anterior cervical discectomy and fusion (ACDF):*** The likelihood of reoperation was substantially lower at 24 months with 1-level cervical arthroplasty versus ACDF (strength of evidence [SOE]: High); 2-level cervical arthroplasty was also associated with a lower likelihood of reoperation at 24 months (SOE: Low), with similar results at longer followup times. However, rates of reoperation for ACDF at the index level may be influenced by the need to remove an existing plate to treat adjacent segment disease. There were no differences between cervical arthroplasty and ACDF in pain or function with 1-level surgery (SOE: Moderate), whereas evidence was less strong with 2-level disease (SOE: Low) across various measures and timepoints.
- ***Anterior versus posterior approach:*** Reoperation rates were similar in patients with radiculopathy and 1-level disease (SOE: Low), but the likelihood of experiencing any serious adverse event was higher with posterior approaches than ACDF in patients with 3 or more level disease (SOE: Low).
- ***Standalone cage versus plate and cage in ACDF:*** Fusion rates were similar between the two approaches (SOE: Moderate); postoperative arm pain, function, quality of life, and adjacent level ossification were also similar (SOE: Low). Few reoperations were reported.
- ***Laminoplasty versus laminectomy and fusion:*** Postoperative neurologic function (SOE: Moderate) and general function (SOE: Low) were similar between the two approaches (SOE: Low), but the risk of experiencing a complication was lower with laminoplasty (SOE: Low), with no difference in reoperation rates (SOE: Moderate).
- ***Other comparisons:*** Evidence for other comparisons was limited. No studies meeting inclusion criteria were available to guide management of cervical degenerative disease (CDD) in asymptomatic patients with radiographic spinal cord compression or to guide management of pseudarthrosis after anterior cervical fusion.

Background and Purpose

This systematic review identifies and synthesizes research on treatments for CDD in patients with or without cervical radiculopathy or myelopathy. This topic was nominated by the Congress of Neurological Surgeons (CNS), which published prior guidelines on the management of CDD in 2009.[1-4] This review is intended to be broadly useful to clinicians and policy makers, and will also inform the development of updated guidelines from CNS or others.

Methods

This review follows standard methods for systematic reviews[5] that are further described in the full protocol available on the Agency for Healthcare Research and Quality website: https://effectivehealthcare.ahrq.gov/products/cervical-degenerative-disease/protocol. The protocol was registered with PROSPERO (CRD42023386838). Searches were conducted in Ovid MEDLINE®, CINAHL®, Embase®, and Cochrane CENTRAL databases from 2006 for operative treatment and 1980 for nonoperative treatment to February 15, 2023.

Investigators developed pre-established eligibility criteria in accordance with established methods[5] and revised the criteria with input from a technical expert panel and federal partners. Methods are discussed in more detail in the full report.

Results

A total of 4,705 references from electronic database searches and reference lists were reviewed. Across all Key Questions, 114 studies in 140 publications were included. The largest number of studies evaluated the effectiveness of cervical arthroplasty compared with ACDF in patients with cervical spondylotic radiculopathy or myelopathy at one or two levels (the Key Question that compared arthroplasty with ACDF, k=36). Main findings are summarized by Key Question in Table A. Results are discussed in more detail in the full report.

Table A. Summary of findings: cervical degenerative disease treatment

Key Question	Comparison	Fusion; Effect (SOE)	Pain; Effect (SOE)	Function; Effect (SOE)	Quality of Life; Effect (SOE)	Adverse Events; Effect (SOE)
KQ 1. Radiographic spinal cord compression, no myelopathy	Surgery vs. nonoperative treatment	No evidence	No evidence	No evidence	No evidence	No evidence
KQ 2. Radiographic spinal cord compression, mild to severe myelopathy	Surgery vs. nonoperative treatment	No evidence	No evidence	Insufficient	No evidence	Insufficient
KQ 3. CDD	Surgery vs. nonoperative treatment	No evidence	Insufficient	Insufficient	No evidence	No evidence
KQ 4. CDD	ACDF vs. ACDF + collar	Insufficient	Insufficient	Insufficient	No evidence	No evidence
	ACDF vs. ACDF + EMS	Small, favors ACDF + EMS (+)	Insufficient	Insufficient	No evidence	No evidence
	Laminoplasty vs. Laminoplasty + collar	NA	Similar (+)	Similar (+)	No evidence	No evidence
	Laminoplasty vs. laminoplasty + exercise	NA	Insufficient	No evidence	No evidence	No evidence
KQ 5. Cervical radiculopathy	Anterior vs. posterior surgery	Insufficient	Neck and Arm pain: Similar (+)	Similar (+)	Similar (+)	Reoperation: Similar (+)

Key Question	Comparison	Fusion; Effect (SOE)	Pain; Effect (SOE)	Function; Effect (SOE)	Quality of Life; Effect (SOE)	Adverse Events; Effect (SOE)
KQ 6. CDD with ≥3 level disease	Anterior vs. posterior surgery	Insufficient	Neck pain: Similar (+) Arm pain: Insufficient	Similar (+)	Insufficient	Mortality, severe dysphagia: Similar (+) Reoperation Insufficient SAE: Moderate to Large, favors anterior (+)
KQ 7. Cervical myelopathy	Laminectomy and fusion vs. Laminoplasty	NA	Insufficient	Similar (++)	No evidence	Reoperation: Similar (++) AEs: Moderate to Large, favors laminoplasty (+)
KQ 8. CDD	Cervical arthroplasty vs. ACDF	NA	Similar (++)	Similar (++)	No evidence	Reoperation: Large, favors cervical arthroplasty: 1-level: (+++) 2-level: (+) SAE: Small, favors cervical arthroplasty (+) Neurological events: Similar 1-level: (+) 2-level: Insufficient
KQ9. ACDF	Standalone cage vs. plate and cage	Similar (++)	Neck pain: Similar (+) Arm pain: Insufficient	Similar (+)	Similar (+)	Adjacent level ossification: Similar (+)
	Titanium/titanium -coated vs. PEEK cage	Small, favoring PEEK (+)	Insufficient	Small, favoring PEEK (+)	No evidence	Insufficient
	Autograft vs. allograft vs. other osteogenic materials	Insufficient	Insufficient	Insufficient	Insufficient	AEs: Large, favors nonuse of BMP-2 (+)
KQ 10. Pseudarthrosis prior anterior fusion surgery	Posterior approach vs. revision anterior arthrodesis	No evidence	No evidence	No evidence	No evidence	No evidence

Key Question	Comparison	Fusion; Effect (SOE)	Pain; Effect (SOE)	Function; Effect (SOE)	Quality of Life; Effect (SOE)	Adverse Events; Effect (SOE)
KQ 11. Myelopathy, prognostic utility of MRI	T2-weighted increased signal intensity and intensity ratio, sharp signal intensity	No evidence	No evidence	No evidence	No evidence	Neurologic recovery: favors no signal, less sharp signal, increased signal intensity ratio (+)
	Segmental abnormalities, diffusion tensor tactography, diffusion-based spectrum imaging, radionomic-based extra tree model	No evidence	No evidence	No evidence	No evidence	Neurologic recovery: Insufficient
KQ 12. Imaging to detect pseudarthrosis	Dynamic radiographs (asymptomatic)	Predicts pseudarthrosis (+)	NA	NA	NA	NA
	Dynamic radiographs (symptomatic)	Predicts pseudarthrosis (+)	NA	NA	NA	NA
	Angular measurement in dynamic radiographs (population NR)	Insufficient	NA	NA	NA	NA
KQ 13. CDD and ACDF	IONM vs. no IONM	NA	No evidence	No evidence	No evidence	Neurologic complications: Similar (+)

ACDF = anterior cervical discectomy and fusion; AE = adverse event; BMP-2 = bone morphogenetic protein 2; CDD = cervical degenerative disease; EMS = electromagnetic stimulation; IONM = intraoperative neuromonitoring; KQ = Key Question; MRI = magnetic resonance imaging; NA = not applicable; NR = not reported; PEEK = polyetheretherketone; SAE = serious adverse event; SOE = strength of evidence; T2 = T2 weighted image
Strength of Evidence: low (+), moderate (++), high (+++)

Conclusions

There were few differences in benefits between surgical approaches, devices, and techniques for the treatment of CDD. However, there were some differences in the frequency of adverse events for some comparisons. Reoperation rates were lower with artificial disc replacement than ACDF; however, indication for reoperation was not consistently described and the potential impact on re-operation at index level for plate removal to treat adjacent segment disease is unknown. Limited evidence also suggests a lower likelihood of experiencing any serious adverse event with ACDF than posterior cervical disc fusion, and a lower risk for any complication with laminoplasty compared with laminectomy and fusion. There was limited or no evidence for other comparisons.

References

1. Matz PG, Anderson PA, Kaiser MG, et al. Introduction and methodology: guidelines for the surgical management of cervical degenerative disease. J Neurosurg Spine. 2009 Aug;11(2):101-3. doi: 10.3171/2009.1.SPINE08712. PMID: 19769488.
2. Fehlings MG, Arvin B. Surgical management of cervical degenerative disease: the evidence related to indications, impact, and outcome. J Neurosurg Spine. 2009 Aug;11(2):97-100. doi: 10.3171/2009.5.SPINE09210. PMID: 19769487.
3. Congress of Neurological Surgeons. Guideline for the Surgical Management of Cervical Degenerative Disease. Congress of Neurological Surgeons; 2009. https://www.cns.org/guidelines/browse-guidelines-detail/surgical-management-of-cervical-degenerative-disea2022.
4. Surgical Management of Cervical Degenerative Disease. Rockville, MD: Effective Health Care Program, Agency for Healthcare Research and Quality; Content last reviewed June 2021. https://effectivehealthcare.ahrq.gov/get-involved/nominated-topics/cervical-degenerative-disease
5. Agency for Healthcare Research and Quality. Methods guide for effectiveness and comparative effectiveness reviews, Agency for Healthcare Research and Quality. Rockville, MD: 2020. https://effectivehealthcare.ahrq.gov/products/collections/cer-methods-guide.

1. Introduction

1.1 Background

The cervical spine is comprised of seven vertebrae with discs between the vertebrae that are comprised mostly of water. Cervical degenerative disease (CDD) refers to a cascade of events that leads to changes of the vertebral discs resulting in disc desiccation and height loss. These changes may cause uncovertebral and facet joint hypertrophy (enlargement of vertebral joints) leading to vertebral foraminal narrowing (stenosis), which may cause radiculopathy (pain, motor and sensory deficits) as the exiting nerve roots are pinched, or more central stenosis with compression of the spinal cord and associated myelopathy (sensory and motor deficits and pain or myelopathy may be asymptomatic). While both conditions can affect the neck and upper extremities, cervical spondylotic myelopathy can also cause poor proprioception and spasticity of the lower extremities resulting in gait disturbances, as well as disturbances in bladder function caused by compression of motor and sensory neurologic pathways travelling through the cervical cord. Cervical radiculopathy and cervical spondylotic myelopathy may exist simultaneously.

Although the etiology of CDD is not fully understood, it is a common condition that becomes more prevalent with age. The estimated prevalence of any spinal degenerative disease from 2005 to 2017, in people 65 and older, based on Medicare data of approximately 1.7 million individuals, is 27.3 percent, with the highest prevalence for degenerative disc disease (12.2%).[1] In a separate Medicare database study, 3,156,215 individuals were identified with degenerative cervical disease (incidence 18.9% for females, 13.1% for males between 2006 and 2012).[2] However, the presence of CDD may not correlate well with symptoms.[3] For example, one systematic review[4] found the prevalence of multilevel degenerative disc pathology to be 64.5 percent in asymptomatic subjects (compared with 89.7% in a symptomatic population).

1.2 Management of Cervical Degenerative Disease

Of the over 3 million individuals with CDD in the Medicare study mentioned above, 32 percent were treated nonoperatively and 7 percent were treated with spinal fusion (permanently joining two or more vertebrae) within a year of diagnosis.[2] Surgical treatment for cervical radiculopathy varies and includes both anterior and posterior based procedures. When approached anteriorly, intervertebral spacers and additional plating may be used, the vertebrae may or may not be fused, and the cervical disc(s) may or may not be replaced.[5] In addition to anterior cervical discectomy with fusion, cervical disc replacement and anterior cervical corpectomy (removal of the vertebral body) with fusion, surgical treatment for cervical spondylotic myelopathy also includes posterior procedures: laminoplasty (surgery to enlarge spinal canal by cutting the bony roof [lamina] and allowing it to open like a door), laminectomy (surgery that enlarges spinal canal by removing a portion of the lamina), and laminectomy with fusion.[6] Nonoperative treatment of CDD includes analgesics, corticosteroids, neck immobilization, traction of the cervical spine, interventional approaches (e.g., radiofrequency ablation [a procedure that destroys nerve tissue that sends pain signals to the brain using radiowaves), physical therapy, exercises, thermal therapy, and avoidance of provocative activities.[7,8] The goals of both surgical and nonoperative treatments are to alleviate pain, improve neurologic function, and prevent progression or recurrence.

While cervical myelopathy and radiculopathy are clinical diagnoses, magnetic resonance imaging (MRI) is used to confirm levels where compression of the spinal cord or nerve roots is evident. Various degenerative features can be seen on cervical MRI such as decreased vertebral height, disc height loss, osteophyte formation, disc bulging and location, hypertrophy and ossification of the posterior longitudinal ligament, spinal cord compression and flattening, and tethering (attachment) of the spinal cord to the spinal canal.[9] MRI findings can then help guide treatment. It is important to note that the presence of degenerative findings on MRI does not equate to symptomatic consequence. One study found that 28 percent of asymptomatic volunteers over the age of 40 years (N=23, levels=97) demonstrated cervical degenerative changes on MRI (versus 14% in those less than 40 years of age).[10] Intraoperative neuromonitoring (e.g., somatosensory, motor evoked potential measurements, spontaneous and triggered electromyography) is used during cervical spine surgery to provide intraoperative assessments of neural function and detect neurological injury during surgery to potentially mitigate or prevent further injury.

1.3 Purpose and Scope of the Review

This systematic review identifies and synthesizes research on treatments for CDD in patients with cervical radiculopathy and/or myelopathy. This topic was nominated by the Congress of Neurological Surgeons (CNS), which published prior guidelines on the management of CDD in 2009.[11-14] This review is intended to be broadly useful to clinicians and policy makers, and will also inform the development of updated guidelines from CNS or others. This review also includes nonoperative management of CDD as compared with operative management, which was not part of the previous CNS guidelines.

2. Methods

2.1 Systematic Review Design Process

This Comparative Effectiveness Review follows methods of the Agency for Healthcare Research and Quality (AHRQ) Methods Guide for Effectiveness and Comparative Effectiveness Reviews (hereafter the "AHRQ Methods Guide").[15] All methods were determined a priori and a protocol was developed through a process that included collaboration with a Technical Expert Panel, federal partners, and public input on Key Questions and study eligibility criteria. The protocol was registered on the PROSPERO systematic reviews registry (CRD42023386838) and published on the AHRQ website: https://effectivehealthcare.ahrq.gov/products/cervical-degenerative-disease/protocol.

2.1.1 Key Questions

The review is defined by 13 Key Questions that address the effectiveness and harms of treatments for cervical degenerative disease (CDD), as well as how effectiveness and harms may differ by patient and disease characteristics (e.g., age, gender, severity of disease, vertebral level(s) of involvement). Two Contextual Questions were also included to help inform the report. Contextual Questions are not reviewed using systematic review methodology. The Key Questions, Contextual Questions, and analytic framework (Figure 1) are below.

Key Question 1: In patients with radiographic spinal cord compression and no cervical spondylotic myelopathy, what are the comparative effectiveness and harms of surgery compared to non-operative treatment or no treatment?

Key Question 2: In patients with radiographic spinal cord compression and mild to severe myelopathy, what are the effectiveness and harms of surgery versus non-operative treatment or no treatment? How do the effectiveness and harms vary by level of severity of myelopathy at the time of surgery?

Key Question 3: In patients with cervical degenerative disease, what are the comparative effectiveness and harms of surgical compared to non-operative treatment?

Key Question 4: In patients with cervical degenerative disease, what are the comparative effectiveness and harms of therapies added on to surgery (pre- or post-operative) compared with the same surgery alone?

Key Question 5: In patients with cervical radiculopathy due to cervical degenerative disease, what are the comparative effectiveness and harms of posterior versus anterior surgery?

Key Question 6: In patients with cervical degenerative disease, what are the comparative effectiveness and harms of posterior versus anterior surgery in patients with greater than or equal to three level disease?

Key Question 7: In patients with cervical spondylotic myelopathy due to cervical degenerative disease, what are the comparative effectiveness and harms of cervical laminectomy and fusion compared to cervical laminoplasty in patients?

Key Question 8: In patients with cervical spondylotic radiculopathy or myelopathy at one or two levels, what are the comparative effectiveness and harms of cervical arthroplasty compared to anterior cervical discectomy and fusion?

Key Question 9: In patients undergoing anterior cervical discectomy and fusion, what are the comparative effectiveness and harms of surgery based on interbody graft material or device type?

Key Question 10: In patients with pseudarthrosis after prior anterior cervical fusion surgery, what are the comparative effectiveness and harms of posterior approaches compared to revision anterior arthrodesis?

Key Question 11: In patients with cervical spondylotic myelopathy, what is the prognostic utility of preoperative magnetic resonance imaging (MRI) findings for neurologic recovery after surgery?

Key Question 12: What are the sensitivity and specificity of imaging assessment for identifying symptomatic pseudarthrosis after prior cervical fusion surgery?

Key Question 13: In patients with cervical spondylotic myelopathy, what are the comparative effectiveness and harms of intraoperative neuromonitoring (e.g., with somatosensory or motor evoked potential measurements) versus no neuromonitoring on clinical outcomes in patients undergoing surgery?

For purposes of these Key Questions, we focused on symptomatic CDD; with the exception of Key Question 1, evaluation and management of asymptomatic disease is beyond the scope of this review.

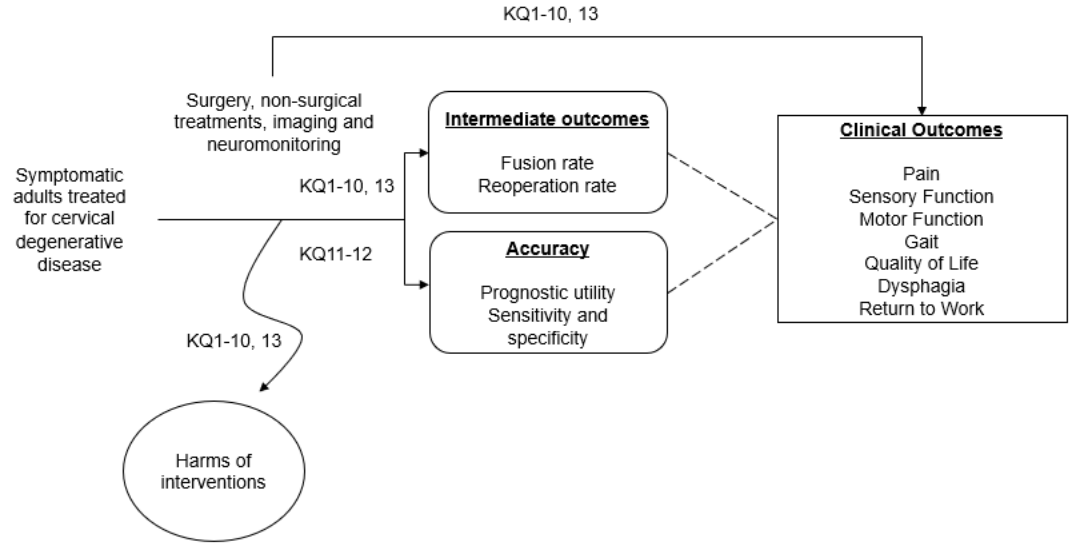
2.1.2 Contextual Questions

Contextual Question 1: What is the prevalence of cervical degenerative disease with spinal cord compression in asymptomatic patients?

Contextual Question 2: What is the natural history of untreated spinal cord compression in patients with cervical degenerative disease?

2.1.3 Analytic Framework

Figure 1. Analytic framework



KQ = Key Question
The analytic framework illustrates how the populations, interventions, and outcomes relate to the Key Questions in the review.

2.2 Study Selection

2.2.1 Literature Search Strategy

We conducted electronic searches in Ovid MEDLINE®, Embase®, and Cochrane CENTRAL from 1980 to February 15, 2023 (see Appendix A1.1 for full strategies). For Key Questions that compare operative approaches, we searched databases for studies published after 2006 (studies published in 2007 or earlier were included in the 2009 guidelines).[13] Additionally, we reviewed all studies included in the 2009 guidelines for inclusion in this review.[13] For Key Questions not covered by the 2009 guidelines (e.g., operative versus nonoperative studies, neuromonitoring studies) we searched the databases from 1980 to the present in order to identify relevant, earlier studies based on when technologies such as neuromonitoring and advanced imaging were first used in research trials. Reference lists of included systematic reviews were screened for additional studies and relevant references were carried forward. A Federal Register notification for a Supplemental Evidence and Data for Systematic review portal was posted from August 12th

to September 12th, 2022, for submission of unpublished studies. The search strategy was peer-reviewed by another medical librarian.

2.2.2 Inclusion and Exclusion

Criteria were established *a priori* to determine eligibility for inclusion and exclusion of abstracts in accordance with the AHRQ Methods Guide.[15] The criteria for inclusion and exclusion of studies for this systematic review are based on the Key Questions and are described in Table 1 (see Appendix A for complete details, and Appendix B for all included studies). More information on data management methods can be found in Appendix A2.1. For studies meeting inclusion criteria, evidence tables were constructed, with results relevant to each Key Question abstracted in Appendix C and Risk of Bias ratings in Appendix D. Excluded studies and their exclusion codes are included in Appendix E.

Table 1. PICOTS – inclusion and exclusion criteria

PICOTS	Include	Exclude
Population	• Age 18 and above with symptomatic cervical degenerative disease (e.g., pain, radiculopathy, myelopathy) for all KQs except for KQ1, which includes asymptomatic patients • Effectiveness and harms of surgery based on patient characteristics, disease characteristics and radiographic characteristics (e.g., age, gender, comorbidities [e.g., comorbid lumbar disease, autoimmune disease, neurological disease, mental illness, Down's syndrome], severity of cervical degenerative disease, Frailty Index, sagittal vertical aspect, degree of kyphosis, prior treatment [e.g., bracing, traction, medications, massage, acupuncture, injections, chiropractic care, spinal manipulation], duration of pain, skill of surgeon)	• Younger than 18 years • Patients without cervical degenerative disease • Nonhumans
Interventions	• Cervical spine surgery (e.g., discectomy, disc replacement, fusion up to T2, cervical arthroplasty, laminectomy, laminoplasty, corpectomy, cervical hybrid surgery, foraminotomy, ACDF cage vs. ACDF cage + plate) • Non-surgical treatments (e.g., heat, exercise, acupuncture, drugs, radiofrequency ablation, steroid injections, Botox® for neck pain, psychological strategies [e.g., cognitive behavioral therapy], occupational therapy, multidisciplinary rehabilitation) • Intraoperative neuromonitoring • Imaging to identify symptomatic pseudarthrosis after cervical fusion surgery • Preoperative MRI to predict neurologic recovery in myelopathy	• Preoperative imaging using CT or plain films • KQ4: intraoperative therapy • KQ7: laminectomy without fusion
Comparators	• Any included intervention • Placebo, waitlist, active control • No comparator (KQs 11 and 12)	• Nonoperative intervention versus nonoperative intervention without surgical comparator

2. Methods

PICOTS	Include	Exclude
Outcomes	• Pain, sensory function, motor function, gait, quality of life (e.g., VAS, NRS, NDI, SF-36, SF-12, EQ-5Dm, mJOA score, Nurick score, MDI, PROMIS-29), dysphagia scales, return to work • Fusion rate, reoperation rate • Harms (e.g., withdrawals due to adverse events, serious adverse events, new symptomatic adjacent segment disease, postoperative infection, device failure, ossification of the posterior ligament, development of kyphotic deformity) • Sensitivity and specificity of imaging after cervical fusion surgery	• Nonvalidated instruments
Timing	• All time periods	None
Setting	• Inpatient, outpatient, ambulatory surgical centers	None
Study types and designs	• RCTs, prospective trials and retrospective observational studies with a control group (study N≥50), current systematic reviews • KQs 11-12 and studies focused on harms as a primary outcome: large intervention series (N≥50; can be single arm, but everyone received the same intervention)	• KQ1-10: pre-post single-arm studies, case series (everyone selected based on outcome), case reports, systematic reviews published prior to 2007 • KQ11-12: pre-post non-intervention studies, case series, case reports, systematic reviews published prior to 2007
Language	• English language	• Non-English

ACDF = anterior cervical discectomy and fusion; CT = computed tomography; EQ-5Dm = EuroQol-5 dimension instrument; KQ = Key Question; MDI = myelopathy disability index; MRI = magnetic resonance imaging; mJOA = modified Japanese orthopedic association scale; NDI = Neck Disability Index; N(P)RS = numerical pain rating scale; PROMIS-29 = patient reported outcome measurement information system; RCT = randomized controlled trial; QOL = quality of life; SF-12 = 12-Item Short Form Health Survey; SF-36 = 36-Item Short Form Health Survey; VAS = visual analogue scale

We limited our review to adults with CDD who were treated with surgical interventions; comparison groups were limited to other surgical interventions with or without nonsurgical interventions (e.g., physical therapy, neck collar), nonoperative treatment alone or no treatment. Only studies with a relevant comparison group were included in this review. Single-arm studies were not included due to increased risk of bias and lack of comparative data. Primary effectiveness outcomes fell into five general categories: fusion, pain, neurologic function, general function, and quality of life. Nonexaustive examples of neurological function outcomes included the modified Japanese Orthopedic Association scale (mJOA) and the Nurick Classification Scale; outcomes classified as general function included the Neck Disability Index (NDI), Odom's criteria, and the 36-Item Short Form Health Survey (SF-36); outcomes classified as pertaining to quality of life included the Euro Quality of Life-5 Dimension scale, the Veteran's RAND 12-Item Health Survey, and the Swallowing Quality of Life scale. Other prioritized outcomes included rates of serious adverse events, study discontinuation due to adverse events and specific adverse events (e.g., need for reoperation, neurologic deficits).

2.3 Risk of Bias Assessment of Individual Studies

Predefined criteria were used to assess the risk of bias (also referred to as quality or internal validity) for each individual included study, using criteria appropriate for the study design based on the AHRQ Methods guide,[15] the Cochrane Back and Neck Group,[16] and the U.S. Preventive Services Task Force[17] (Appendix D1.1). Each study was independently reviewed for risk of bias by two team members. Any disagreements were resolved through consensus. Based on the risk of bias assessment, included studies were rated as having "low," "moderate," or "high" risk of bias (Appendix D1.1). Studies rated high risk of bias were not excluded a priori, but were considered to be less reliable than low or moderate risk of bias studies when synthesizing the evidence. See Appendix D1.1 for additional details.

Because most studies were rated moderate risk of bias, we call out in the text studies rated high risk of bias as extra caution should be exercised when drawing conclusions from such studies.

2.4 Data Analysis and Synthesis

Evidence tables identify study characteristics, results of interest, and risk of bias ratings for all included studies and summary tables highlight the main findings. Studies were reviewed and highlighted using a hierarchy-of-evidence approach, where the best evidence is the focus of the synthesis for each Key Question. Since the Key Questions varied in nature and scope, the approach to synthesis also varied. We analyzed the evidence according to Key Question, using both qualitative (narrative) and where possible quantitative (meta-analysis) methods. Randomized controlled trials were prioritized and studies with lower risk of bias ratings were given more consideration in our synthesis for each clinical indication and outcome.

Meta-analyses were conducted to obtain more precise effect estimates for comparative effectiveness of various interventions for cervical spine; analyses of randomized and nonrandomized evidence were conducted separately. A random effects model based on the profile likelihood method[18] was used to obtain pooled risk ratio and mean difference. Statistical heterogeneity among the studies was assessed using Cochran's χ^2 test and the I^2 statistic.[19] For analyses with at least 10 trials, we constructed funnel plots and performed the Egger test to detect small sample effects (a marker for potential publication bias).[20] All meta-analyses were conducted using Stata/SE 16.1 (StataCorp, College Station, TX). See Appendix A2.1 for additional details on data synthesis and analysis, and Appendix F for additional forest plots.

To help determine the degree of effect, we examined the magnitude of relative risks and mean differences according to Table 2. There were instances where a statistically significant difference between treatments was of such a small magnitude as to not be clinically meaningful. Conversely, there were instances where a small, moderate, or large effect was found but was not statistically significant.

Table 2. Definition of effect sizes

Effect Size	Definition
Small effect	MD 0.5 to 1.0 points on a 0 to 10-point scale, 5 to 10 points on a 0 to 100-point scale SMD 0.2 to 0.5 RR/OR 1.2 to 1.4
Moderate effect	MD >1 to 2 points on a 0 to10-point scale, >10 to 20 points on a 0 to 100-point scale SMD >0.5 to 0.8 RR/OR 1.5 to 1.9
Large effect	MD >2 points on a 0 to10-point scale, >20 points on a 0 to 100-point scale SMD >0.8 RR/OR ≥2.0

MD = mean difference; OR = odds ratio; RR = relative risk; SMD = standardized mean difference
Table 2 taken from the Cervical Degenerative Disease Protocol, published online at
https://effectivehealthcare.ahrq.gov/sites/default/files/product/pdf/cervical-degenerative-protocol.pdf

2.5 Grading the Strength of the Body of Evidence

The strength of evidence (SOE) for each body of evidence was assessed as high, moderate, low, or insufficient, using the approach described in the AHRQ Methods Guide,[15] based on study limitations, consistency, directness, precision, and reporting bias. These criteria were applied regardless of whether evidence was synthesized quantitatively or qualitatively. Strength of evidence ratings reflected our confidence or certainty in the findings. Strength of evidence was considered insufficient when evidence was lacking, sparse, or too conflicting such that we were unable to draw conclusions. SOE was initially assessed by one researcher and confirmed by a second. SOE was not conducted for composite outcomes. Descriptions of criteria and overall grades are described in full in Appendix A and G.

2.6 Peer Review and Public Commentary

An associate editor from a different Evidence-based Practice Center reviewed the draft report. Experts were invited to provide external peer review of this systematic review; AHRQ also provided comments. In addition, the draft report was posted on the AHRQ website June 9 to July 7, 2023 for public comment. All comments were reviewed and used to inform revisions to the draft report. AHRQ will post a disposition of comments table 3 months after publication of the final report.

3. Results

3.1 Description of Included Studies

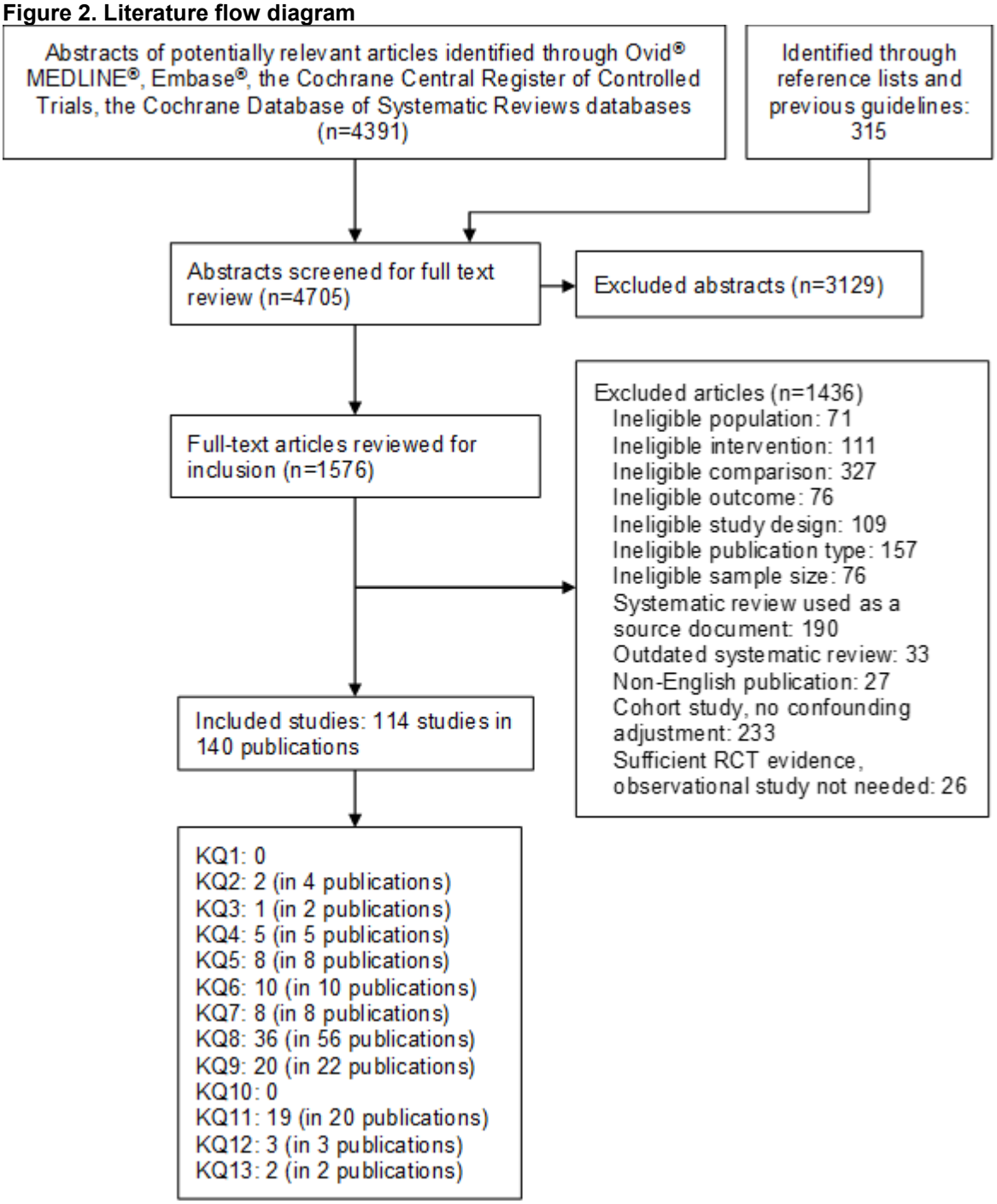
A total of 4,705 references from electronic database searches and reference lists were reviewed. After dual review of titles and abstracts, 1,576 papers were selected for full-text review, of which 1,436 articles were excluded. Of the 114 studies in 140 publications included across all Key Questions, 57 (in 82 publications) were randomized controlled trials (RCTs), 56 (in 57 publications) were observational studies, and one was a systematic review (Figure 2). Results are arranged by Key Question, then by outcome, and are summarized below, followed by tables in the accompanying text.

A list of excluded studies with reason for exclusion are in Appendix E**.** Data abstraction of study characteristics and results, quality assessment for all included studies, and details for grading strength of evidence (SOE) are available in Appendixes C, D, and G, respectively, while Appendix H includes all appendix references.

Most studies were rated moderate risk of bias. For these studies we do not call their risk of bias in the text. Instead we call out studies that were rated high risk of bias as additional caution should be exercised when interpreting study results.

3.1 Results, Description of Included Studies

Figure 2. Literature flow diagram



KQ = Key Question, RCT = randomized controlled trial.
57 (in 82 publications) were randomized controlled trials (RCTs), 56 (in 57 publications) were observational studies, and one was a systematic review.
Note: In the excluded articles list, when sufficient RCT evidence existed, eligible observational studies were excluded, as their level of evidence (risk of bias) would have been lower than the RCTs.

3.2 Key Question 1: In patients with radiographic spinal cord compression and no cervical spondylotic myelopathy, what are the comparative effectiveness and harms of surgery compared to non-operative treatment or no treatment?

No studies met eligibility criteria for Key Question 1.

3.3 Key Question 2: In patients with radiographic spinal cord compression and mild to severe myelopathy, what are the effectiveness and harms of surgery versus non-operative treatment or no treatment? How do the effectiveness and harms vary by level of severity of myelopathy at the time of surgery?

3.3.1 Key Findings

- Evidence from one small RCT and one small nonrandomized study of interventions (NRSI) was inadequate to determine the benefits and harms of surgery versus conservative treatment for cervical myelopathy (SOE: Insufficient).

3.3.2 Description of Included Studies

One RCT (N=68) described in three publications[21-23] and one NRSI (N=80)[24] compared surgery versus conservative treatment for cervical myelopathy (Appendix C). The duration of followup in the RCT was 3 years[21,22] and 10 years.[23] The duration of followup in the NRSI was 3 years.[24] In the NRSI, patients were stratified by degree of myelopathy (mild and moderate versus severe) in both the surgery and conservative treatment groups. In the RCT, all patients had slowly or nonprogressing mild to moderate myelopathy. The RCT was conducted in the Czech Republic and received government funding; the NRSI was conducted in Italy and did not report funding.

The mean age of participants was 53 years with 29 percent females in the RCT and 66 years with 44 percent female in the NRSI. The duration of disease was 2 years (range 0.3 to 12 years) in the RCT and the mean duration of symptoms was 25 months (range 3 to 57 months) in the NRSI.

Surgery consisted of anterior decompression (N=22) with bone graft (N=20), corpectomy (N=6), and laminoplasty (N=5) in the RCT. An anterior approach was used in 1- or 2-level cord compression and a posterior approach was used in multilevel spinal stenosis. Surgery consisted of microsurgical anterior corpectomy, discectomy, use of titanium mesh and anterior plating in the NRSI. For 3- or multi-level corpectomy, posterior stabilization was also performed. Surgical patients wore a cervical collar for 4 weeks postoperatively. In the RCT, conservative treatment consisted of cervical collar, anti-inflammatory medication, and bed rest. However, surgical patients also received these treatments. Conservative treatment in the NRSI was similar to treatments in the RCT, but also included physiotherapy.

The RCT was rated moderate risk of bias due to lack of blinding and unclear randomization methods (Appendix D). The NRSI was rated high risk of bias due to unclear differences in patient baseline characteristics across groups and potential selection bias in treatment given (Appendix D). The strength of evidence for neurologic and general function was rated insufficient due to conflicting evidence from two small studies (Appendix G).

3.3.3 Detailed Analysis

3.3.3.1 Fusion

No studies reported fusion outcomes.

3.3.3.2 Pain

No studies reported pain outcomes.

3.3.3.3 Neurologic Function

Evidence from one small RCT and one small NRSI was inadequate to determine the benefits and harms of surgery versus conservative treatment on neurologic function in patients with cervical myelopathy (SOE: Insufficient).

In the RCT, patients were considered to be responders if Modified Japanese Orthopaedic Association Scale (mJOA) scores (maximum 18 points) were improved or unchanged following treatment.[22] The likelihood of mJOA response was slightly less with surgery compared with conservative therapy at 6 months (N=66, 61% vs. 73%, relative risk [RR] 0.83, 95% confidence interval (CI) 0.59 to 1.18) and at 36 months (N=59, 59% vs. 73%, RR 0.80, 95% CI 0.55 to 1.16), although differences were not statistically significant. However, mean mJOA scores were not different between surgery and conservative treatment at 6, 12, 24, and 36 months after controlling for baseline values. Ten-year followup of the RCT (N=47) also found no differences between treatment groups on the mJOA (14 vs. 15, p=0.114).[23]

In the NRSI, patients were divided into four groups (N=20 patients per group) and followed for 3 years: patients with mild to moderate myelopathy treated with surgery; patients with mild to moderate myelopathy treated conservatively; patients with severe myelopathy treated with surgery; patients with severe myelopathy treated conservatively.[24] Mild to moderate myelopathy was defined as a mJOA score of 12 and above, severe myelopathy as a score below 12. Patients with severe myelopathy experienced a longer duration of symptoms (40 months) than patients with mild to moderate disease (10 months) and were more likely to receive multilevel surgery than surgical patients with mild to moderate disease. Mean mJOA scores improved over time for both surgery and conservative treatment but favored surgery at 12 and 36 months in patients with mild to moderate myelopathy (12 months mJOA: 15.4 vs. 14.2, p=0.03; 36 months: 16.1 vs. 15.2, p=0.013). In patients with severe myelopathy improvement in mJOA scores was greater with surgery compared with conservative treatment beginning at 6 months (6 months mJOA: 9.5 vs. 7.9, p=0.045; 12 months: 11.5 vs. 8.6, p=0.001; 36 months: 12.45 vs. 8.65, p<0.001).

3.3.3.4 General Function

Evidence from one small RCT and one small NRSI was inadequate to determine the benefits and harms of surgery versus conservative treatment on general function in patients with cervical myelopathy (SOE: Insufficient).

The time required to complete the 10-meter Walk Test in the RCT (N=66) increased over time through 24 months in patients treated with surgery (baseline: 7.9 seconds; 6 months: 8.7 sec; 12 months: 9.9 sec; 24 months: 11.7 sec; 36 months: 9.4 sec), whereas there was little change in time needed to complete the 10-meter walk throughout the followup period with conservative treatment (baseline: 7.4 sec; 6 months: 7.2 sec; 12 months: 7.4 sec; 24 and 36 months: 7.5 sec).[21] These differences in walk time between treatments were statistically significant (p-value range 0.034 to 0.003), although the differences between groups is not likely clinically meaningful. Ten-year followup of the RCT (N=47) found no differences on the 10-meter Walk Test (7.3 seconds vs. 7.1 seconds, p=0.207).[23] There was no difference, however, in the NRSI, between treatment with surgery versus conservative therapy on the 10-meter Walk Test in patients with mild to moderate myelopathy, whereas there was greater improvement on the 10-Meter Walk Test with surgery in patients with severe myelopathy at 12 and 36 months (12

months: 11.4 seconds vs. 14.4 seconds, p=0.005; 36 months: 10.30 seconds vs. 14.10 seconds, p=0.002).[24]

In the RCT, patients were videoed performing activities of daily living (ADL) such as buttoning a shirt, brushing teeth and hair, walking, going up and down stairs, and running and were evaluated by blinded observers on a 7-point improvement scale that ranged from 3 (excellent) to -3 (poor); 0 represented no change in ability.[21] Patients treated with surgery showed a greater likelihood of improvement in ADLs compared with conservative treatment at 6 months (20% vs. 5.9%) but there was also a greater likelihood of worsening in ADLs with surgery (20% vs. 8.8%) at 6 months. There were no differences between treatments in changes in ADL abilities at 12, 24, or 36 months. Video evaluation of decreased ability to perform ADLs was also not different between treatment groups at 10 years (mean of two evaluators: 56.8% vs. 50%, p>0.05).[23] However, with the limited sample size available, this 10-year followup was likely underpowered to demonstrate a difference between surgery and conservative treatment.

Although more patients in the RCT reported that their disease course had improved after surgery compared with conservative therapy at 6 months posttreatment (61% vs. 20%, p=0.001), self-perception of improved diseased course deteriorated over time in the surgery group (p=0.019 for negative trend) and was 20 percent at 36 months compared with a relatively stable course with conservative treatment.[21] Ten-year followup of the RCT (N=47) found no difference between treatment groups on a subjective evaluation of worsened status (45.5% vs. 56%, p=0.47).[23]

The physical component summary score (PCS) and the mental component summary score (MCS) on the 12-Item Short Form Health Survey (SF-12) were not different posttreatment (unclear posttreatment time) in patients with mild to moderate myelopathy who received surgery compared with patients who received conservative therapy (PCS: 37.4 vs. 37.95, p=0.75; MCS: 47.5 vs. 46.7, p=0.78).[24] However, improvement in scores was greater with surgery versus conservative treatment in patients with severe myelopathy (PCS: 53.3 vs. 26.85, p<0.001; MCS: 61.2 vs. 31.4, p<0.001).

3.3.3.5 Quality of Life

No studies reported quality of life outcomes.

3.3.3.6 Harms

The NRSI reported that two patients with severe myelopathy who received conservative treatment demonstrated progressive neurological worsening (defined as a worsening of 1 point on the mJOA).[24] Surgical complications in this study included 5/40 patients (12.5%) who experienced airway obstruction, graft displacement, and/or wound hematoma. There were no deaths.

The findings of the NRSI, particularly the findings in patients with severe myelopathy, should be interpreted with caution as the individuals in the severe myelopathy group who received conservative treatment consisted of those who refused surgery against medical advice, which may have introduced selection bias.

3.4 Key Question 3: In patients with cervical degenerative disease, what are the comparative effectiveness and harms of surgical compared to non-operative treatment?

3.4.1 Key Findings

- There was inadequate evidence from one small RCT on the comparative effectiveness of anterior cervical discectomy and fusion (ACDF), physiotherapy, and treatment with a cervical collar on pain and function in patients with cervico-brachial pain without spinal cord compression (SOE: Insufficient).

3.4.2 Description of Included Studies

One RCT (N=81) described in two publications[25,26] compared treatment for cervico-brachial pain with cervical decompression and fusion, physiotherapy, or neck collar (Appendix C). All patients had nerve root compression on magnetic resonance imaging (MRI) without spinal cord compression, a history of pain for 3 or more months, and were followed for 16 months. The study was conducted in Sweden.

The mean age of participants was 47 years and 46 percent were female; race or ethnicity were not reported. The worst affected level was C5-C6 (49%) followed by C6-C7 (37%). Prior treatments included physiotherapy (85%; physiotherapy uses a hands on approach to healing, e.g., massage, fascial releases, whereas physical therapy uses hands-on methods but also incorporates physical exercises and use of a cervical collar (42%). Mean duration of pain was 34 months (range 5 to 120 months).

Surgery consisted of ACDF using the Cloward technique and fusion achieved with purified cow bone graft; one patient received a posterior laminectomy. Surgical patients sometimes wore a collar for 1 to 2 days postoperatively. Physiotherapy included traction (70%), strengthening exercises (56%), stretching exercises (56%), massage (33%), heat (33%), and transcutaneous electrical stimulation (22%), among other modalities. Patients treated with cervical collars used a rigid collar during the day and an optional soft collar at night for 3 months.

The trial was rated moderate risk of bias due to lack of blinding and overlap in treatments after 16 weeks (Appendix D). The strength of evidence for pain, neurologic function and general function was rated insufficient due to limited evidence from one small trial (Appendix G).

3.4.3 Detailed Analysis

3.4.3.1 Fusion

No studies reported fusion outcomes.

3.4.3.2 Pain

There was inadequate evidence from one small RCT on the comparative effectiveness of ACDF, physiotherapy and treatment with a cervical collar on pain in patients with cervico-brachila pain without spinal cord compression (SOE: Insufficient).

There were no differences between treatments in current pain or worst pain using the visual analogue scale (VAS) (0-100) at baseline.[25] At 14 to 16 weeks followup patients treated with surgery experienced less “current” pain that patients treated with a collar (N=54, 0-100 VAS: 27 vs. 48, $p<0.01$), but there was no difference between surgery, physiotherapy, and use of a collar

in "current" pain at 16 months (N=81, VAS: 30 vs. 39 vs. 35, p>0.05). Results were similar regarding "worst" pain with surgical patients experiencing less "worst" pain than collar patients at 14-16 weeks (N=54, VAS: 43 vs. 64, p<0.001) but no differences in "worst" pain between treatments at 16 months (N=81, VAS: 42 vs. 53 vs. 52, p>0.05, respectively).

3.4.3.3 Function

3.4.3.3.1 Neurological Function

There was inadequate evidence from one small RCT on the comparative effectiveness of ACDF, physiotherapy and treatment with a cervical collar on neurologic function in patients with cervico-brachila pain without spinal cord compression (SOE: Insufficient).

Specific muscle strength before and after treatment was also assessed.[26] Patients in the surgery group experienced greater improvements in muscle strength (strength expressed as the ratio of the affected to the unaffected side) at 14 to 16 weeks in pinch grip, elbow extension and shoulder internal rotation compared with patients treated with physiotherapy and greater improvements in wrist flexion and elbow flexion compared to those treated with a cervical collar (data not provided). At 16 months, patients treated with surgery experienced greater improvements in wrist extension, elbow extension, shoulder abduction, and shoulder internal rotation compared with patients treated with physiotherapy. There were no differences in strength improvement between surgery and collar treatment or between physiotherapy and collar treatment at 16 months (data not provided).

At 14 to 16 weeks posttreatment, there was no difference in the likelihood of improvement in paresthesias with surgery compared with physiotherapy or collar treatment (N=81, 52% vs. 45% vs. 37%, p>0.05) but a large increase in the likelihood of improvement in sensory loss with surgery compared with either treatment (41% vs. 15%, RR 2.75, 95% CI 1.0 to 7.5, both comparisons with surgery).[26] At 16 months, there remained no difference between treatment in the likelihood of improvement in paresthesias between surgery, physiotherapy, and treatment with a collar (N=81, 58% vs. 67% vs. 66%, p>0.05). There was also no difference between treatments in the likelihood of improvement in sensory loss at 16 months (N=81, 27% vs. 14% vs. 15%, p>0.05).

3.4.3.3.2 General Function

There was inadequate evidence from one small RCT on the comparative effectiveness of ACDF, physiotherapy and treatment with a cervical collar on general function in patients with cervico-brachila pain without spinal cord compression (SOE: Insufficient).

The ability to complete basic activities of daily life (e.g., dressing, prolonged sitting) to more rigorous physical activity (e.g., running, heavy work) was assessed using the disability rating index (DRI).[25] Overall mean score on the DRI ranges from 0 to 100, with ability on each of 12 activities rated using a 0-100 VAS scale indicating "without difficulty" to "not at all." There was no difference between treatment with surgery versus physiotherapy at 14-16 weeks on improvement in disability, however treatment with surgery resulted in improved dressing and heavy work compared with treatment with a collar, while treatment with physiotherapy was associated with greater ability to walk, sit for a long time, and complete heavy work compared with collar treatment (p<0.05, data not provided). At 16 months the ability to do heavy work was greater with surgery compared to the other treatments (p<0.05, data not provided). No other differences on the DRI were noted.

Although findings from this small study tended to favor surgery, especially in the short term, these findings should be interpreted with caution due to patients receiving additional treatments beyond the randomized treatment and the heterogeneity of treatment (especially physiotherapy). After 16 weeks, 8/27 surgery patients (30%) underwent a second surgery. Additionally, one patient treated with physiotherapy (4%) and five treated with collar (19%) underwent surgery. Forty-one percent of surgery patients (11/27) received physiotherapy as did 44% (12/27) of patients treated with a collar. Additionally, the use of specific physiotherapy modalities (e.g., traction, exercises, cryotherapy) varied and was at the discretion of the local physiotherapist.

3.4.3.4 Quality of Life

This study did not report quality of life outcomes.

3.4.3.5 Harms

This study did not report harms or adverse events.

3.5 Key Question 4:. In patients with cervical degenerative disease, what are the comparative effectiveness and harms of therapies added on to surgery (pre- or post-operative) compared with the same surgery alone?

3.5.1 Key Findings

- Laminoplasty
  - There was low strength evidence of no difference in pain and function between use of a post-operative collar plus laminoplasty versus laminoplasty alone (SOE: Low).
  - There was inadequate evidence to determine the effects on pain with laminoplasty plus exercise versus laminoplasty alone (SOE: Insufficient).
- ACDF
  - There was low-strength evidence that use of post-operative pulsed electro-magnetic field (PEMF) stimulation after ACDF was associated with increased fusion versus treatment with ACDF alone (SOE: Low); pain and function were similar with or without PEMF after ACDF (SOE: Low).
  - There was inadequate evidence to determine the effects on fusion, pain, and function of ACDF plus post-operative collar compared with ACDF alone (SOE: Insufficient).

3.5.2 Description of Included Studies

Five RCTs (N=546)[27-31] compared surgery plus post-operative therapy to surgery alone (Appendix C). The average mean followup duration was 12 months (range 1 week to 2 years). Two trials were conducted in Japan,[30,31] and one trial each in the United States,[29] Sweden,[27] and China.[28]

The average study mean age of participants was 59 years (range 47 to 73 years); the average proportion of females in studies was 38 percent (range 29% to 47%). Two trials reported race, one enrolling a majority of White participants (93%)[29] and the other enrolling Chinese participants.[28] Studies enrolled patients with clinical and/or radiological evidence of cervical myelopathy[28,30,31] or radiculopathy.[27,29] Patients had 1-2 level disease in 1 trial (N=33),[27] 1-4 levels (60% had 2 levels) in 1 trial (N=323),[29] and a mean of 4.5 levels in 1 trial (N=90).[30] Two trials did not report number of disease levels.[28,31]

One trial was rated low risk of bias,[28,29] and the remainder were rated moderate risk of bias (Appendix D). Methodological limitations included unclear blinding of providers or assessors and high loss to followup. Evidence for pain and function with laminoplasty plus exercise versus laminoplasty alone and evidence for fusion, pain and function for ACDF plus post-operative collar versus ACDF alone were rated insufficient due to limited evidence from one small trial each (Appendix G).

3.5.3 Detailed Analysis

3.5.3.1 Laminoplasty Plus Nonoperative Therapy Versus Laminoplasty

Three RCTs (N=190) assessed laminoplasty plus post-operative Philadelphia collars[28,30] or exercise therapy incorporating 3 months of daily strengthening and range of motion exercises.[31]

3.5.3.1.1 Fusion

No study reported fusion outcomes.

3.5.3.1.2 Pain

There was no difference in pain between the use of a post-operative collar plus laminoplasty versus laminoplasty alone (SOE: Low). There was inadequate evidence to determine the effects on pain with laminoplasty plus exercise versus laminoplasty alone (SOE: Insufficient).

Single-door laminoplasty plus rigid Philadelphia collar worn for 3 weeks post-operatively was associated with less improvement in mean VAS scores (0-10 scale) than laminoplasty alone at weeks 1 (0.8 vs. 3.8, p=0.023) and 2 (-0.9 vs. 1.8, p=0.046) in one trial rated low risk of bias (N=35), with no difference at other timepoints (3 weeks: -1.2 vs. 1.1, p=0.148) or at other followup times (6 weeks and 3, 6, and 12 months).[28] One trial (N=90) compared modified double-door laminoplasty plus Philadelphia collar worn for 2 weeks post-operatively and found no differences in change in VAS (0-10 scale) at 12 months (-0.19 vs. -0.04, p>0.05) or throughout the study period (p=0.487).[30]

One RCT (N=65) found no difference in mean VAS scores (0-100 scale) for neck pain and stiffness at 2 weeks and 3 months postoperative between muscle-preserving laminoplasty with exercises versus laminoplasty alone (3 months: -1.8 vs. -2.5, p=0.623).[31]

3.5.3.1.3 Function

3.5.3.1.3.1 Neurologic Function

There was no difference in neurologic function between the use of a post-operative collar plus laminoplasty versus laminoplasty alone (SOE: Low).

One trial of open-door laminoplasty (N=35) found no difference on mJOA scores between 3 weeks of post-operative collar versus no collar at 6 weeks (mJOA: 13.8 vs. 13.3, p=0.613)[28] or longer followup. This was consistent with 12-month results from the second collar trial (N=90) which reported no difference in end-of-study mJOA scores between 2 weeks of post-operative collar use and no collar (11.1 vs. 11.8, p=0.22).[30]

3.5.3.1.3.2 General Function

There was no difference in general function between the use of a post-operative collar plus laminoplasty versus laminoplasty alone (SOE: Low). Two trials (N=125) of laminoplasty with or without the addition of a postoperative Philadelphia collar for 2 or 3 weeks were consistent in finding no difference in 36-Item Short Form Health Survey (SF-36) PCS and MCS scores with collar use compared to no collar. One RCT (N=35) of single-door laminoplasty found no differences in SF-36 scores between the use of a post-operative collar for 3 weeks versus no collar at 6 weeks after surgery when controlling for baseline scores (PCS: 6.4 vs. 2.8; MCS: 4.1 vs. 0, p>0.05) or at longer followup times (3, 6, 12, 24 months).[28] One RCT (N=90) of double-door laminoplasty plus 2 weeks of postoperative collar use versus no collar also found no difference at 12 months in change in SF-36 PCS or MCS scores (PCS: 1.5 vs. 1.4, p>0.05; MCS: 0.1 vs. 0.4, p>0.05).[30] The trial of open-door laminoplasty also found no difference on Neck Disability Index (NDI) between 3 weeks of post-operative collar and no collar at 6 weeks (NDI: 24.8 vs. 34.0, p=0.147) or at longer followup.[28]

3.5.3.1.4 Quality of Life

No study reported quality of life outcomes.

3.5.3.2 ACDF Plus Nonoperative Therapy Versus ACDF

One trial (N=33) assessed ACDF versus ACDF plus rigid Philadelphia collar worn for 6 weeks postoperative[27] and one trial (N=323) compared ACDF with ACDF plus PEMF, delivered using a Cervical-Stim device for 4 hours daily from 1 week to 3 months postoperatively in a trial of active smokers (all patients wore a cervical collar for 1 week postoperatively).[29]

3.5.3.2.1 Fusion

There was inadequate evidence to determine the effects on fusion between ACDF with or without collar use (SOE: Insufficient). Use of post-operative PEMF stimulation after ACDF was associated with increased fusion versus treatment with ACDF alone (SOE: Low).

All ACDF patients in one 24-month trial (N=33) achieved radiographic fusion regardless of collar use (100% vs. 100%).[27] Surgical details were not provided.

PEMF was associated with small increase in fusion rates at 6 months in one trial (N=323) based on a per protocol analysis versus ACDF with no PEMF (N=240; 83.6% vs. 68.6%, p=0.0065); fusion rates were also improved in intent-to-treat analyses assuming missing patients fused (N=323; 85.9% vs. 76.3%, p=0.0269) or imputing patient status at last visit (N=281; 78.2% vs. 64.8%, p=0.0127), but not when assuming missing patients did not fuse (65.6% vs. 56.3%, p=0.0835).[29] However, there was no difference in fusion rates in the per protocol analysis at 12 months.[29] This study used a Smith-Robinson technique with allograft and cervical plate system.

3.5.3.2.2 Pain

The ACDF trial of PEMF versus no PEMF found similar VAS scores for shoulder/arm pain at rest or with activity at 6 and 12 months postoperative (date provided in graph form)[29] (SOE: Low).

3.5.3.2.3 Function

3.5.3.2.3.1 General Function

There was inadequate evidence to determine the effect on general function of ACDF plus post-operative collar compared with ACDF alone for all time points (SOE: Insufficient).

Collar use was associated with greater improvement in SF-36 PCS scores from baseline than ACDF without a collar at 6 weeks (mean difference [MD] 5.8; 95% CI 0.8 to 10.7), 3 months (MD 6.8; 95% CI 0.4 to 13.1), 6 months (MD 7.4; 95% CI 1.4 to 13.4), and 12 months (MD 7.5; 95% 0.3 to 14.6), but not at 24 months (MD 4.9; 95% CI -0.8 to 10.5; p=0.088).[27] In the same trial, there was no difference in mean change in SF-36 MCS scores at 6 weeks (MD -1.9; 95% CI -11.1 to 7.4) or at longer postoperative followup times.[27]

Six-weeks' collar use was associated with greater improvement in NDI scores from baseline than no collar at 6 weeks (MD -4.4; 95% CI -8.6 to -0.2), but not at 3 months (MD -2.1, 95% CI -8.0 to 3.8) or at other timepoints.[27] There was no difference in NDI scores between daily PEMF and no stimulation at 6 months (31.0 vs. 23.0, p>0.05) or 12 months postoperative (25.6 vs. 22.8, p>0.05).[29]

3.5.3.2.4 Quality of Life

No study reported quality of life outcomes.

3.6 Key Question 5: In patients with cervical radiculopathy due to cervical degenerative disease, what are the comparative effectiveness and harms of posterior versus anterior surgery?

3.6.1 Key Findings

- There was low-strength evidence of no differences in neck and arm pain between anterior versus posterior approaches short term (3, 6 months) and intermediate term (12, 24 months) (SOE: Low).
- There was inadequate evidence to determine benefits of anterior versus posterior approaches for neck pain (immediately postoperative), fusion, or neurologic function (SOE: Insufficient).
- There was low-strength evidence of no difference between approaches on measures of general function or quality of life (SOE: Low).
- There was low-strength evidence of no difference between approaches in the likelihood of reoperation (SOE: Low).
- Neurologic deficits were reported inconsistently and various measures were used across studies, however there was low-strength evidence of no differences between approaches were reported (SOE: Low).
- One nonrandomized study reported higher 30-day mortality with ACDF versus posterior cervical foraminotomy (PCF), but there were very few deaths (SOE: Insufficient).
- No serious adverse events with either approach were reported in three RCTs; evidence on specific adverse events was limited; one RCT reported no difference in approaches for surgery-related adverse events (SOE: Insufficient).

3.6.2 Description of Included Studies

Four RCTs (N=277)[32-35] compared anterior versus posterior approaches (Appendix C). The average mean followup duration was 27 months (range 12 to 60 months). One trial was conducted in the United States,[34] one in Germany,[33] one in Egypt,[32] and one in the Netherlands.[35] All four trials were conducted at single sites. The average study mean age of participants for the trials was 45 years (range 43 to 51 years); the average proportion of females in trials was 55 percent (range 50% to 66%). No trials reported race. All four trials limited enrollment to patients with radiculopathy; two trials excluded patients with myelopathy,[32,34] and the other two did not report myelopathy.[33,35] Patients in all four trials had single-level disease. Two trials were rated moderate risk of bias[34,35] and two trials were rated high risk of bias (Appendix D).[32,33] One trial stated that no funding was received,[33] one trial reported government funding,[35] and two trials did not address funding.[32,34] Primary methodologic concerns were unclear randomization and treatment allocation concealment, dissimilarity between treatment groups at baseline and lack of assessor blinding.

Four retrospective NRSIs (N=47,684), including one database study, compared anterior versus posterior procedures (Appendix C).[36-39] Three NRSIs were conducted in the United States[36,37,39] and one in the United Kingdom[38] Three studies[36-38] drew patients from a single site and one[39] used an insurance administrative database (N=46,598). The average study mean age of participants was 50 years (range 48 to 53 years); the average proportion of females in studies was 44 percent (range 31% to 54%). One study reported race, enrolling a majority of White

participants (88%).[37] All four NRSIs limited enrollment to patients with radiculopathy. Patients had single-level disease in three NRSIs.[36,38,39] A mean of 2.6 surgical levels was reported in one study.[37] Funding was not reported in two NRSIs,[36,38] one was government funded[39] and one stated that no funding was received.[37] Three NRSIs were rated moderate risk of bias[37-39] and one was rated high risk of bias (Appendix D).[36] Common methodologic limitations were unclear loss to followup and lack of clarity regarding assessor blinding. Additionally, lack of clarity regarding patient enrollment and comparability of treatment groups at baseline combined with inadequate adjustment for confounding for prognostic variables were concerns resulting in the NRSI being rated high risk of bias.

For many outcomes, authors did not provide adequate data to calculate effect sizes and confidence intervals. Although NRSI may have adjusted for some outcomes, authors did not always provide adjusted estimates for our outcomes of interest. Given the potential for differences in patient characteristics between anterior and posterior procedures in NRSIs, results from these studies should be interpreted cautiously.

Evidence was insufficient for fusion, neurologic function, general function, quality of life, mortality and serious adverse events, based on a combination of two or more of the following: high risk of bias, inconsistent findings, and lack of precision (Appendix G).

3.6.3 Detailed Analysis

3.6.3.1 Anterior Versus Posterior

The anterior approach used was anterior cervical foraminotomy (ACF) in one RCT,[32] anterior cervical decompression without fusion (ACD) in one RCT,[34] and anterior cervical decompression and fusion (ACDF) in three RCTs[33-35] and all four NRSIs.[36-39] All studies used posterior cervical foraminotomy as the comparator.

3.6.3.1.1 Fusion

There was inadequate evidence to determine benefits and harms of anterior versus posterior surgical approaches on cervical fusion (SOE: Insufficient).

One RCT (N= 30) rated high risk of bias reported that no participants in either the ACF group or the posterior cervical foraminotomy group had radiologic evidence of instability on cervical x-rays at time of discharge or at a mean of 14 months.[32] Authors did not define stability or criteria for determining fusion.

3.6.3.1.2 Pain

There were no differences in neck and arm pain between anterior versus posterior approaches in the short (3, 6 months) and intermediate term (12, 24 months) (SOE: Low); there was inadequate evidence to determine the benefits and harms of anterior versus posterior approaches on neck pain immediately post-operative (SOE: Insufficient).

At 12 months the proportion of ACDF vs. PCF patients experiencing a 26-point improvement (0-100 scale) in VAS neck pain (62% vs. 52%) or 41-point improvement in VAS neck pain (60% vs. 54%) was reported as comparable in one RCT (N=243);[35] an RR could not be calculated.

One small trial (N=30) rated high risk of bias reported that ACF was associated with lower neck pain VAS scores (0-10 scale) within a week of discharge ($p<0.001$), however the reported confidence interval for the difference between groups suggested no difference (MD -3.13, 95% CI -4.52 to 1.75) and is likely a typographical error and should be (MD -3.13, 95% CI -4.52

to -1.75).[32] One RCT (N=175) also rated high risk of bias, compared ACDF versus PCF at 3, 6, 12, and 24 months for arm pain VAS (0-100 scale), neck pain VAS (0-100 scale) and North American Spine Society (NASS) pain (0-6 scale).[33] The mean differences across measures did not change with time and there were no differences between ACDF and PCF in arm pain VAS (range from -1 to 1), neck pain VAS scores (range from 1 to 4) or NASS pain scores (range from -0.1 to 0.1) at any timepoint. Statistical tests were not reported and reported data were inadequate to calculate confidence intervals for effect sizes, but the authors noted that the clinical results were the same in both groups. The largest RCT (n=243, moderate quality) found no difference in VAS neck pain scores at 12 months (MD -2.70, 95% CI -9.67 to 4.27) or VAS arm pain (MD – 2.80, 95% CI, -8.85 to 3.25).[35] Pooled estimates across the RCTs also reveal no difference in VAS arm pain at 12 months between ACDF and PCF (2 RCTs, N=403, MD -1.36, 95% CI -5.23 to 1.86, I^2= 0%; Appendix F Figure F-1).[33,35] Across the same two RCTs, there was again no difference between ACDF and PCF in VAS neck pain (MD 0.31, 95% CI -6.20 to 5.81, I^2=10.6%; Appendix F Figure F-2).[33,35]

The fourth RCT (N=72) rated moderate risk of bias, reported similar rates of patient-reported complete or partial pain improvement (unvalidated measure) for anterior approaches (ACD and ACDF) versus PCF at day 1 postoperatively (100% vs. 100%, RR 1.00), at 2 months (98% vs. 100%, RR 0.98, 95% CI 0.94 to 1.02, p=0.32), and at approximately 60 months postoperatively (96.5% vs. 100%, RR 0.96, 95% CI 0.90 to 1.03, p=0.32).[34]

Findings for pain from two NRSIs were consistent with those of the RCTs. The larger study (N=688) found no difference in mean scores for VAS arm pain (0-10 scale) at 3 months (4.20 vs. 3.82, MD 0.38, p>0.05), 12 months (4.06 vs. 4.07, MD 0.01, p>0.05) or 24 months (3.85 vs. 4.48, MD -0.63, p>0.05).[38] In the smaller NRSI (N=70) rated high risk of bias, there were no differences between ACDF versus PCF in VAS score (0-10 scale, not specified for arm or neck pain, 2.6 vs. 3.0, MD -0.4, p =0.04) at 12 months.[36] Reported estimates appear to be unadjusted.

3.6.3.1.3 Function

3.6.3.1.3.1 Neurologic Function

There was inadequate evidence to determine benefits and harms of anterior versus posterior approaches on neurologic function for all time points (SOE: Insufficient).

One RCT (N=175) rated high risk of bias[33] reported similar mean NASS neurology scores (0-6 scale) for ACDF and PCF and that no patient had deterioration of symptoms. Means were consistent at 3, 6, 12, and 24 months (range MD -0.2 to 0.2). Statistical tests were not reported and data were inadequate to calculate confidence intervals, but the authors noted that the clinical results were the same in both groups.

3.6.3.1.3.2 General Function

There was no difference in general function between anterior and posterior procedures based on NDI or Odom's criteria at 12 months in RCTs. (SOE: Low)

One moderate-quality RCT (N=243) reported that ACDF and PCF the proportion of reponders was comparable based on NDI (defined as ≥17.3% improvement, 0-100 scale; 63% vs. 66%; data were insufficient to calculate RR).[35] There was also no difference in mean change scores on NDI at 12 months (MD -1.2 , 95% CI -5.8 to 3.5).

There was no difference in function between ACF and PCF at 12 months across two RCTs (N=273)[32,35] based on Odom's criteria rating of excellent or good (2 RCTS, N= 273, 68.3% vs. 74.6%, RR 0.95, 95% CI 0.81 to 1.12, I^2= 0%) (Appendix F Figure F-3). In the larger trial

analysis with complete cases (N=204) at 1 year suggested that slightly fewer ACDF patients had excellent or good function, but the effect size is below the threshold for a small effect (76% vs. 88%, RR 0.87, 95% CI 0.76 to 0.99).[35]

One NRSI (N=688), reported no difference between ACD and ACDF on the Core Outcome Measures Index-neck (COMI-neck, 0-10 scale), which has items for pain, function, symptom-specific well-being, quality of life and disability.[38] Mean changes in COMI-neck scores (0-10 scale) were similar at 3 months (-2.38 vs. -2.31, p=0.88) and 6 months (-2.94 vs. -2.67, p=0.55); at 24 months the mean COMI-neck scores were also similar (4.16 vs. 4.72, p>0.05; mean change not reported). The proportion of patients who achieved minimum clinically important difference on the COMI-neck score (decrease ≥2 points) was also similar at 3 months (50% vs. 56%, RR 0.89, 95% CI 0.65 to 1.24), 12 months (59% vs. 58%, RR 1.02, 95% CI 0.76 to 1.36), and 24 months (57% vs. 50%, RR 1.14, 95% CI 0.71 to 1.83). One NRSI (N=70) rated high risk of bias found no difference between ACDF versus PCF in Pain Disability Questionnaire functional status subscale scores (0 to 90 scale, 31.3 vs. 43.2, MD -11.9, p=0.30) or Pain Disability Questionnaire total score (52.8 vs. 69.6, p=0.50).[36] One RCT (N=175) rated high risk of bias reported Hilibrand criteria ratings (Poor, Satisfactory, Good, Excellent, measure not validated) for ACDF versus PCF at 3, 6, 12 and 24 months.[33] Data were not available to calculate effect sizes, but the authors noted that the clinical results were the same in both groups at all timepoints: Excellent (84% vs. 83% at 3 months, and 76% vs. 79% at 24 months).

3.6.3.1.4 Quality of Life

There was no difference in EuroQOL-5 Dimensions (EQ-5D, scale 0-1) at 12 months between ACDF and PCF in one RCT (SOE: Low).[35]

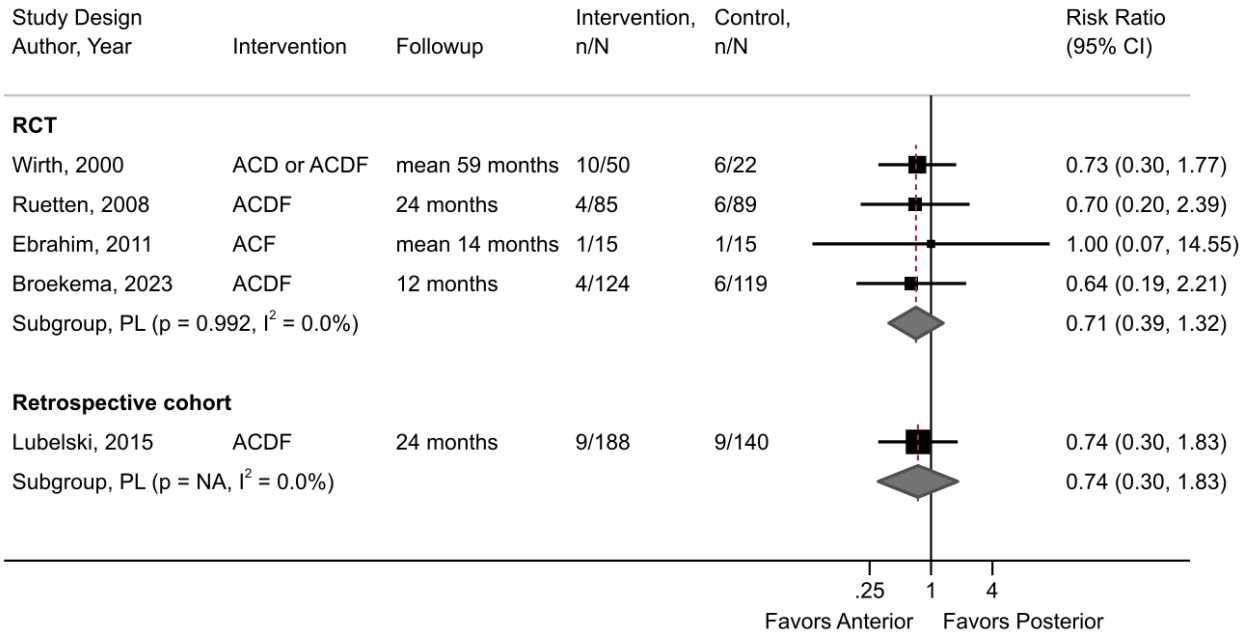
The RCT (N=243) found no difference on EQ-5D between ACDF and PCF in either the proportion of patient meeting a clinically important difference of 0.24 improvement (38% vs. 38%) or in change scores at 12 months (MD -0.01, 95% CI -0.06 to 0.10).[35] Similarly, one NRSI (N=70) rated high risk of bias found no difference in EuroQOL-5 Dimensions (EQ-5D, scale 0-1) at 12 months for ACDF (MD 0.69, 95% CI 0.61 to 0.77) versus PCF (MD 0.72, 95% CI 0.64 to 0.80, p=0.60).[36]

3.6.3.1.5 Reoperation

There was no difference in the likelihood of reoperation between anterior and posterior procedures across four RCTs[32-35] (2 of which were rated high risk of bias) or in one retrospective NRSI (N=328)[37] (Figure 3) (SOE: Low). Exclusion of the high risk of bias RCTs did not substantially change the estimate (2 RCTs, RR 0.70, 95% CI 0.30 to 1.61, I^2= 0%).[34,35]

3.6 Results, Key Question 5

Figure 3. Reoperation: anterior versus posterior cervical foraminotomy



ACF = anterior cervical foraminotomy, ACD = anterior cervical decompression without fusion; ACDF = anterior cervical discectomy and fusion; CI = confidence interval; PL = profile likelihood.

3.6.3.1.6 Harms

There were no differences in neurologic deficits between anterior and posterior approaches, although results were reported inconsistently (SOE: Low); reporting of other adverse events was limited (SOE: Insufficient).

Description and reporting of serious adverse events was limited. One RCT (N=243) reported similar rates of surgery-related adverse events for ACDF and PCF 6% in both groups).[35] Serious (not specified as surgery related) included: post-operative events (anaphylactic reaction to antibiotics, n=1, wound hematoma not requiring surgery, n=1, pulmonary embolism, n=1) and events requiring hospitalization (wound problems 0.8% vs. 1.7%, cardio-thoracic problems 0.08% vs. 2.5%). Slight cage subsidence was reported in one ACDF patient but there were no complaints and no reoperation was required.

Three RCTS (2 of which were rated high risk of bias) reported that no serious adverse events occurred for any patients.[32-34] One RCT (N=72) that compared ACD and ACDF to PCF reported zero deaths.[34] One propensity score matched NRSI (N=46,598) reported higher 30-day mortality with ACDF versus PCF (MD 1 event per 10,000 cases, 95% CI 0.0 to 2.0 per 10,000 cases, p=0.012).[39] Although the MD is significant, it is small, suggesting the possibility of 0 to 2 deaths with PCF. Given that administrative data are subject to misclassification and potential for inadequate adjustment for confounders, this finding should be interpreted cautiously.

Neurologic deficits were reported inconsistently across studies. In one RCT (N=243) there was no difference in new radicular symptoms between ACDF and PCF recipients (3.2% vs. 0.8%, RR 3.84, 95% CI 0.43 to 33.85) as were persistent radicular symptoms (1.6% vs. 6.7%, RR 0.24, 95% CI 0.05 to 1.11); estimates are imprecise.[35] One RCT (N=72) found no difference in anterior versus posterior approaches for new weakness (8% vs. 14%, RR 0.59, 95% CI 0.14 to 2.40, p=0.46) or new numbness (6% vs. 9%, RR 0.66, 95% CI 0.12 to 3.68, p=0.63).[34] The other two RCTs reported specific neurologic deficits: in one small trial (N=30) no patients in either

group developed Horner's syndrome;[32] the other trial (N=175) reported that no patients experienced damage to myelin resulting in paralysis of any degree.[33] One NRSI (N=70) reported that one patient who underwent PCF experienced C6 nerve injury, but did not provide data for patients who underwent ACDF.[36] Central nervous system complications at 30 days postoperatively was similar between anterior and posterior procedures in a large NRSI (N=46,598, MD 4 per 10,000, 95% CI -14 to 22 per 10,000).[39]

Dysphagia was reported inconsistently across studies. One RCT (N=243), reported one case of unresolved dysphagia at 12 months in the ACDF group.[35] One RCT (N=175) reported transient difficulty swallowing for three patients who underwent ACDF and no patients who underwent PCF.[33] In a propensity score matched NRSI (N=46,598), ACDF was associated with higher rates of dysphagia/dysphonia at 30 days versus PCF (MD 14.5 per 1,000 cases, 95% CI 12.6 to 16.4 per 1000, $p<0.001$).[39] Neither study provided information on severity of dysphagia or need for intervention.

One large NRSI (N=46,598) reported that the following were rare but more common with ACDF versus PCF within 30 days after surgery: vascular injury (MD 2 per 10,000 cases, 95% CI 1 to 3 per 10,000 cases, p=0.001), cerebrospinal fluid leak (MD 2 per 10,000 cases, 95% CI 1 to 3 per 10,000 patients, p=0.002), and deep venous thrombus (9 per 10,000 cases, 95% CI 2 to 16 per 10,000 patients, p=0.01). There were no differences between anterior and posterior approaches for pulmonary embolism (MD 2 per 10,000, 95% CI -9 to 12 per 10,000 cases).[39]

3.7 Key Question 6: In patients with cervical degenerative disease, what are the comparative effectiveness and harms of posterior versus anterior surgery in patients with greater than or equal to three level disease?

3.7.1 Key Findings

- There was low-strength evidence of no difference in neck pain, neurologic function and general function intermediate term (12 to 15 months) for ACDF versus posterior cervical decompression and fusion (PCDF) or laminoplasty for three or more levels (SOE: Low).
- The evidence for fusion, neck pain (short term), arm pain, neurologic function (short term) and quality of life was inadequate to draw conclusions (SOE: Insufficient).
- There was inadequate evidence to draw conclusions on reoperation rates between ACDF and posterior procedures (SOE: Insufficient).
- There was low-strength evidence that mortality and severe dysphagia did not differ between ACDF and laminoplasty or PCDF (SOE: Low).
- Rates of new neurologic complications and serious adverse events were inconsistently reported across studies and rare in general; there was low-strength evidence that posterior approaches were more commonly associated with a moderate to large increase in the odds of experiencing a neurologic adverse event and serious adverse event compared with ACDF (SOE: Low).

3.7.2 Description of Included Studies

One RCT[40] and nine NRSIs[41-49] compared anterior (i.e., ACDF) versus posterior surgery (i.e., laminoplasty, PCDF) at three or more levels for treatment of CDD **(**Appendixes C-D**)**.

The RCT (N=34)[40] compared ACDF with posterior laminoplasty for participants with cervical spondylotic myelopathy (CSM) (71%) or ossification of the posterior longitudinal ligament (OPLL) (29%) involving three (71%) or four (29%) levels. Fewer participants randomized to ACDF were diagnosed with OPLL (24% vs. 35%), had four-level disease (18% vs. 41%) or were smokers (12% vs. 41%). Mean participant age was 62 years and 26 percent were female.[40] Race/ethnicity was not reported. Average followup time was 41 months. This trial was conducted in China and was rated high risk of bias.

Across the nine NRSIs, one prospective[44] and eight retrospective,[41-43,45-49] sample sizes ranged from 245 to 13,884 (total N=41,982). The average study patient age was 61 years (range 54 to 63 years) and 43 percent were female (range 31% to 52%). Three studies reported race/ethnicity (White: range 65.5% to 82.3%; Black: 12.3% to 17.0%; Hispanic: 0.5%; Other: 17.7% to 19.1%).[41,47,48] The anterior approach was ACDF (with or without corpectomy) in all nine studies[41-49] and also included anterior cervical corpectomy and fusion in one study.[43] The posterior approach was PCDF in six studies,[41,42,44-46,48] laminectomy and fusion in two studies[43,47] and laminoplasty in two studies.[47,49] Two studies included three treatment groups; one with two anterior arms[43] and one with two posterior arms.[47] The number of involved levels varied across the studies but most included three to five levels; one study included only three levels[48] and another only four levels.[45] One NRSI was rated low risk of bias[46] and the remainder were rated moderate risk of bias.[41-45,47-49] Given the potential for confounding by indication and differences in patient population between those receiving posterior versus anterior procedure, particularly in the NRSI, results should be interpreted cautiously.

Evidence was insufficient for fusion, pain (short and long term), neurologic function (short term), quality of life, and reoperation based on a combination of two or more of the following: high risk of bias, inconsistent findings, and lack of precision (Appendix G).

3.7.3 Detailed Analysis

3.7.3.1 Fusion

There was inadequate evidence to determine the benefits and harms of anterior versus posterior surgical approaches on fusion in participants with three or more level disease (SOE: Insufficient).

One retrospective NRSI that used propensity score matching (N=12,248) found that PCDF was associated with substantially higher odds of pseudarthrosis at 12 months compared with ACDF (odds ratio [OR] 2.43, 95% CI 1.96 to 3.01) at three levels.[48] The RCT did not report fusion.

3.7.3.2 Pain

There was low-strength evidence of no difference in neck pain in the intermediate term (SOE: Low); there was inadequate evidence for neck pain in the short term and arm pain in the intermediate term in participants with three or more level disease (SOE: Insufficient).

One RCT (N=32) rated high risk of bias reported no differences between 3- or 4-level ACDF and laminoplasty in neck pain scores (VAS, 0-10 scale) at 3 months (MD -0.10, 95% CI -0.46 to 0.26) and 6 months (MD 0, 95% CI -0.18 to 0.18) or at 12 months (MD 0.10, 95% CI -0.23 to 0.43) and 15 months (MD -0.10, 95% CI -0.44 to 0.24).[40] Similarly, there were no differences between ACDF (with and without corpectomy) and PCDF at three to five levels for NRS (0-10) neck pain scores (median 2 vs. 2, adjusted OR 0.67, 95% CI 0.37 to 1.21) or arm pain scores (median 1 vs. 0.5, adjusted OR 0.99, 95% CI 0.51 to 1.93) at 12 months in one retrospective NRSI (N=245).[41]

3.7.3.3 Function

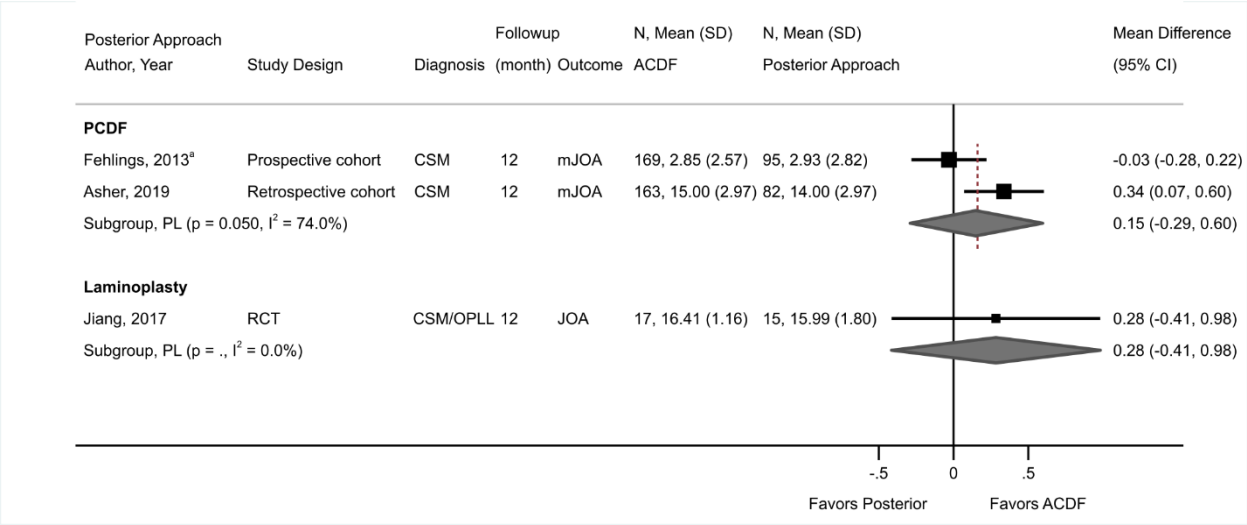
3.7.3.3.1 Neurologic Function

There was low-strength evidence of no difference in neurologic function between anterior and posterior approaches in participants with three or more level disease in the intermediate term (SOE: Low); there was inadequate evidence for determining the benefits and harms on neurologic function in the short term (SOE: Insufficient).

There was no difference in neurologic function at intermediate term (12 months) in one small RCT rated high risk of bias (N=32, MD 0.28, 95% CI -0.41 to 0.98, Japanese Orthopaedic Association Scale [JOA] scores, 0-18 scale)[40] and two NRSIs rated moderate risk of bias (N=506, MD 0.15, 95% CI -0.29 to 0.60, I^2=74.0%, mJOA scores, 0-18 scale)[40,41,44] that compared ACDF with posterior laminoplasty (RCT) or PCDF (NRSIs) for 3- to 5-level disease (Figure 4) (SOE: Low). There was also no difference between groups in JOA scores short term in the RCT (N=32): 3 months (MD -0.40, 95% CI -1.76 to 0.96) and 6 months (MD 0.20, 95% CI -1.14 to 1.54).[40] The pooled estimate across the two NRSIs had substantial heterogeneity (Figure 4), which may be due in part to different study designs, variables controlled for in multivariate analyses, and types of posterior procedures used. The prospective NRSI[44] showed no difference between groups and included patients who underwent laminoplasty (14%) (all

others had PCDF); it was unclear which baseline confounders were controlled for in this study. The retrospective NRSI[41] showed a large improvement with ACDF versus PCDF approaches; multivariate logistic regression models controlled for 19 different baseline variables.

Figure 4. Neurologic function (JOA or mJOA scores): anterior versus posterior approaches for ≥3 levels



ACDF = anterior cervical discectomy and fusion; CI = confidence interval; CSM = cervical spondylotic myelopathy; JOA = Japanese Orthopaedic Association; mJOA = modified Japanese Orthopaedic Association; OPLL = ossification of the posterior longitudinal ligament, PCDF = posterior cervical decompression and fusion; PL = profile likelihood; RCT = randomized controlled trial; SD = standard deviation.
[a] Posterior approach included laminoplasty (14% of patients) or laminectomy and fusion (86% of patients)

One prospective NRSI (N=264) assessed neurologic function with the Nurick score (0-5 scale) and found no difference between 3- to 5-level ACDF and posterior approaches (laminectomy and fusion [86%] or laminoplasty [14%]) in mean change from baseline to 12 months after adjusting for baseline characteristics (MD in change scores 0.19, 95% CI -0.20 to 0.58[44]).

3.7.3.3.2 General Function

There were no differences between anterior and posterior surgery for 3- to 5-level disease at intermediate term (12 months) for any function measure reported across two NRSIs (N=509)[41,44] (SOE: Low). One prospective NRSI (N=264) compared ACDF with laminectomy and fusion (86%) or laminoplasty (14%) and reported the change in NDI scores compared with baseline (MD in change scores -0.97, 95% CI -7.15 to 5.21, scale unclear), SF-36 PCS scores (MD in change scores -1.90, 95% CI -5.30 to 1.50, 0-100 scale) and SF-36 MCS scores (MD in change scores 0.42, 95% CI -2.30 to 3.14, 0-100 scale).[44] One retrospective NRSI (N=245) compared ACDF (with and without corpectomy) with PCDF and reported median NDI scores (16 vs. 17, adjusted OR 0.76, 95% CI 0.42 to 1.37)[41] (SOE: Low).

3.7.3.4 Quality of Life

There was inadequate evidence to determine the benefits and harms of anterior versus posterior approaches on quality of life in participants with three or more level disease (SOE: Insufficient).

3.7 Results, Key Question 6

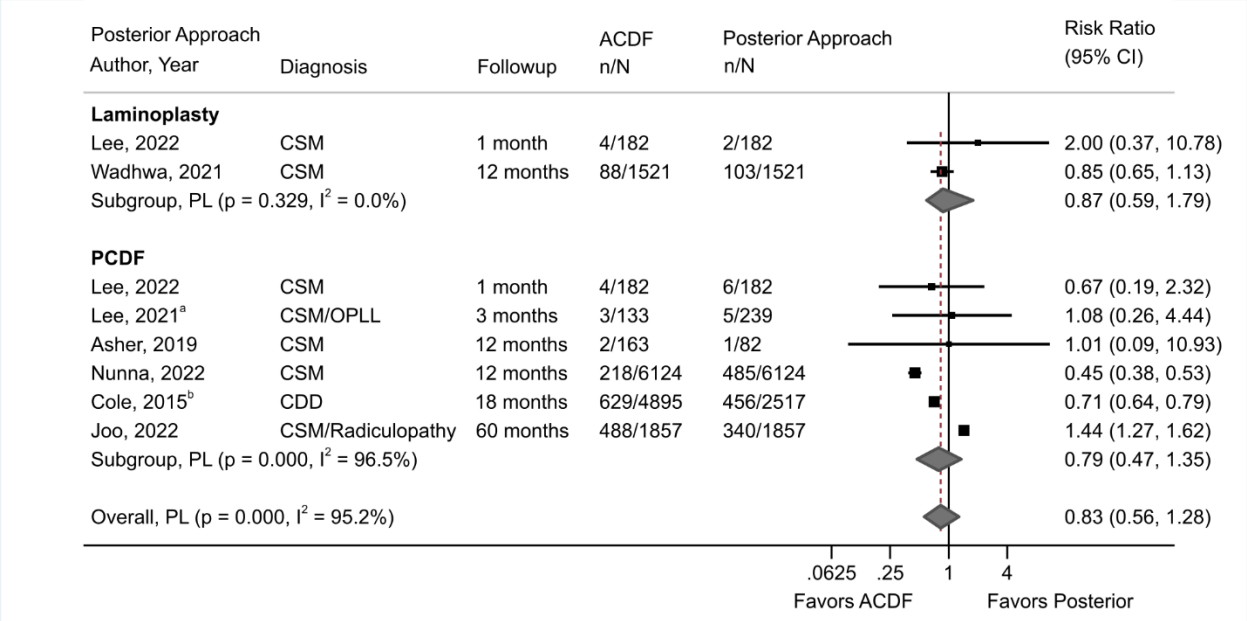
One retrospective cohort study (N=245) found no difference between 3- to 5-level ACDF (with and without corpectomy) and PCDF in EQ-5D scores intermediate term at 12 months (adjusted odds ratio 1.36, 95% CI 0.76 to 2.44, referent = ACDF) after adjusting for a number of baseline variables.[41]

3.7.3.5 Reoperation

There was inadequate evidence to draw conclusion on reoperation rates between ACDF and posterior procedures (SOE: Insufficient).

Seven NRSIs (N=27,579) that compared ACDF with posterior procedures at three or more levels reported reoperation/revision rates.[41,43,45-49] In pooled analysis at any timepoint based on longest followup (range 1 to 60 months), there were no differences between ACDF versus laminoplasty (2 NRSIs, N=3,406, 5.4% vs. 6.2%, RR 0.87, 95% CI 0.59 to 1.79, I^2=0%)[47,49] or PCDF (6 NRSIs, N=24,355, 10.1% vs. 11.8%, RR 0.79, 95% CI 0.47 to 1.35, I^2=96.5%);[41,43,45-48] however, heterogeneity was substantial for the latter comparison (Figure 5). Exclusion of one outlier study[45] at 60 months that included patients with both myelopathy and radiculopathy reduced heterogeneity slightly and resulted in a moderate reduction in the likelihood of reoperation for ACDF compared with PCDF at any timepoint (1-18 months, 5 NRSIs, N=20,641, 7.4% vs. 10.4%, RR 0.59, 95% CI 0.42 to 0.95, I^2=82.4%).[41,43,46-48] These results were driven by two large administrative database studies.[43,48] There was no difference between ACDF and PCDF at 1 to 3 months (2 NRSIs, N=736, RR 0.82, 95% CI 0.32 to 2.08, I^2=0%).[46,47] ACDF was associated with a higher risk of reoperation compared with PCDF (N=3,714, RR 1.44, 95% CI 1.27 to 1.62) in one study at 60 months.[45] It is challenging to draw firm conclusions from this data as definitions of reoperation and revision varied or were not specified across the studies, there were differences in posterior approach used, and the pooled estimates were mainly driven by two large administrative data studies.

Figure 5. Reoperation: anterior versus posterior approaches for ≥3 levels



ACCF = anterior cervical corpectomy and fusion; ACDF = anterior cervical discectomy and fusion; CI = confidence interval; CSM = cervical spondylotic myelopathy; OPLL = ossification of the posterior longitudinal ligament, PCDF = posterior cervical decompression and fusion; PL = profile likelihood.

[a] Study included patients with myelopathy and OPLL

[b] Anterior approach included ACDF or ACCF

One large NRSI (N=12,248) that used administrative data and propensity score matching reported reoperation outcomes that could not be included in the meta-analysis.[48] PCDF was associated with substantially higher odds of wound-specific revision surgery at 1 month (1.2% vs. 0.4%, OR 3.02, 95% CI 2.56 to 3.49) and moderately lower odds of additional anterior or posterior fusion at 12 months (4.3% vs. 7.0%, OR 0.60, 95% CI 0.44 to 0.76) compared with ACDF at three levels.

3.7.3.6 Harms

3.7.3.6.1 Neurologic Deficits

There was low-strength evidence that posterior approaches were more likely associated with a moderate to large increase in the odds of experiencing a neurologic adverse event compared with ACDF (SOE: Low). Reporting of neurological events varied across one RCT (N=32)[40] and six NRSIs (total N=37,095, range 245 to 13,884).[41-44,48,49] The RCT reported no cases of postoperative worsening of myelopathy or C5 root palsy with either 3- or 4-level ACDF versus posterior laminoplasty.[40] Central nervous system complications (not further defined) were rare through 90 days after ACDF (<0.7%) and posterior laminoplasty (0.9%) at three or more levels in one NRSI (N=3,042).[49] Two NRSIs reported that PCDF was associated with moderately higher odds of "neurological complications" compared with ACDF at three or more levels but did not provide further details: 0.59% vs. 0.35% (adjusted OR 1.7, 95% CI 1.0 to 2.8) immediately postoperative in one study (N=13,884)[42] and 1.8% vs. 1.1% (OR 1.6, 95% CI 1.08 to 2.38) at 1 month in another (N=7,412).[43] Two other NRSIs reported no difference between ACDF and PCDF at three to five levels in new neurological deficits (N=264, 4.1% vs. 3.2%, RR 1.31, 95% CI 0.35 to 4.95)[44] or new motor deficits (N=245, 2% vs. 0%)[41] at 12 months. One large NRSI (N=12,248) reported no difference between PCDF and ACDF in the incidence of postoperative coma (0.4% vs. 0.6%, OR 1.26, 95% CI 0.75 to 1.77).[48]

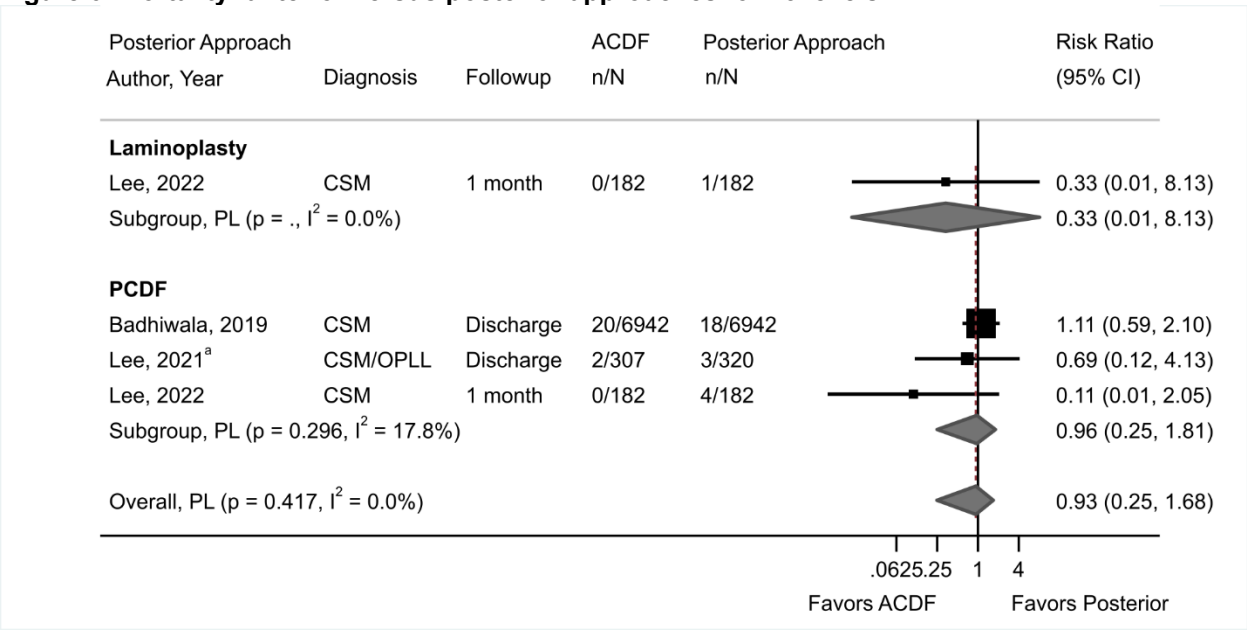
3.7.3.6.2 Mortality

There was low-strength evidence that mortality did not differ between ACDF and laminoplasty or PCDF (SOE: Low).

Three NRSIs (total N=15,057, range 546 to 13,884) that compared anterior with posterior approaches at three or more levels found no difference in short-term mortality after ACDF versus posterior laminoplasty at 1 month (1 NRSI, N=364, 0% vs. 0.05%, RR 0.33, 95% CI 0.01 to 8.13)[47] and ACDF versus PCDF at hospital discharge to 1 month (3 NRSIs, N=14,875, 0.3% vs. 0.3%, RR 0.96, 95% CI 0.25 to 1.81, I^2=17.8%)[42,46,47] (Figure 6). One NRSI (N=12,248) reported no deaths in either arm (ACDF vs. PCDF) and was unable to be included in the pooled analysis.[48]

3.7 Results, Key Question 6

Figure 6. Mortality: anterior versus posterior approaches for ≥3 levels



ACDF = anterior cervical discectomy and fusion; CI = confidence interval; CSM = cervical spondylotic myelopathy; OPLL = ossification of the posterior longitudinal ligament, PCDF = posterior cervical decompression and fusion; PL = profile likelihood.
[a] Study included patients with myelopathy and OPLL

3.7.3.6.3 Dysphagia

There was low-strength evidence that the likelihood of experiencing severe dysphagia did not differ between ACDF and laminoplasty or PCDF (SOE: Low).

Severe dysphagia was rare across two NRSIs that compared ACDF with PCDF or posterior laminoplasty. There were two cases (1%) requiring a nasogastric tube in one study (N=245)[41] and one case (0.5%) requiring an unplanned readmission 11 days post surgery in the other (N=364);[47] all three cases occurred in the ACDF arms (SOE: Low).

One RCT (N=32)[40] and seven NRSIs (total N=41,172, range 245 to 13,884)[41-43,45,46,48,49] also reported dysphagia but did not report the severity; frequencies ranged from 2.7 to 14.0 percent after ACDF and from 0 to 3.6 percent after PCDF across six NRSIs (N=38,130),[41-43,45,46,48] most of which reported a substantial to moderate decrease in the odds/risk of dysphagia with PCDF (OR range 0.20 to 0.61), and from <0.7 to 5.9 percent versus 0 to <0.7 percent in the ACDF versus laminoplasty arms, respectively, across one small RCT (N=32)[40] and one large NRSI (N=3,042), with no differences between treatments.[49]

3.7.3.6.4 Serious Adverse Events

There was low-strength evidence that posterior approaches were more likely associated with a moderate to large increase in the odds of experiencing a serious adverse event compared with ACDF (SOE: Low).

One RCT (N=32) reported that intraoperative dural tear occurred in 5.9 percent of ACDF versus 11.8 percent of PCDF patients (RR 0.50, 95% CI 0.05 to 5.01) and that there were no cases of instrumentation failure or malposition, infection or hematoma.[40]

Across the NRSIs, reporting of serious adverse events varied; adverse events generally occurred more often with posterior approaches versus ACDF.

3.7 Results, Key Question 6

Thrombolic events were rare across eight NRSIs (total N=41,718, range 245 to 13,884) with followup immediately postoperative to 12 months.[41-43,45-49] The frequency of deep vein thrombosis (DVT) or pulmonary embolism ranged from 0 to 2.3 percent (ACDF) versus 0 to 4.3 percent (PCDF or posterior laminoplasty). Four of the studies (N=37,258) reported that posterior approaches were associated with moderate to large increases in the odds of experiencing a thrombolic event compared with ACDF (range of ORs 1.75 to 3.7).[42,43,45,48]

Stroke/cerebrovascular events occurred variably across three NRSIs with short-term followup (1 to 3 months); one study (N=546) reported no events in either arm (ACDF vs. PCDF or posterior laminoplasty),[47] one study (N=627) reported more events after ACDF (1.8% vs. 0% PCDF, p=0.016),[46] while the third found that PCDF was associated with a large increase in the odds of stroke compared with ACDF (N=12,248, 4.2% vs. 2.5%, OR 1.68, 95% CI 1.48 to 1.89).[48]

Sepsis was rare across three NRSIs (total N=7,302, range 546 to 3,714).[45,47,49] One study reported substantially higher odds of having sepsis within 3 months after PCDF compared with ACDF (N=3,714, 2.5% vs. 0.7%, adjusted OR 3.56, 95% CI 1.96 to 6.91)[45] while the other two studies (N=3,588) reported similar rates between groups (ACDF, range <0.7% to 1.1% vs. PCDF/posterior laminoplasty, range <0.7% to 1.7%)[47,49]

Surgical site infection was reported by four NRSIs. Three studies (N=22,702)[43,48,49] reported that posterior approaches (PCDF or laminoplasty) were associated with a large increase in the odds of surgical site infection compared with ACDF at 1 to 3 months (frequency range 2.4% to 4.7% vs. 0.8% to 1.0%, OR range 3.1 to 3.7) and the fourth (N=245) found no difference between groups (1% each).[41]

Wound dehiscence was infrequent across four NRSIs, two of which reported that PCDF was associated with a substantial increase in the odds of experiencing this complication compared with ACDF (N=19,660, frequency range 1.3% to 2.7% vs. 0.1% to 0.5%, range of ORs 5.6 to 10.8)[43,48] and two that found no difference between groups (1% each, N=245, 1 RCT)[41] and (0% each, N=264, 1 RCT).[44]

Dural tear/durotomy occurred more often with ACDF versus PCDF in one study (N=627, 9.4% vs. 3.2%, RR 3.02, 95% CI 1.50 to 6.10)[46] while no events were reported in either group in another study (N=264).[44]

One NRSI found that PCDF was associated with a large increase in the odds of having any severe adverse event through 3 months compared with ACDF (N=3,714, 13% vs. 6.1%, OR 2.31, 95% CI 1.83 to 2.93).[45]

A variety of other serious adverse events were reported across five NRSIs (total N=21,813, range 546 to 13,884);[42,45-47,49] event rates ranged from 0.04 to 4.5 percent in the ACDF arms and from 0 to 7.7 percent in the posterior arms (PCDF or laminoplasty) and included kidney injury (4 studies)[45-47,49] cardiac complications (4 studies),[42,46,47,49] transfusion (3 studies),[45-47] respiratory complications (3 studies),[42,46,49] and arterial injury and hardware instrument failure malposition (1 study).[42] Excluding perioperative blood transfusion in one study, which had the highest frequency of events across all these complications (N=627, 4.5% with ACDF vs. 7.7% with a posterior approach),[46] the range across treatment arms was 0 to 3.7 percent (ACDF) versus 0.06 to 3.6 percent (posterior approach). There were no cases of myocardial infarction or vocal cord paralysis in one NRSI (N=245).[41]

3.8 Key Question 7: In patients with cervical spondylotic myelopathy due to cervical degenerative disease, what are the comparative effectiveness and harms of cervical laminectomy and fusion compared to cervical laminoplasty?

3.8.1 Key Findings

- Evidence was inadequate to determine the effect of laminectomy versus laminoplasty on neck, shoulder, or arm pain (SOE: Insufficient).
- There was moderate-strength evidence of little difference between laminectomy and fusion versus laminoplasty on neurologic function (SOE: Moderate) and low-strength evidence of no difference between laminectomy and fusion versus laminoplasty on general function (SOE: Low).
- There was moderate-strength evidence of no difference in reoperation rates between laminectomy and fusion compared with laminectomy (SOE: Moderate).
- There was low-strength evidence of fewer complications with laminoplasty compared with laminectomy and fusion (SOE: Low).

3.8.2 Description of Included Studies

Two RCTs (N=46)[50,51] and 6 NRSI (N=15,523)[52-57] compared cervical laminectomy and fusion with cervical laminoplasty (Appendix C). The followup duration was 1 year in both of the RCTs and ranged from 1 year to 5 years in the nonrandomized studies. Trials were conducted in the United States and Egypt, with NRSI studies conducted in the United States (3 studies), Japan, China, and a multinational setting.

The mean age of participants was 58 years in one trial and not reported in the other (most participants in the second trial ranged from 50 to 59 years); mean ages in the nonrandomized studies ranged from 54 to 64 years. The average proportion of females in the trials was 30 and 58 percent; the proportion of females in the NRSI studies ranged from 21 to 55 percent. Race and ethnicity were not reported in any of the studies. One trial enrolled patients with at least 3 levels of spinal cord compression,[50] while the other did not report the number of disease levels.[51] Two nonrandomized studies enrolled patients with 3 or more levels of spinal cord compression,[54,57] whereas the number of disease levels was not specified in the other NRSI studies.

One RCT was rated high risk of bias[50] and the other was rated as moderate risk of bias.[51] All of the observational studies were rated moderate risk of bias (Appendix D). The evidence comparing laminectomy and fusion with laminoplasty for neck, shoulder, and arm pain was rated insufficient due to limited and conflicting evidence (Appendix G).

3.8.3 Detailed Analysis

3.8.3.1 Fusion

No study reported fusion outcomes in the laminectomy fusion arm only.

3.8.3.2 Pain

There was inadequate evidence to determine the benefits and harms of laminectomy and fusion compared with laminoplasty on neck, shoulder, or arm pain (SOE: Insufficient).

One RCT (N=30) found a moderate benefit in neck pain with laminectomy and fusion compared with laminoplasty at 1 year (MD -1.33, p<0.05) but no difference in limb pain (MD 0.4, p>0.05).[50] The other RCT (N=16) reported improvement in neck and arm pain from baseline only in patients who underwent laminoplasty (surgical approaches not directly compared, numeric values not reported, p<0.05, both outcomes).[51]

Among the nonrandomized studies assessing neck[52,54] or shoulder[52] pain, two (N=148) reported no differences in VAS scores between laminectomy and fusion and laminoplasty at 1 or 3 years.[52,54] Another observational study (N=121) reported no differences in improved pain (74% vs. 60%; p=0.141) for posterior laminectomy and fusion versus laminoplasty.[57]

3.8.3.3 Function

3.8.3.3.1 Neurologic Function

There was moderate-strength evidence of no difference between laminectomy and fusion versus laminoplasty on neurologic function (SOE: Moderate).

Two head-to-head RCTs (N=46) assessed neurologic function with the mJOA and the Nurick Classification Scale for Spinal Cord Compression (i.e., Nurick's grade 0 to 5) at 1 year post-operative.[50,51] Pooled analysis of the two trials found no difference in function between cervical laminectomy and fusion versus laminoplasty using the mJOA (N=46, MD -0.03, 95% CI -0.68 to 0.74, I^2=76%).[50,51] One trial reported no significant difference between laminectomy and fusion compared with laminoplasty in Nurick grade (1.40 vs. 1.67; p=0.23),[50] while the other trial reported a significant pre-post difference for laminoplasty only (numeric values not reported; p<0.05).[51]

Four nonrandomized studies reported neurologic function using the mJOA or JOA score; three reported no difference between laminectomy and fusion versus laminoplasty[52,54,57] and one reported a significant benefit of laminoplasty over laminectomy and fusion (mean mJOA at 2 years: 3.49, 95% CI 2.84 to 4.13 vs. 2.39, 95% CI 1.91 to 2.86; p=0.0069).[53] However, this study reported no significant difference in Nurick's grade at 2 years (mean 1.57, 95% CI 1.23 to 1.90 vs. 1.18, 95% CI 0.92 to 1.44; p=0.077).

3.8.3.3.2 General Function

There was low-strength evidence of little difference between laminectomy and fusion versus laminoplasty on general function (SOE: Low).

Neck disability scores on the NDI were not different between laminectomy and fusion versus laminoplasty 1-year postoperatively (1 RCT, N=30, MD 3.86, p=0.2)[50] and only improved with laminoplasty in the other trial (N=16, surgical approaches not directly compared, numeric values not reported, p=0.05).[51] The same trial (N=16) reported improvement from baseline on the SF-36 with laminoplasty only (numeric values not reported, p<0.05).[51,52,54] Two NRSIs reported no differences on the NDI,[52,53] and three reported no differences between surgical approaches in SF-12 or SF-36 PCS or MCS scores.[52-54] Another observational study reported no differences in improved gait (71% vs. 68%; p=0.674) as assessed on a 5-point NRS.[57]

3.8.3.4 Quality of Life

No study reported quality of life outcomes.

3.8.3.5 Harms

There was moderate-strength evidence of no difference between laminectomy and fusion compared with laminectomy in reoperation rates (SOE: Moderate) and low-strength evidence of fewer complication overall with laminoplasty compared with laminectomy and fusion (SOE: Low).

Both trials reported no significant differences in harms, though event rates were low.[50,51] Likewise, four NRSI studies (N=582) found no differences in infection, device failure, or reoperation rates.[52-54,57] A large database study (PearlDiver Mariner Database, N=11,860, unsure of matched sample size)[55] reported similar revision rates for laminoplasty and laminectomy with fusion (5.63% vs. 5.90%, p=0.62) at 1 year but fewer surgical site infections (matched OR 0.60; p=0.002), wound complications (matched OR 0.67, p=0.002) and dysphagia (matched OR 0.77; p=0.01) with laminoplasty compared with laminectomy and fusion.[55] Also reported in this study were reduce rates of spinal cord injury (matched OR 0.6, p=0.02), limb paralysis (matched OR 0.67, p<0.001), respiratory failure (matched OR 0.74, p=0.01), renal failure (matched OR 0.84, p=0.04), and sepsis (matched OR 0.85, p=0.04) with laminoplasty versus laminectomy and fusion. No complication was reported more likely with laminoplasty. An earlier propensity-matched analysis of patients from this same database (N=928) found lower revision rates at 1 year with laminoplasty versus laminectomy and fusion (2.4% vs. 7.1%; p<0.001).[56] The dissimilar findings may be due a larger sample size (this is an assumption as the matched sample size was not reported in the later study) to changes in surgical methods and/or skill of the surgeon over time. Two additional NRSI studies reported no differences in dysphagia between groups.[53,57]

3.9 Key Question 8:. In patients with cervical spondylotic radiculopathy or myelopathy at one or two levels, what are the comparative effectiveness and harms of cervical arthroplasty compared to anterior cervical discectomy and fusion?

3.9.1 Key Findings

- In participants receiving single-level interventions:
  - There was moderate-strength evidence of no difference between cervical arthroplasty and ACDF in likelihood of success (response) for any pain or function measure at short, intermediate, and long term (SOE: Moderate).
  - There were also moderate-strength evidence of no differences between cervical arthroplasty and ACDF in pain or function at short, intermediate, or long term: neck or arm pain, neurologic status or general function (SOE: Moderate).
  - There was high-strength evidence that cervical arthroplasty was associated with substantially lower likelihood of reoperation at the index level versus ACDF (SOE: High).
  - There was low-strength evidence that cervical arthroplasty was associated with slightly lower likelihood of any serious adverse event at short term versus ACDF, but there were no differences at times >24 months and serious adverse events were variably defined (SOE: Low for all times).
  - There was low-strength evidence of no differences in neurological events or deficits between cervical arthroplasty and ACDF at short, intermediate, or long term (SOE: Low).
  - There was inadequate evidence on the likelihood of mortality between cervical arthroplasty and ACDF (SOE: Insufficient).

- In participants receiving 2-level interventions:
  - There was moderate-strength evidence of no differences between cervical arthroplasty and ACDF on pain (neck or arm), neurologic function and general function at short, intermediate, and long term (SOE: Moderate).
  - Reoperation at the index level was substantially less likely with cervical arthroplasty at all times reported (24 to >60 months) (SOE: Low).
  - Cervical arthroplasty was associated with slightly lower likelihood of serious adverse events compared with ACDF at 24 months, but there was no difference between procedures at 120 months for World Health Organization (WHO) Grade 3 or 4 (scale 0-4, 4 most serious) adverse events (SOE: Low).
  - Evidence for neurological deficits or events and for mortality was inadequate to draw conclusions (SOE: Insufficient).

- In participants receiving 1-, 2- or 3-level interventions
  - There was no difference between cervical arthroplasty and ACDF in VAS neck pain scores at intermediate term (SOE: Low).
  - Evidence was inadequate to draw conclusions for neurologic and general function and harms (SOE: Insufficient).

3.9.2 Description of Included Studies

Twenty-two RCTs in 45 publications (N=4,120) compared cervical arthroplasty with ACDF (Appendix C).[58-102] The average followup duration was 56 months (range 6 to 108 months). Eight trials each were conducted in the United States[65,72,75,76,86,87,93,98] and in China;[61-63,79,91,99-101] two trials in Germany;[89,90] and one trial each in India,[74] the Netherlands,[103] Spain,[64] and Turkey.[82]

The average study mean age of participants was 45 years (range 37 to 50 years); the average proportion of females in studies was 47 percent (range 20% to 63%). Five trials reported race, four enrolling mostly White participants (range 89% to 93%)[72,76,93,98] and the other enrolling Han (Chinese) participants.[63] One trial reported ethnicity, enrolling mostly non-Hispanic participants (94%).[65]

Studies enrolled participants with clinical and/or radiological evidence of cervical radiculopathy and/or myelopathy, although only three trials reported baseline values.[64,74,89] Participants had 1-level disease in 15 trials (N=3,036),[61,75,76,79,82,86,87,89-91,93,98,100,101,103] 2-level disease in four trials (N=872),[63,65,72,99] and mixed-level (1, 2 or 3) disease in three trials (N=196).[62,64,74] Of the single-level trials, six (in 23 publications) were US Food and Drug Administration (FDA) Investigational Device Exemption (IDE) trials[58-60,67,68,70,75-78,80,81,84-87,92,93,95-98,102] and of the 2-level trials, two (in 9 publications) were IDE trials.[65,66,71-73,80,83,94,95]

Six trials were rated low risk of bias,[65,76,79,86,87,93] six trials were rated high risk of bias,[61,64,82,90,91,101] and the remainder were rated moderate risk of bias[62,63,72,74,75,89,98-100,103] (Appendix D). Methodological limitations included unclear randomization techniques, unclear blinding, and high attrition.

Two prospective, multicenter NRSIs (N=349 and N=352) of recently completed FDA IDE trials compared newer cervical arthroplasty devices (M6-C and Simplify discs) with historic ACDF controls (Appendix C).[104,105] Propensity score matching was done to facilitate baseline comparability between groups. Followup was 24 months in both studies. One study enrolled participants with clinical and radiological evidence of cervical radiculopathy with or without myelopathy at 1-level[105] and the other study enrolled participants with cervical radiculopathy and/or myelopathy at 2-levels.[104] The study mean ages of participants were 45 years and 48 years and the proportion of females were 50 and 52 percent. Race/ethnicity was not reported by either study. The study mean body mass indexes were 27.5 and 28.9. Both studies were conducted in the United States and were rated moderate risk of bias (Appendix D).

Eight non-IDE NRSIs were included for the evaluation of harms only and included seven large database/registry studies,[106-112] one a post-hoc analysis of an FDA IDE trial[113] (Appendix C). Sample sizes ranged from 342 to 143,060 (total N=206,887). The average study mean age of patients was 50 years (range 46 to 54 years) and the proportion of females was 51 percent (range 50% to 52%). Across three studies most patients were White (82%; range 81% to 85%); one study reported 94 percent of patients were non-Hispanic[113] and four studies did not report race/ethnicity.[109-112] Two studies[107,113] enrolled patients with radiculopathy and/or myelopathy; three studies[106,111,112] specifically excluded patients with myelopathy and the remaining three studies[108-110] only stated that patients had CDD. Followup ranged from 30 days to 84 months. One study took place in Germany,[110] and all others in the United States. Four studies were rated moderate risk of bias[107,111-113] and four high risk of bias[106,108-110] (Appendix D).

For the FDA IDE trials, an attempt was made to reconcile conflicting information among multiple reports presenting the same data and when necessary, we used the data from the FDA Summary of Safety and Effectiveness Data (SSED): 1-level[114-120] and 2-level indications.[121-123]

For measures of success, we focused on the FDA required definition and reported alternative definitions as applicable. Only FDA approved devices are included for this Key Question.

In the results below for benefits, we report outcomes according to the following timeframes: short term (<12 months), intermediate term (12 to 60 months) and long term (>60 months).

Evidence was insufficient for mortality (all levels), neurologic deficit/events (2-levels and mixed 1-, 2- or 3-levels), and neurologic function, general function, reoperation and serious adverse events (mixed 1-, 2- or 3-levels) based on a combination of two or more of the following: high risk of bias, inconsistent findings, and lack of precision (Appendix G).

3.9.3 Detailed Analysis

3.9.3.1 Single-Level Cervical Arthroplasty Versus ACDF

Fifteen trials (N=3,036) (in 33 publications) compared single-level cervical arthroplasty and ACDF, including six FDA IDE trials (in 23 publications)[58-60,67,68,70,75-78,80,81,84-87,92,93,95-98,102] and nine non-IDE trials (in 10 publications),[61,79,82,89-91,100,101,103] as did one FDA IDE NRSI.[105] Six additional NRSIs compared harms for single-level cervical arthroplasty and ACDF.[106-110,113]

3.9.3.1.1 Fusion

Seven RCTs (across 15 publications) (N=2,382) that compared single-level cervical arthroplasty and ACDF reported fusion success in their ACDF arms.[59,60,68,75-78,86,87,92-95,98,101] One trial (N=56) reported short-term fusion success in 89.3 percent of participants,[101] seven RCTs (N=853) reported intermediate-term fusion success in 93.9 percent (range 89.1% to 98.2%) of participants[59,68,75,78,92,98,101] and two RCTs (N=181) reported long-term fusion success in 96.5 percent (range 95.5% to 96.9%) of participants.[60,95] One RCT reported successful fusion in the cervical arthroplasty arm as well, but this may be attributed to participant crossover after initial randomization.[92,93]

3.9.3.1.2 Pain

3.9.3.1.2.1 Neck Pain

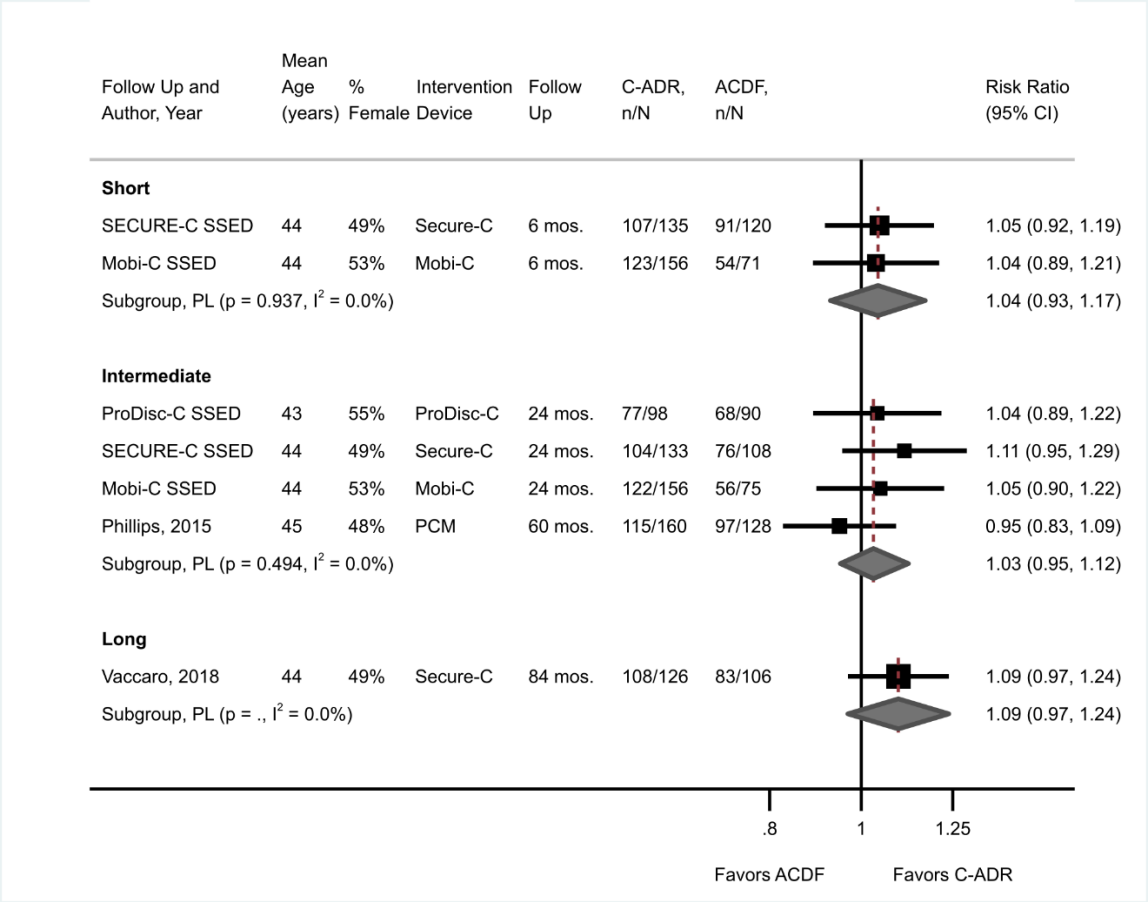
There was moderate-strength evidence of no differences between cervical arthroplasty and ACDF in neck pain or likelihood of success (response) for neck pain at short, intermediate, and long-term (SOE: Moderate).

Four RCTs (N=1,230) (in 5 publications)[92,97,114,118,119] that compared single level cervical arthroplasty versus ACDF reported neck pain success (response) defined as postoperative ≥20-point improvement on VAS. There were no differences in likelihood of neck pain success between cervical arthroplasty and ACDF at short term (2 RCTs, N=482, 79% vs. 75.0%, RR 1.04, 95% CI 0.93 to 1.17, I^2=0%),[114,119] intermediate term (4 RCTs, N=948, 76.4% vs. 74.1%, RR 1.03, 95% CI 0.95 to 1.12, I^2=0%)[92,114,118,119] or long term (1 RCT, N=232, 85.7% vs. 78.3%, 1.09, 95% CI 0.97 to 1.24)[97] (Figure 7**)**. In one prospective NRSI IDE study using propensity-matched historical controls, more cervical arthroplasty participants had ≥20-point improvement on VAS neck pain versus ACDF at 24 months (N=301, 91.2% vs. 77.9%, p=0.013).[120]

One of the above trials reported neck pain success at 84 months using an alternative definition, a ≥10-point improvement on VAS, and was not included in the meta-analysis at long term; there was no difference between cervical arthroplasty and ACDF using this criterion (N=191, 87.5% vs. 83.3%, RR 1.05, 95% CI 0.93 to 1.20).[95]

3.9 Results, Key Question 8

Figure 7. Neck pain success (≥20-point improvement on VAS): comparison of cervical arthroplasty with ACDF (1-level interventions)

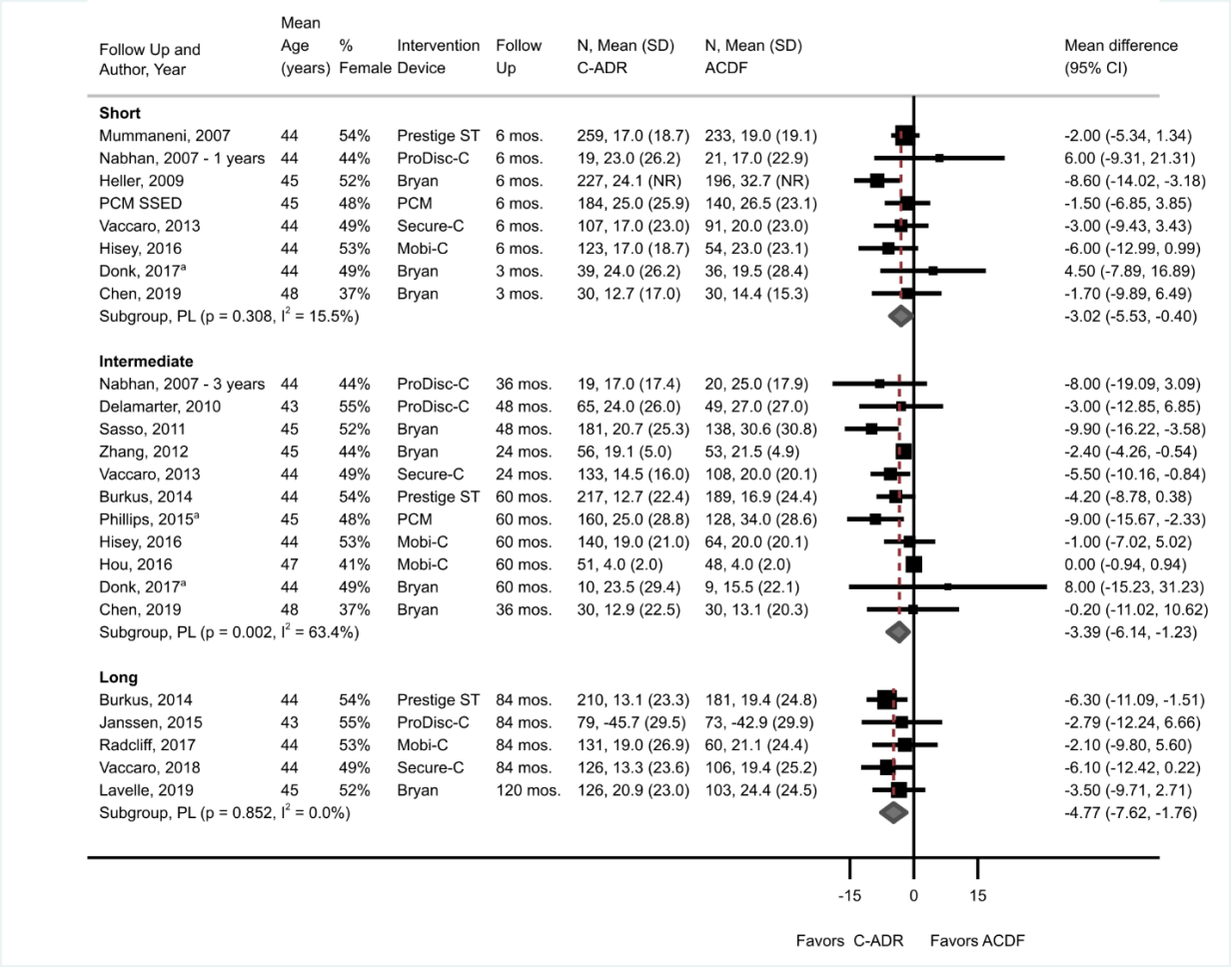


ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; mos. = months; PL = profile likelihood; SSED = Summary of Safety and Effectiveness Data (FDA); VAS = visual analogue scale.

Eleven RCTs (N=2,696) (in 19 publications)[60,61,67,69,75,78,79,81,84,86,88,89,92,95-98,100,116] contributed to evaluation of mean differences in neck pain scores at various times. There were no differences between cervical arthroplasty and ACDF in VAS neck pain scores (0-100 scale) as estimates were below the threshold for a small effect at short term (8 RCTs, N=1,789, MD -3.02, 95% CI -5.53 to 0.40, I^2=15.5%),[61,69,75,78,86,89,98,116] intermediate term (11 RCTs, N=1,898, MD -3.39, 95% CI -6.14 to -1.23, I^2=63.4%),[60,61,67,69,78,79,88,92,96,98,100] and long term (5 RCTs, N=1,195, MD -4.77, 95% CI -7.62 to -1.72, I^2=0%)[60,81,84,95,97] (Figure 8). Exclusion of one, small (N=60) trial rated high risk of bias[61] did not substantially change effect estimates but did slightly increase heterogeneity in the short term (7 RCTs, N=1,729, MD -3.11, 95 % CI -5.92 to -0.15, I^2=26.6%)[69,75,78,86,89,98,116] and intermediate term (10 RCTs, N=1,838, MD -3.55, 95% CI -6.48 to -1.30, I^2=67.1%).[60,67,69,78,79,88,92,96,98,100] Exclusion of one trial[69] that did not specify if neck or arm pain was evaluated also did not substantially change effect estimates at short term (7 RCTs, N=1,714, MD -3.24, 95% CI -5.95 to -0.77, I^2=12.2%)[61,75,78,86,89,98,116] or intermediate term (10 RCTs, N=1,879, MD -3.51, 95% CI -6.35 to -1.33, I^2=66.4%).[60,61,67,78,79,88,92,96,98,100] Although funnel plot analysis and Egger's test (p=0.035) may suggest publication/small study bias for neck pain scores at intermediate term, most trials found no effect leading to less concern regarding publication bias (Appendix F, Figure F-4).

3.9 Results, Key Question 8

Figure 8. Neck pain VAS scores (0-100 scale): comparison of cervical arthroplasty with ACDF (1-level interventions)



ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; FDA = Food and Drug Administration; mos. = months; PL = profile likelihood; SD = standard deviation; SSED = Summary of Safety and Effectiveness Data (FDA); VAS = visual analogue scale.
[a] Scores estimated from graphs in article.

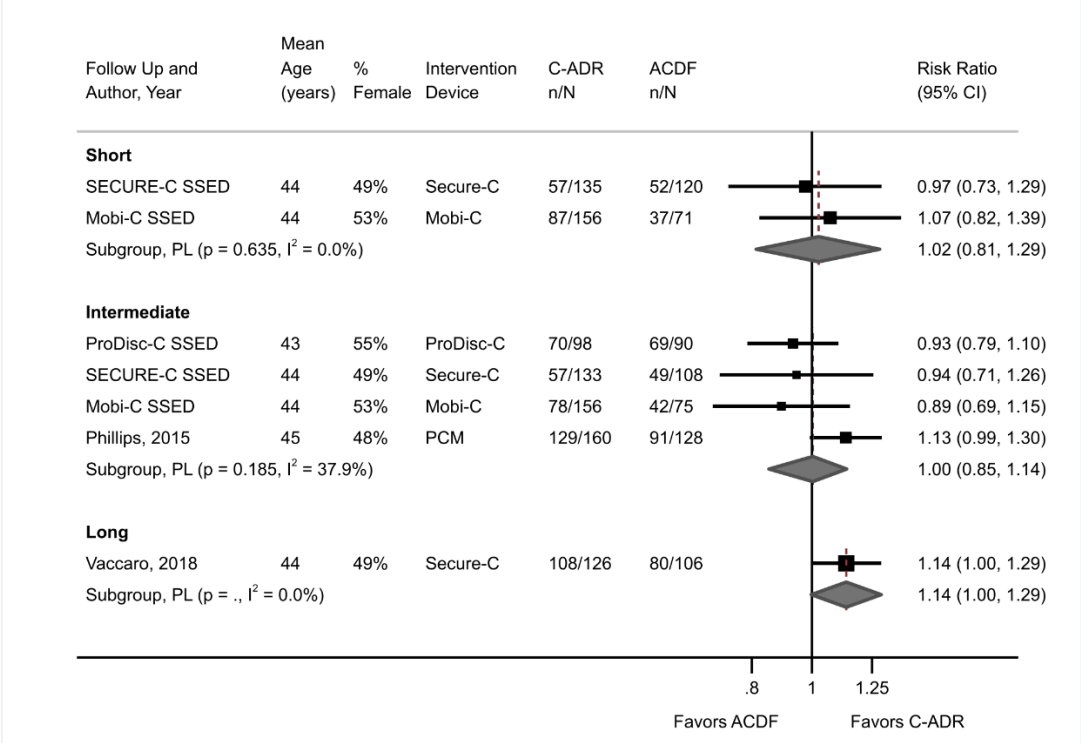
3.9.3.1.2.2 Arm Pain

There was moderate-strength evidence of no differences between cervical arthroplasty and ACDF in arm pain or likelihood of success (response) for arm pain at short, intermediate, and long-term (SOE: Moderate).

Four RCTs (N=1,148) (in 5 publications)[92,97,114,118,119] that compared cervical arthroplasty with ACDF for single level disease reported arm pain success (response) defined as postoperative ≥20-point improvement on VAS (0–100). Some studies reported arm pain success in both arms. Conservative estimates, using the lower risk ratio for studies reporting VAS for both arms, revealed no difference in likelihood of arm pain success between cervical arthroplasty and ACDF at short term (2 RCTs, N=482, 49.5% vs. 46.6%, RR 1.02, 95% CI 0.81 to 1.29, I^2=0%),[114,119] intermediate term (4 RCTs, N=948, 61.1% vs. 62.6%, RR 1.0, 95% CI 0.85 to 1.14, I^2=37.9%),[92,114,118,119] or long term (1 RCT, N=232, 85.7% vs. 75.5%, RR 1.14, 95% CI 1.00 to 1.29, I^2=0%)[97] (Figure 9). Estimates based on higher risk ratios for studies reporting VAS for both arms were similar and led to the same conclusion of no difference between cervical arthroplasty and ACDF for all time points. In one prospective NRSI IDE study using propensity-

matched historical controls, more cervical arthroplasty participants experience ≥20-point improvement on VAS arm pain (worst side) versus ACDF at 24 months (N=301, 90.5% vs. 79.9%, p=0.001).[120]

Figure 9. Arm pain success (≥20-point improvement on VAS): comparison of cervical arthroplasty with ACDF (1-level interventions)

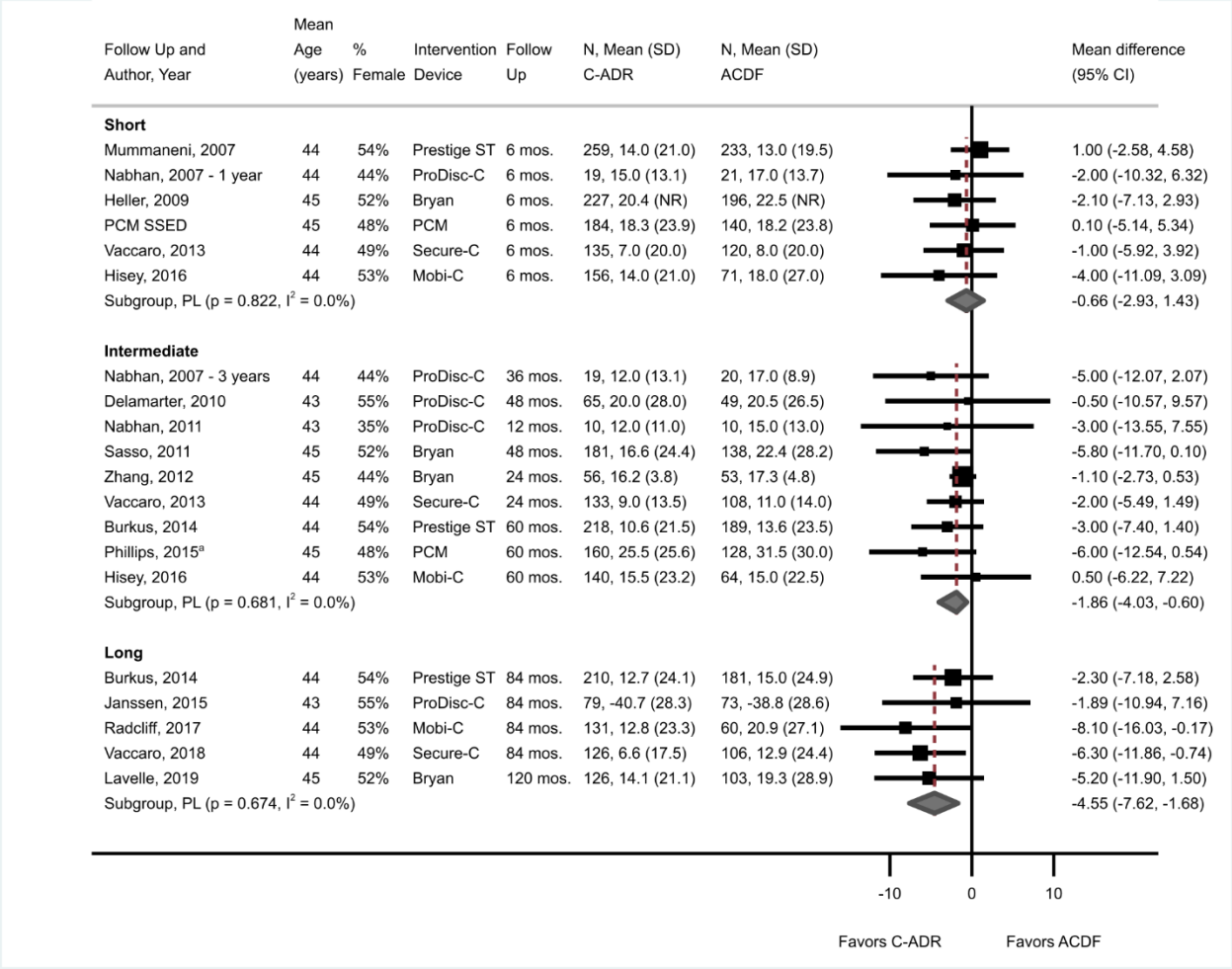


ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; FDA = Food and Drug Administration: mos. = months; PL = profile likelihood; SSED = Summary of Safety and Effectiveness Data (FDA); VAS = visual analogue scale.

Nine RCTs (N=2,460) (in 17 publications)[60,67,75,78,81,84,86,88-90,92,95-98,100,116] assessed arm pain at various times. Three publications reported pain scores for both arms. Using a conservative estimate with the smaller effect estimate of the two arms, there was no difference between cervical arthroplasty and ACDF in VAS arm pain scores (0-100 scale) short term (6 RCTs, N=1,761, MD -0.66, 95% CI -2.93 to 1.43, I^2=0%),[75,78,86,89,98,116] intermediate term (9 RCTs, N=1,741, MD -1.86, 95% CI -4.03 to -0.60, I^2=0%),[60,67,78,88,90,92,96,98,100] or long term (5 RCTs, N=1,195, MD -4.55, 95% CI -7.62 to -1.68, I^2=0%)[60,81,84,95,97] (Figure 10). Exclusion of one small (N=20) trial rated high risk of bias[90] did not impact the effect size. Using the larger effect estimate when both arms were measured, slightly increased the estimate at short term but not the conclusion of no difference between treatments (MD -1.11, 95% CI -3.56 to 1.02); estimates at intermediate and long term were similar to the conservative estimates.

3.9 Results, Key Question 8

Figure 10. Arm pain VAS scores (0-100): comparison of cervical arthroplasty with ACDF (1-level)



ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; FDA = Food and Drug Administration; PL = profile likelihood; SD = standard deviation; SSED = Summary of Safety and Effectiveness Data (FDA); VAS = visual analogue scale.
[a] Scores estimated from graphs in article.

3.9.3.1.3 Function

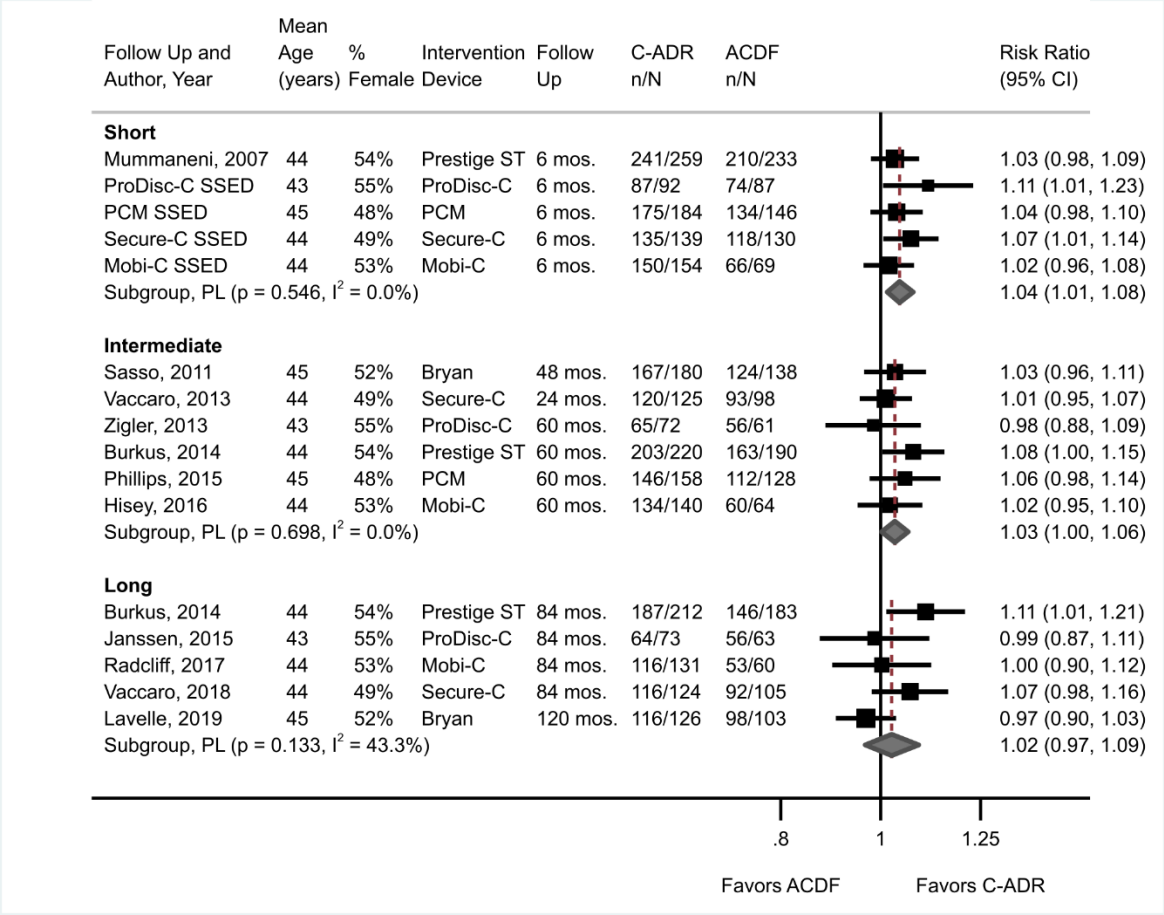
3.9.3.1.3.1 Neurologic Function

There was moderate-strength evidence of no differences between cervical arthroplasty and ACDF in neurologic function at short, intermediate, and long term (SOE: Moderate).

Six RCTs (N=2,271) (in 15 publications)[60,78,81,84,86,92,95-98,102,114,116,118,119] that compared single-level cervical arthroplasty and ACDF reported neurologic success (response) defined as maintenance or improvement (compared with preoperative status) in all three of the following areas: motor function, sensory function and deep tendon reflexes. There were no differences between cervical arthroplasty and ACDF in the likelihood of neurological success short-term (5 RCTs, N=1,493, 95.2% vs. 90.5%, RR 1.04, 95% CI 1.01 to 1.08, I^2=0%),[86,114,116,118,119] intermediate term (6 RCTs, N=1,574, 93.3% vs. 89.5%, RR 1.03, 95% CI 1.00 to 1.06, I^2=0%),[60,78,92,96,98,102] or long term (5 RCTs, N=1,180, 89.9% vs. 86.6%, RR 1.02, 95% CI 0.97 to 1.09, I^2=43.3%)[60,81,84,95,97] (Figure 11). One prospective NRSI IDE study that used propensity matched ACDF historical controls reported neurological success, defined as maintenance or

improvement compared with baseline, was similar for cervical arthroplasty and ACDF at 24 months (N=314, 99.3% vs. 98.8%).[120]

Figure 11. Neurological success: comparison of cervical arthroplasty with ACDF (1-level interventions)



ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; FDA = Food and Drug Administration; mos. = months; PL = profile likelihood; SSED = Summary of Safety and Effectiveness Data (FDA); VAS = visual analogue scale.

Four RCTs (N=354), three rated high risk of bias[63,91,101] and one low risk of bias,[79] reported JOA scores (0-17). There was no differences between cervical arthroplasty and ACDF in pooled analysis at intermediate term (4 RCTs, N=354, MD 0.60, 95% CI -0.007 to 0.97, I^2=1.9%) or in one short-term trial rated high risk of bias (1 RCT, N=60, MD 0.25, 95% CI -0.25 to 0.75).[63]

One trial reported the proportion of participants who had the same or an improved Nurick grade at 60 months compared with baseline; there were no differences (i.e., point estimate below the threshold for a small effect) between cervical arthroplasty and ACDF (N=285, 99.4% vs. 96.9%, RR 1.03, 95% CI 0.99 to 1.06).[93]

3.9.3.1.3.2 General Function

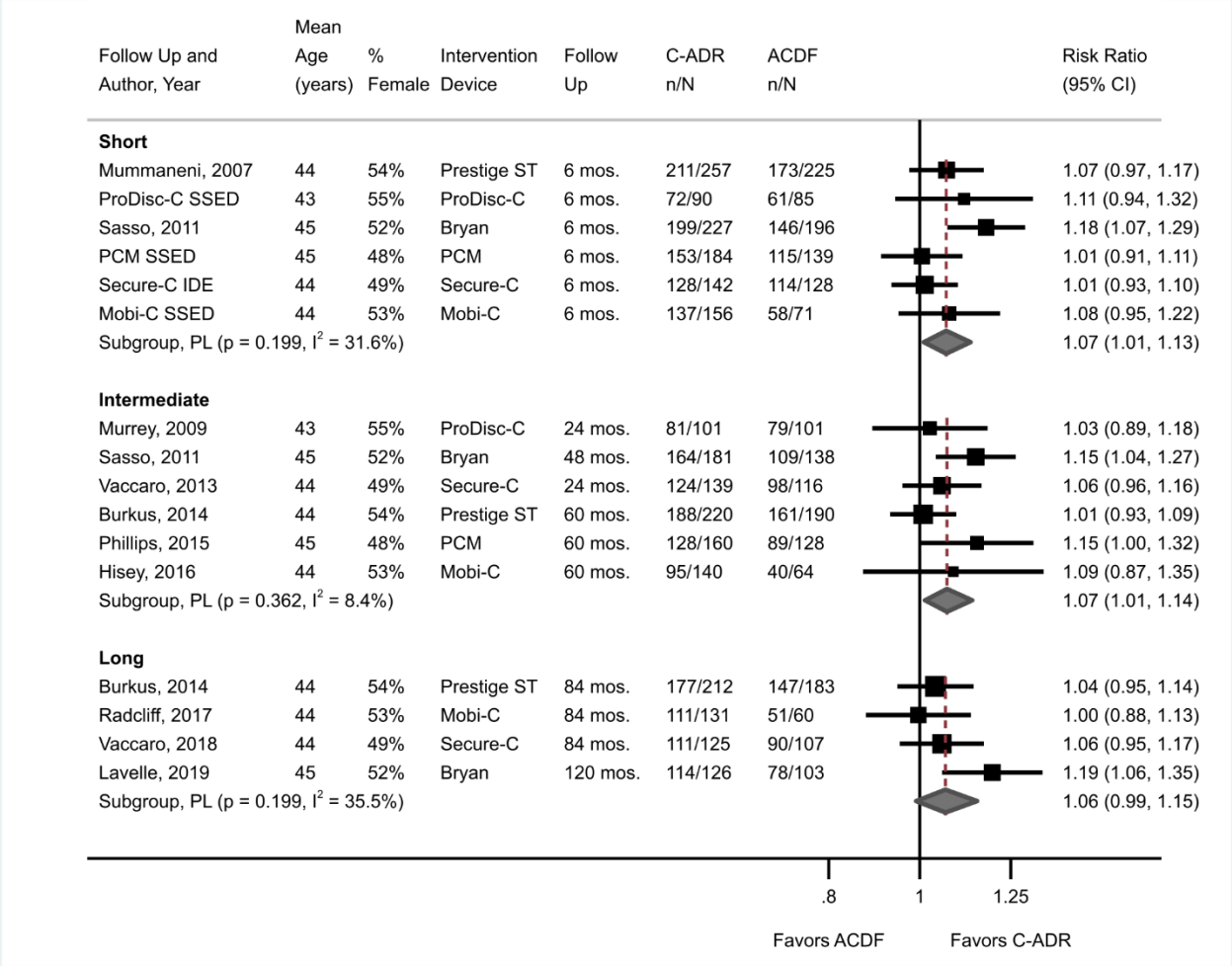
There was moderate-strength evidence of no differences between cervical arthroplasty and ACDF in general function at short, intermediate, and long term (SOE: Moderate).

3.9 Results, Key Question 8

3.9.3.1.3.2.1 NDI

Six RCTs (N=2,271) (in 14 publications)[60,78,84,86,87,92,95-98,114,116,118,119] that compared cervical arthroplasty with ACDF for single-level disease reported NDI success (response) defined as postoperative NDI score improvement of ≥15 points from the baseline score (FDA definition). There were no differences between cervical arthroplasty and ACDF in the likelihood of NDI success short term (6 RCTs, N=1,900, 85.2% vs. 79.0%, RR 1.07, 95% CI 1.01 to 1.13, I^2=31.6%),[86,96,114,116,118,119] intermediate term (6 RCTs, N=1,678, 82.9% vs. 78.2%, RR 1.07, 95% CI 1.01 to 1.14, I^2=8.4%),[60,78,87,92,96,98] or long term (4 RCTs, N=1,047, 86.4% vs. 80.8%, RR 1.06, 95% CI 0.99 to 1.15, I^2=35.5%)[60,84,95,97] (Figure 12). In one prospective NRSI IDE study that used propensity-matched historical controls, there was no difference in NDI success (≥15-point NDI improvement) following cervical arthroplasty versus ACDF at 24 months (N=301, 90.5% vs. 85.1%, p=0.372).[120]

Figure 12. NDI success (≥15-point improvement): comparison of cervical arthroplasty with ACDF (1-level interventions)

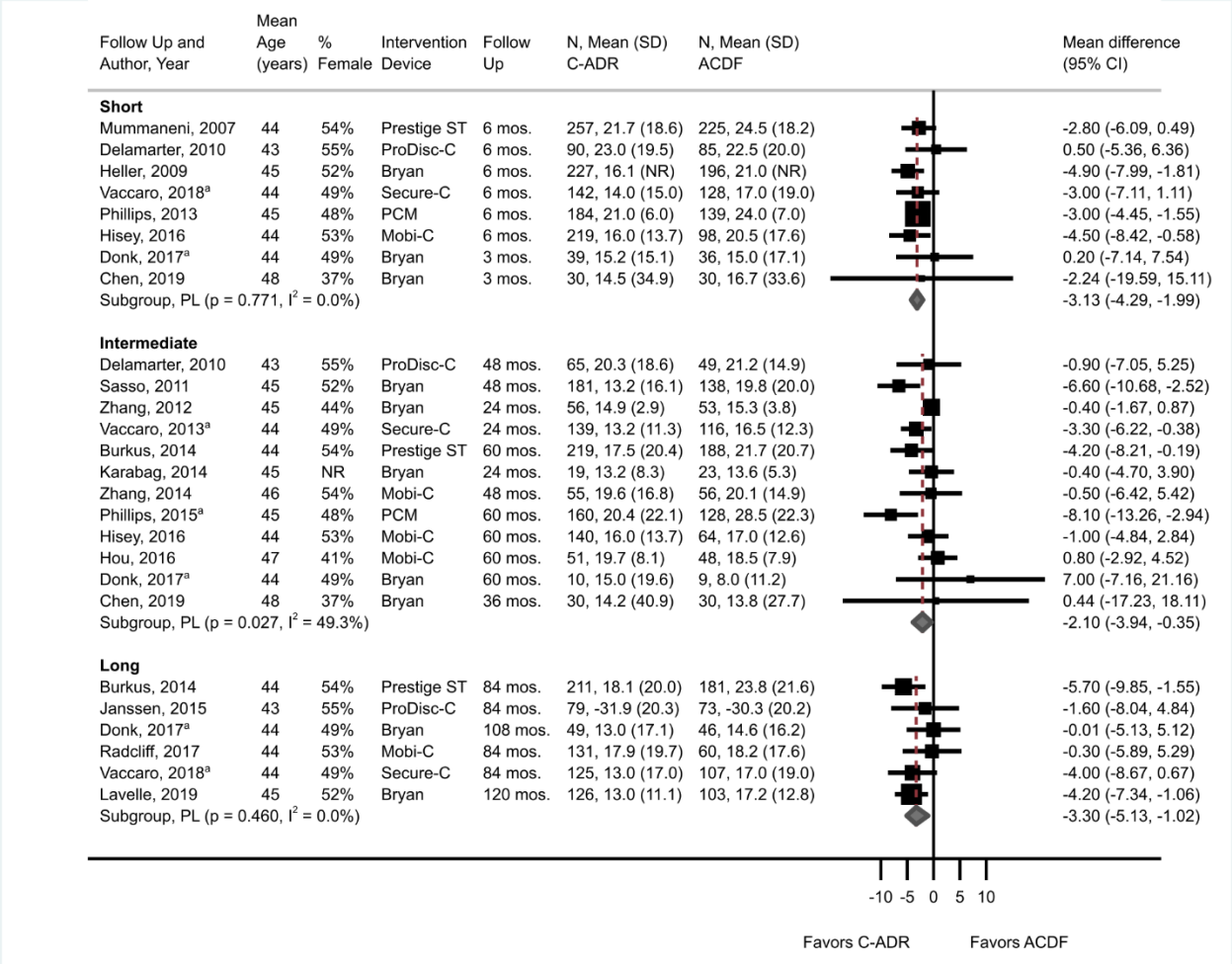


ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; FDA = Food and Drug Administration; mos. = months; NDI = Neck Disability Index; PL = profile likelihood; SSED = Summary of Safety and Effectiveness Data (FDA).

Twelve RCTs (N=2,800) (in 19 publications)[60,61,67,69,75,78,79,81,82,84,86,92,93,95-98,100,101] that compared cervical arthroplasty with ACDF reported NDI scores (0-100 scale). There were no

differences between cervical arthroplasty and ACDF in NDI scores as estimates were below the threshold for a small effect at short term (8 RCTs, N=2,125, MD -3.13, 95% CI -4.29 to -1.99, I^2=0%),[61,67,69,75,78,86,93,97] intermediate term (12 RCTs, N=2,027, MD -2.10, 95% CI -3.94 to -0.35, I^2=49.3%),[60,61,67,69,78,79,82,92,96,98,100,101] or long term (6 RCTs, N=1,291, MD -3.30, 95% CI -5.13 to -1.02, I^2=0%)[60,69,81,84,95,97] (Figure 13). Exclusion of trials rated high risk of bias[61,82,101] had no impact on effect estimates or statistical heterogeneity in the short term (7 RCTs, N=2,065, MD -3.14, 95% CI -4.30 to -1.99, I^2=0%)[67,69,75,78,86,93,97] and slightly increased effect size and increased heterogeneity at intermediate term (9 RCTs, N=1,814, MD -2.45, 95% CI -4.70 to -0.35, I^2=62.5%).[60,67,69,78,79,92,96,98,100] Exclusion of a trial rated moderate risk of bias[69] with unclear sample sizes resulted in a small increase in effect size long term (5 RCT, N=1,288, MD -3.78, 95% CI -5.74 to -1.54).[60,81,84,95,97] There was no indication of publication/small study bias for NDI scores at intermediate term based on funnel plot analysis (Egger's test, p=0.416) (Appendix F, Figure F-5).

Figure 13. NDI scores (0-100): comparison of cervical arthroplasty with ACDF (1-level interventions)



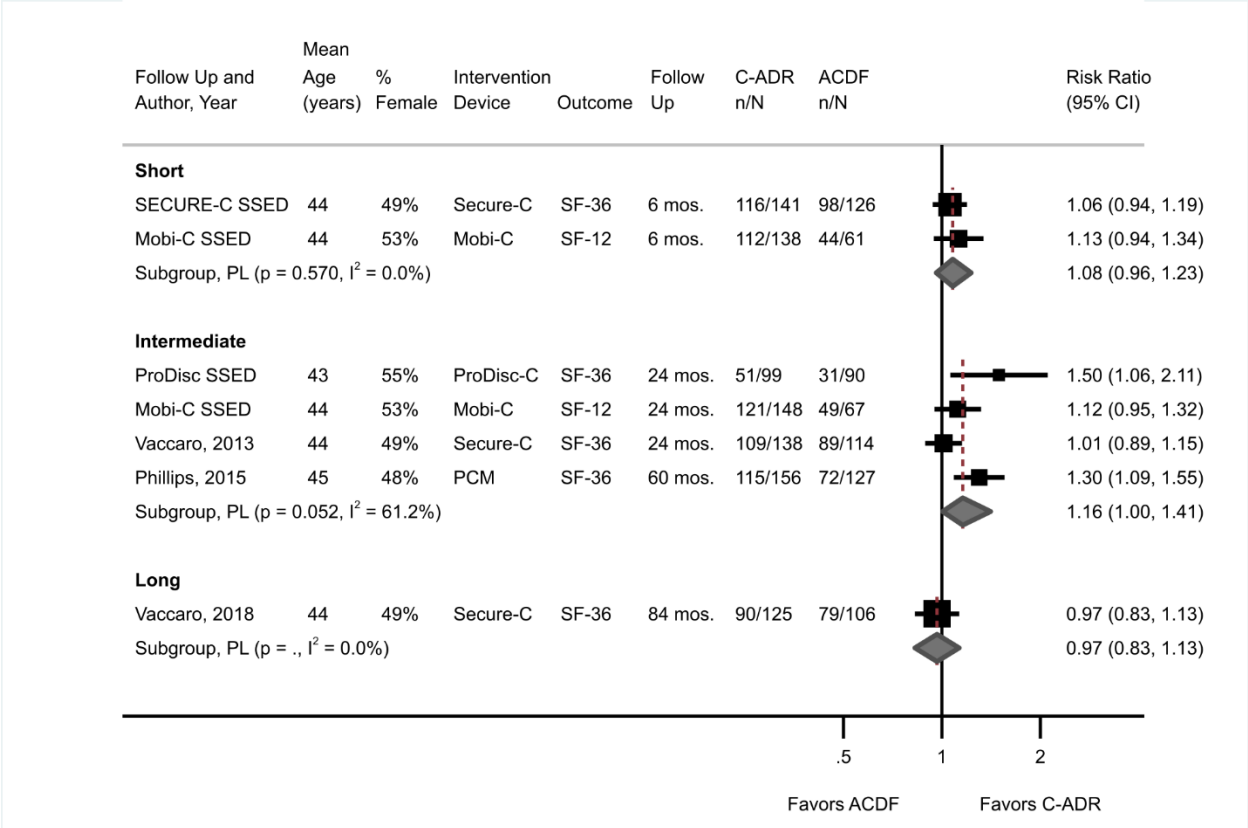
ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; FDA = Food and Drug Administration; mos. = months; NDI = Neck Disability Index; PL = profile likelihood; SD = standard deviation.

[a] Scores estimated from graphs in article.

3.9.3.1.3.2.2 SF-36 and SF-12 PCS and MCS

Four RCTs (N=1,148) (in 6 publications)[92,97,98,114,118,119] that compared cervical arthroplasty with ACDF for single-level disease reported SF-36 and SF-12 PCS and MCS (0-100 scale). Success for these component scores was defined as postoperative score improvement of ≥15 points from baseline scores. The likelihood of PCS success was similar for cervical arthroplasty and ACDF short term (2 RCTs, N=466, 81.7% vs. 75.9%, RR 1.08, 95% CI 0.96 to 1.23, I^2=0%),[114,119] intermediate term (4 RCTs, N=939, RR 1.16, 95% CI 1.00 to 1.41, I^2=61.2%),[92,98,114,118] and long term (1 RCT, N=231, 72.0% vs. 74.5%, 0.97, 95% CI 0.83 to 1.13)[97] (Figure 14). Exclusion of one outlier trial[118] at intermediate term resulted in a slightly attenuated effect estimate but did not reduce heterogeneity or change the conclusion (3 RCTs, N=750, RR 1.12, 95% CI 0.96 to 1.34, I^2=59.8%).[92,98,114] In one prospective NRSI IDE study using propensity-matched historical controls, more cervical arthroplasty participants maintained or improved PCS score versus ACDF at 24 months (N=301, 97.3% vs. 89.2%, p=0.023).[120] The likelihood of MCS success was also similar for cervical arthroplasty and ACDF at all time points: short term (2 RCTs, N=466, 49.1% vs. 42.8%, RR 1.13, 95% CI 0.86 to 1.50, I^2=0%),[114,119] intermediate term (4 RCTs, N=939, 47.3% vs. 48%, RR 0.97, 95% CI 0.80 to 1.16, I^2=27.5%)[92,98,114,118] and long term (1 RCT, N=231, 47.2% vs. 43.4%, RR 1.09, 95% CI 0.82 to 1.45)[97] (Figure 15). In the prospective NRSI IDE study, there was no difference in MCS maintenance or improvement between procedures at 24 months (N=301, 77.6% vs. 77.0%).[120]

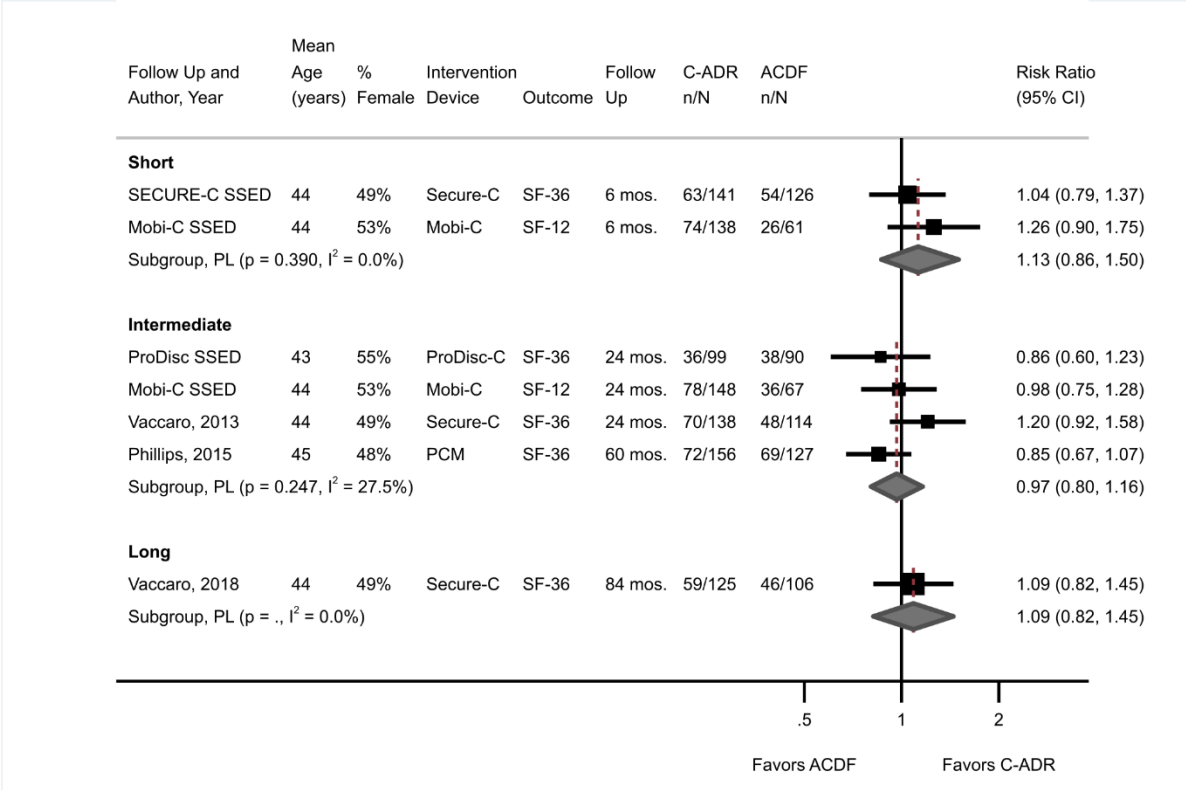
Figure 14. SF-36 or SF-12 PCS success (≥15-point improvement): comparison of cervical arthroplasty with ACDF (1-level interventions)



ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; FDA = Food and Drug Administration; mos. = months; PCS = Physical Component Score; PL = profile

likelihood; SF-12 = 12-Item Short Form Health Survey; SF-36 = 36-Item Short Form Health Survey; SSED = Summary of Safety and Effectiveness Data (FDA).

Figure 15. SF-36 or SF-12 MCS success (≥15-point improvement): comparison of cervical arthroplasty with ACDF (1-level interventions)

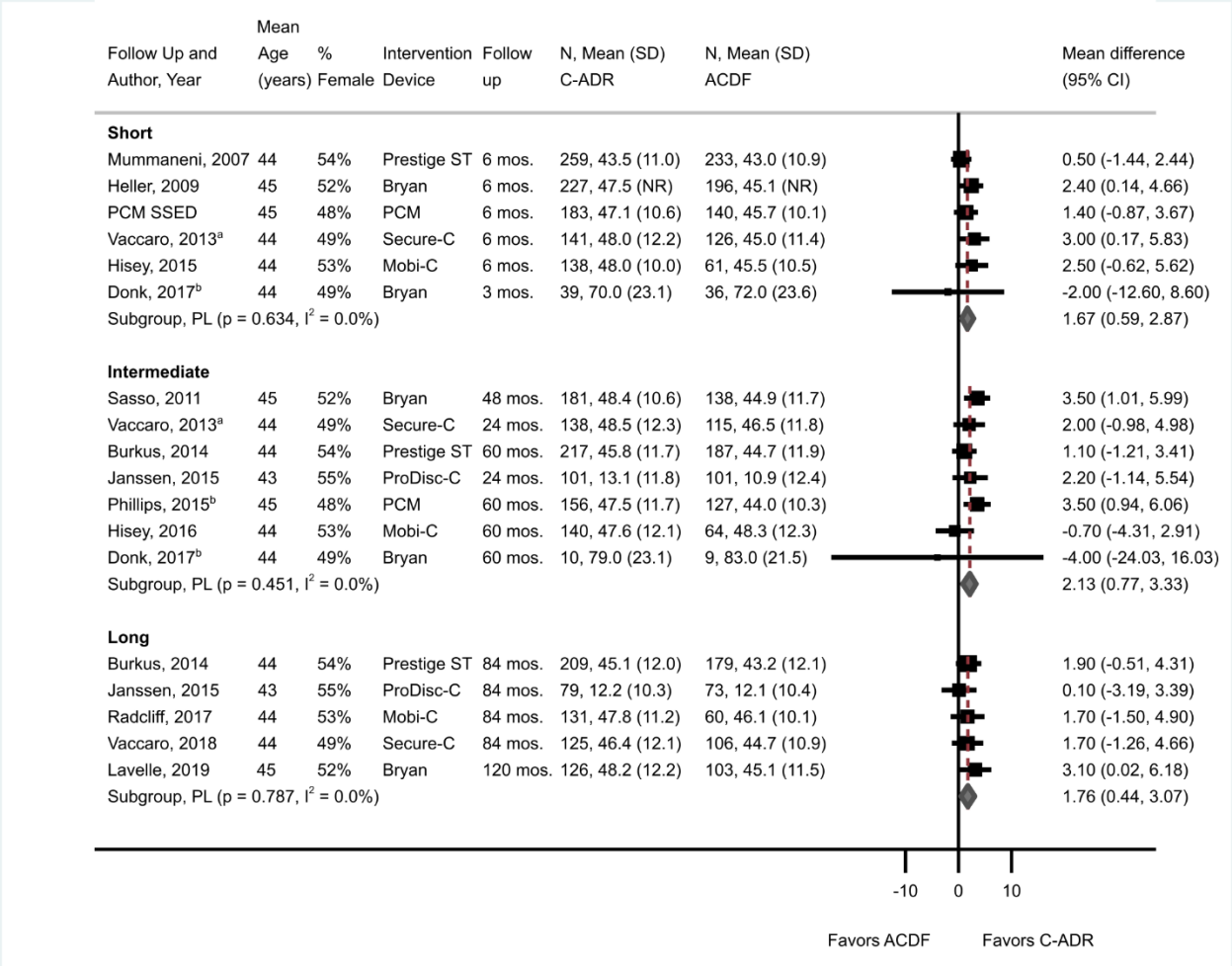


ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; FDA = Food and Drug Administration; MCS = Mental Component Score; mos. = months; PL = profile likelihood; SF-12 = 12-Item Short Form Health Survey; SF-36 = 36-Item Short Form Health Survey; SSED = Summary of Safety and Effectiveness Data (FDA).

Seven RCTs (N=2,368) (in 14 publications)[60,69,75,77,78,81,84,86,92,95-98,116] that compared cervical arthroplasty with ACDF reported SF-36/12 PCS and MCS scores (0-100 scale). There were no differences between cervical arthroplasty and ACDF in PCS scores (Figure 16) as estimates were below the threshold for a small effect in the short-term (6 RCTs, N=1,779, MD 1.67, 95% CI 0.59 to 2.87, I^2=0%), intermediate term (7 RCTs, N=1,684, MD 2.13, 95% CI 0.77 to 3.33, I^2=0%), or long term (5 RCTs, N=1,191, MD 1.76, 95% CI 0.44 to 3.07, I^2=0%). Similarly, there were no differences between cervical arthroplasty and ACDF in MCS scores (Figure 17) as estimates were below the threshold for a small effect in the short-term (6 RCTs, N=1,779, MD 1.14, 95% CI -0.14 to 2.17, I^2=0%), intermediate term (7 RCTs, N=1,814, MD 0.83, 95% CI -0.75 to 2.41, I^2=32.2%), and long term (3 RCTs, N=574, MD 0.64, 95% CI -1.47 to 2.82, I^2=0%). Effect estimates for PCS and MCS did not differ following the exclusion of one trial with unclear samples sizes.[69] No studies were rated high risk of bias.

3.9 Results, Key Question 8

Figure 16. SF-36 or SF-12 PCS scores (0-100): comparison of cervical arthroplasty with ACDF (1-level interventions)



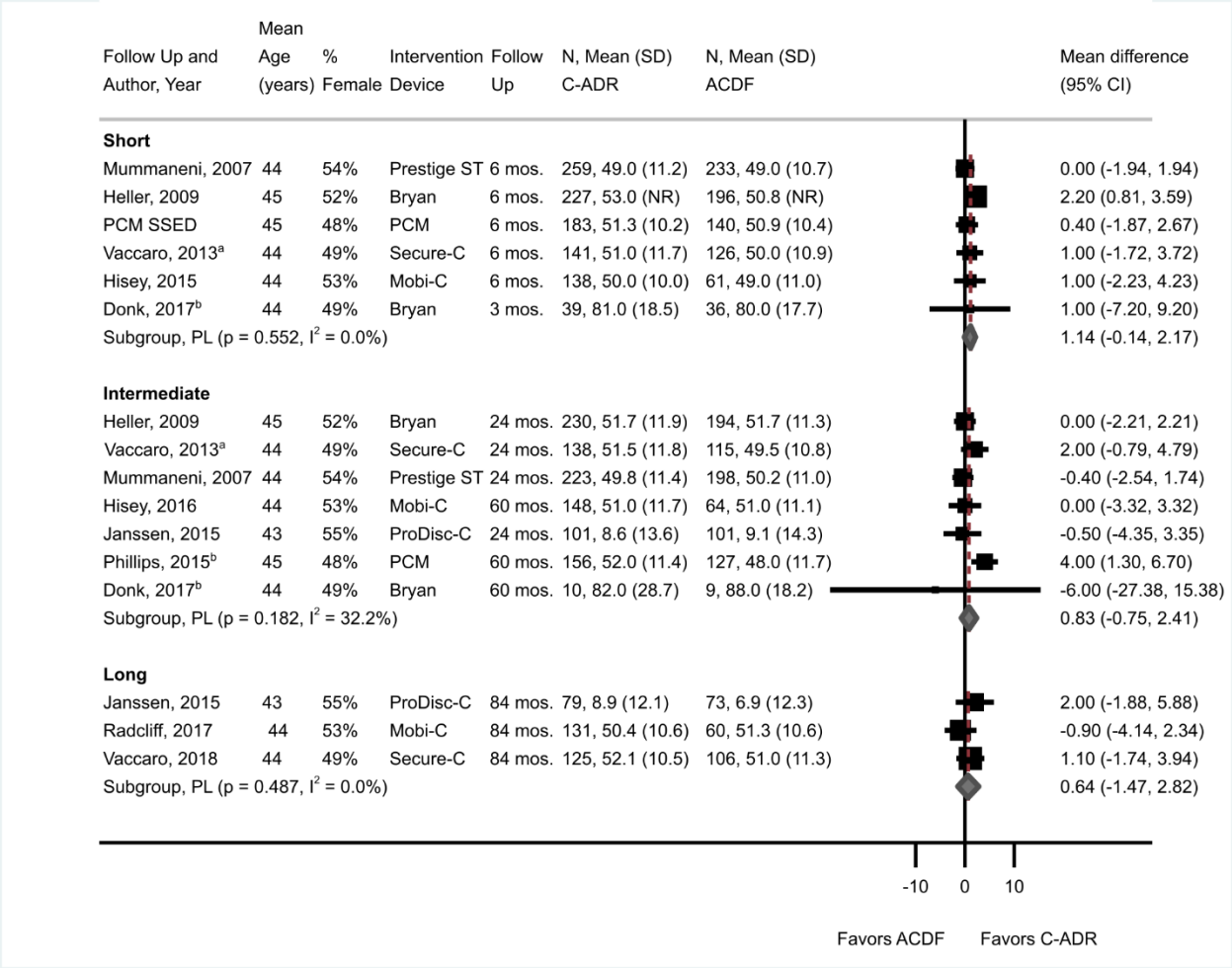
ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; FDA = Food and Drug Administration; mos. = months; PCS = Physical Component Score; PL = profile likelihood; SF-12 = 12-Item Short Form Health Survey; SF-36 = 36-Item Short Form Health Survey; SD = standard deviation; SSED = Summary of Safety and Effectiveness Data (FDA).

[a] n/N obtained from the SECURE-C SSED.

[b] Scores estimated from graphs in article.

3.9 Results, Key Question 8

Figure 17. SF-36 or SF-12 MCS scores (0-100): comparison of cervical arthroplasty with ACDF (1-level interventions)



ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; FDA = Food and Drug Administration; MCS = Mental Component Score; mos. = months; PL = profile likelihood; SF-12 = 12-Item Short Form Health Survey; SF-36 = 36-Item Short Form Health Survey; SD = standard deviation; SSED = Summary of Safety and Effectiveness Data (FDA).

[a] n/N obtained from the SECURE-C SSED.

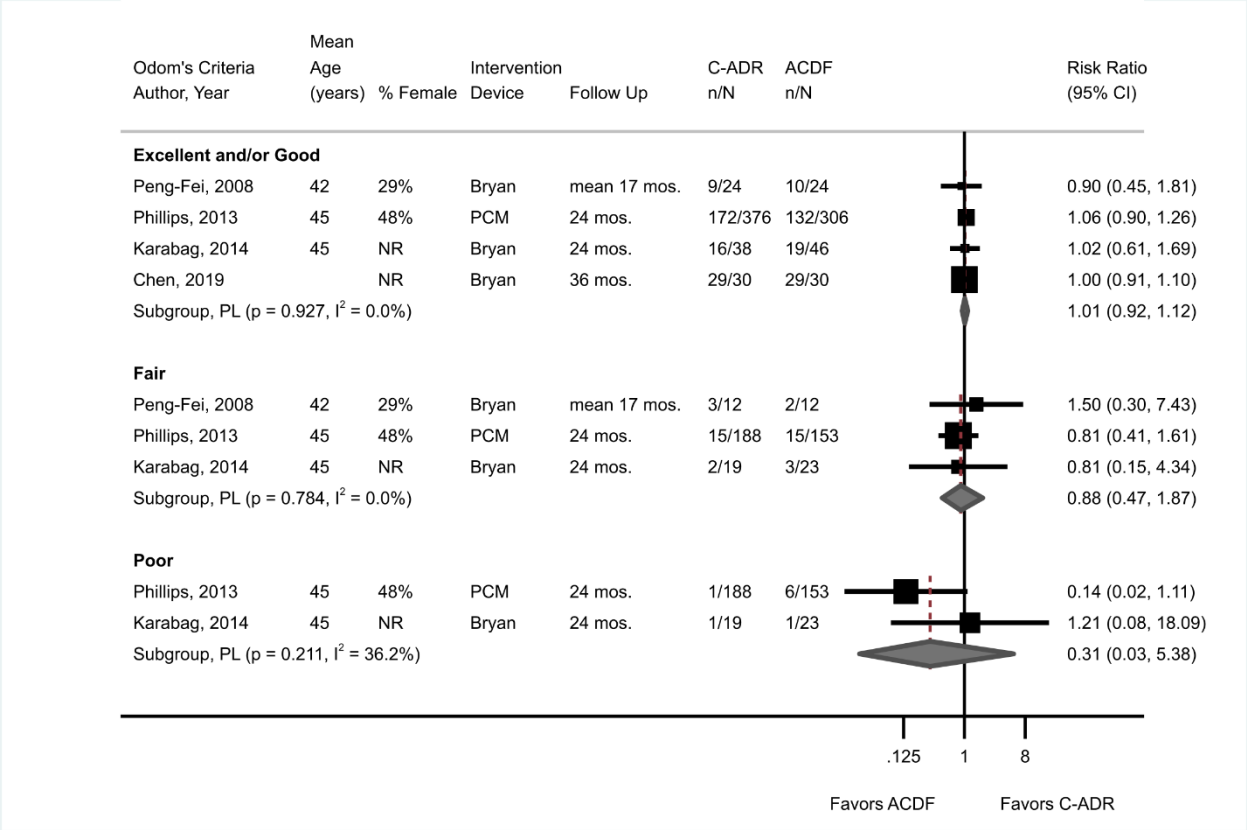
[b] Scores estimated from graphs in article.

3.9.3.1.3.2.3 Odom's Criteria

Four RCTs (N=553)[61,82,91,93] used Odom's criteria to categorize overall improvement as excellent (i.e., all pre-operative symptoms relieved, abnormal findings improved), good (i.e., minimal persistence of symptoms, abnormal findings unchanged or improved), fair (i.e., definite relief of some symptoms, others unchanged or slightly improved) or poor (i.e., symptoms and signs unchanged or exacerbated). There were no differences between single-level cervical arthroplasty and ACDF in the likelihood of having excellent or good results based on Odom's criteria (4 RCTs, N=847, 48.3% vs. 46.8%, RR 1.01, 95% CI 0.92 to 1.12, I^2=0%) at intermediate term.[61,82,91,93] However, three of the RCTs (all small) were rated high risk of bias,[61,82,91] while the one large RCT was rated moderate risk of bias.[93] Based on the highest quality trial, there was no difference between procedures in the likelihood of having excellent or good improvement (1 RCT, N=682, 45.7% vs. 43.1%)[93] (Figure 18). In one prospective NRSI IDE study using propensity-matched historical controls, there was no difference between cervical

arthroplasty and ACDF in the likelihood of having excellent or good results using Odom's criteria at 24 months (N=301, 90.5% vs. 79.9%).[120]

Figure 18. Odom's criteria: comparison of cervical arthroplasty with ACDF (1-level interventions)



ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; mos. = months; PL = profile likelihood.

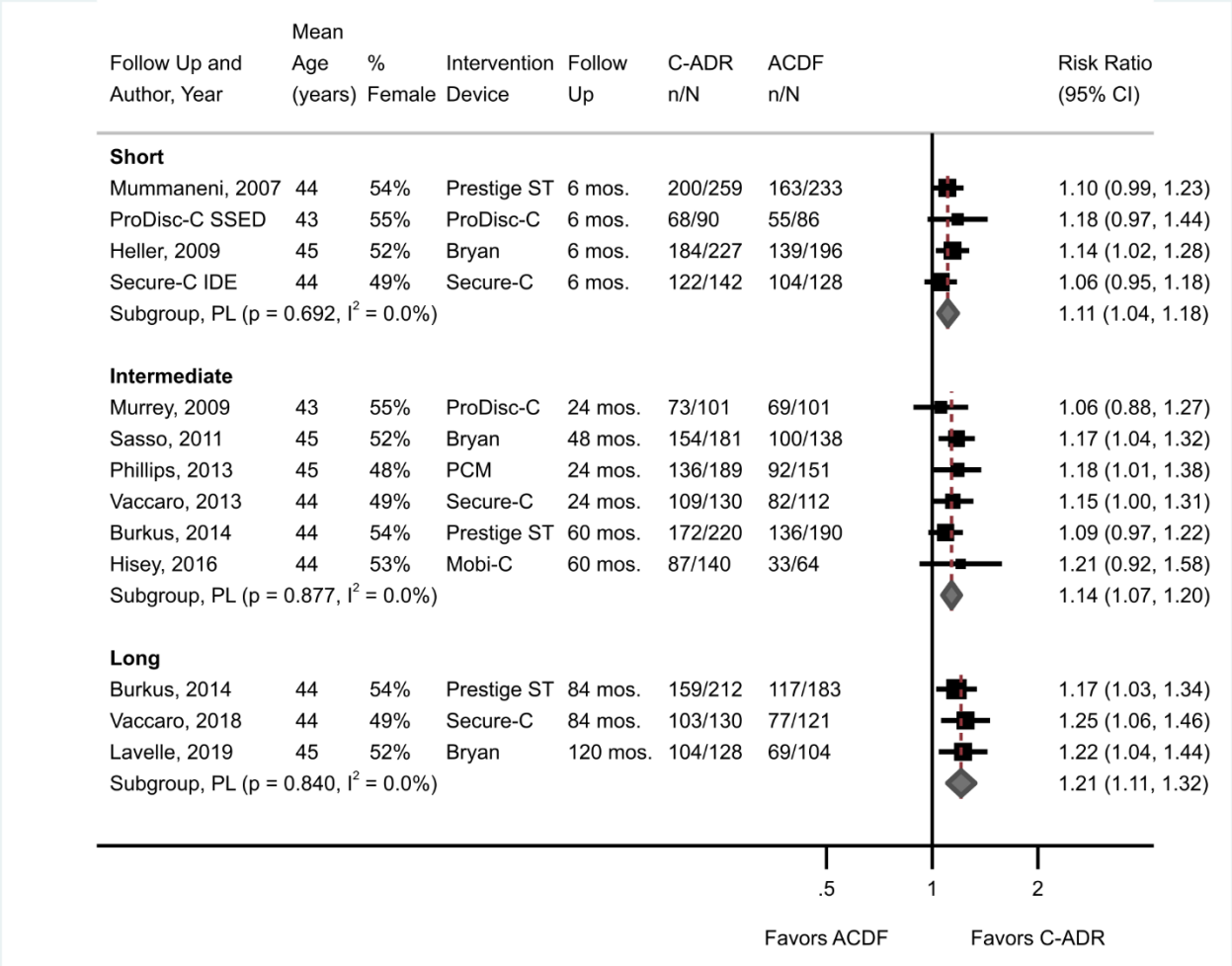
3.9.3.1.3.3 Overall Success (Composite)

The FDA IDE trials were required to report overall success, a composite outcome for six RCTs (N=2,271) (in 11 publications)[60,75,78,84,86,87,93,96,98,118,119] that included a threshold of ≥15-point NDI improvement (0-50 scale) from baseline, improvement or maintenance of neurologic status, no serious adverse events and no additional surgical procedures that might be considered "failure" (e.g., removal, revision, supplemental fixation). In participants with single-level interventions, effect estimates were below the threshold for a small effect and classified as no difference in overall success comparing cervical arthroplasty with ACDF in the short term (4 RCTs, N=1,361, 79.9% vs. 71.7%, RR 1.11, 95% CI 1.04 to 1.18, I^2=0%)[75,86,118,119] and intermediate term (6 RCTs, N=1,717, 76.1% vs. 67.7%, RR 1.14, 95% CI 1.07 to 1.20, I^2=0%);[60,78,87,93,96,98] but a slightly increased likelihood of overall success favoring cervical arthroplasty was seen long term (3 RCTs, N=878, 76.1% vs. 67.7%, RR 1.21, 95% CI 1.11 to 1.32, I^2=0%)[60,84,98] (Figure 19). In one prospective NRSI IDE study using propensity-matched historical controls, there was no difference between cervical arthroplasty and ACDF in overall response (same definition as in RCTs) at 24 months (N=301, 86.8% vs. 79.3%, p=0.265).[120]

One of the above trials reported overall success at 84 months using a different criterion for NDI (improvement in NDI score ≥30 points if preoperative score ≥60 or improvement of ≥50% if preoperative score <60) and included an additional requirement for radiographic success, and

was not included in the meta-analysis at long term; there was no difference between cervical arthroplasty and ACDF using this criteria (N=166, 55.2% vs. 50.0%, RR 1.10, 95% CI 0.80 to 1.52).[95]

Figure 19. Overall success: comparison of cervical arthroplasty with ACDF (1-level interventions)



ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; FDA = Food and Drug Administration; mos. = months; PL = profile likelihood; SSED = Summary of Safety and Effectiveness Data (FDA).

3.9.3.1.3.4 Quality of Life

None of the included studies reported on quality-of-life measures.

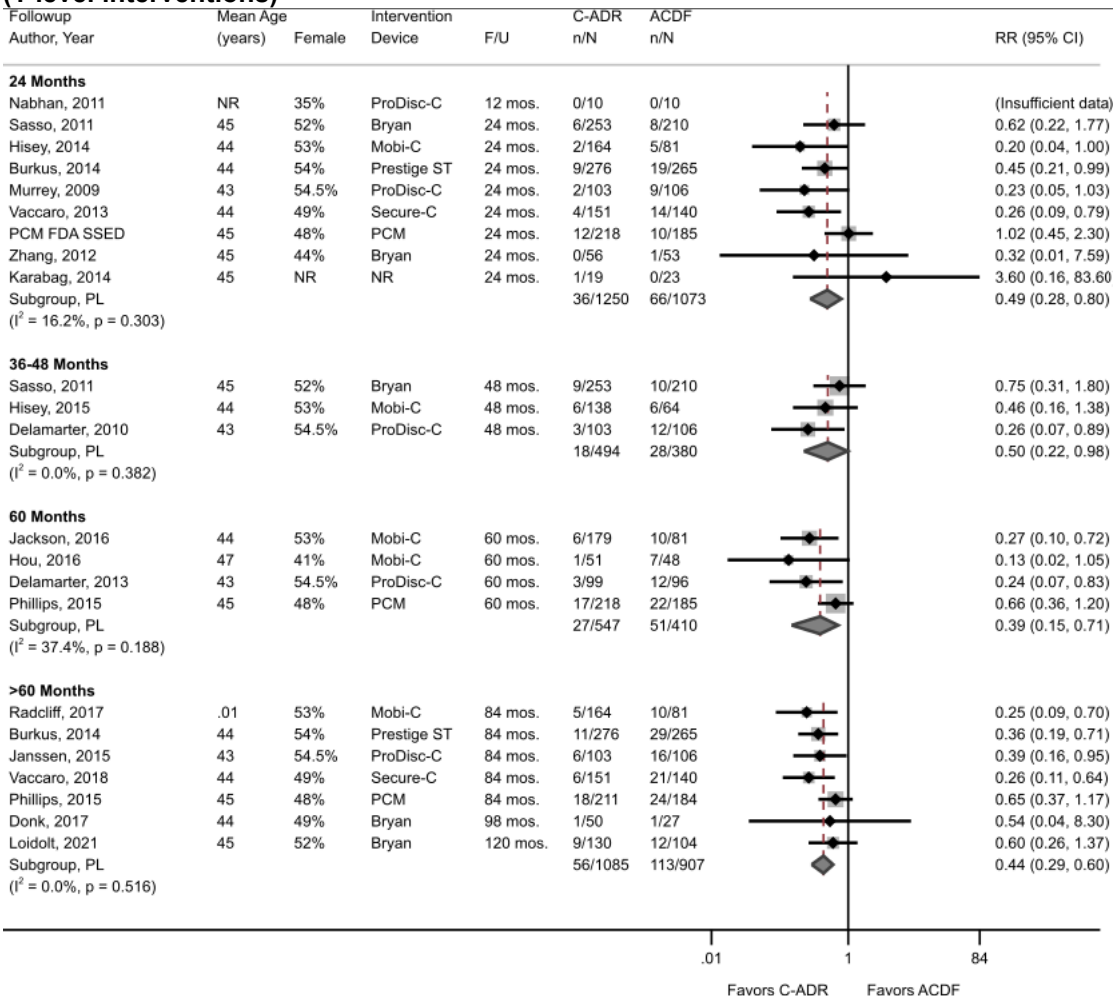
3.9.3.1.3.5 Reoperation and Subsequent Surgery

There was high-strength evidence that cervical arthroplasty was associated with substantially lower likelihood of reoperation that included the index level versus ACDF (SOE: High). Rates of reoperation for ACDF at the index level may be influenced by the need to remove an existing plate to treat adjacent segment disease (ASD), rather than the indication for reoperation being driven by an issue at the index procedure. This may artificially inflate the reported reoperation rate at the index procedure level for ACDF when compared with cervical arthroplasty. Studies were not consistently clear in the indication for reoperation. The clinical relevance of removing the plate as a part of a procedure addressing ASD is minimal.

3.9 Results, Key Question 8

Reoperation including any additional procedure at the index level was substantially less frequent with cervical arthroplasty versus ACDF for single-level disease at all time points reported in RCTs including short term up to 24 months (9 RCTs, N=2,323, 2.9% vs. 6.2%, RR 0.49, 95% CI 0.28 to 0.80, I^2=16.2%)[60,76,82,87,90,96,98,100,116] and long term from 84 to 120 months (7 RCTs, N=1,992, 5.2% vs. 12.5%, RR 0.44, 95% CI 0.29 to 0.60, I^2=0%)[60,69,81,85,92,95,97] (Figure 20).

Figure 20. Reoperation involving the index level: comparison of cervical arthroplasty with ACDF (1-level interventions)



ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; FDA = Food and Drug Administration; mos. = months; PL = profile likelihood; SSED = Summary of Safety and Effectiveness Data (FDA).

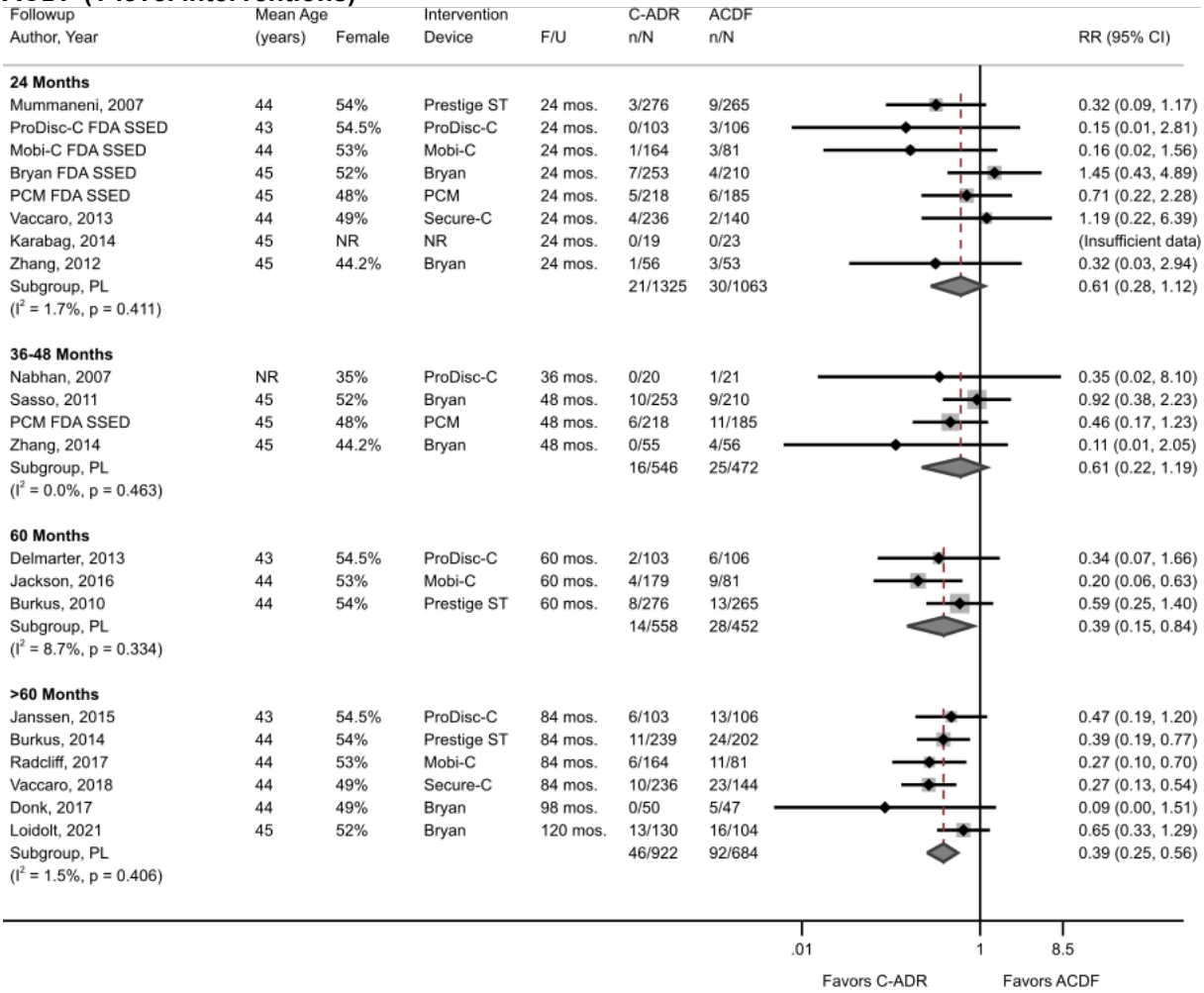
One prospective NRSI IDE study of cervical arthroplasty using historical ACDF controls found no difference in index-level reoperation up to 24 months (N=349, 1.9% vs. 4.8%, RR 0.39, 95% CI 0.11 to 1.43).[120]

Reoperation across two NRSIs was less common than that reported in RCTs. No difference in 30-day reoperation was seen in one NRSI (1.2% vs. 0.4%, adjusted OR 0.60, 95% CI 0.14 to 2.56).[109] Another NRSI reported that reoperation was less common following cervical arthroplasty within 90 days of index surgery compared with ACDF (2.04% vs. 3.35%, adjusted

OR 0.63, 95% CI 0.44 to 0.92) but no difference between cervical arthroplasty and ACDF longer-term up to 5 years (adjusted hazard ratio 0.86, 95% CI 0.60 to 1.23).[108] While overall reoperation rates were lower in these database NRSIs, it is possible the RCTs, particularly IDE trials may provide more accurate detail regarding specific indications.

Subsequent surgery rates at adjacent levels were similar between cervical arthroplasty and ACDF at up to 24 months[82,86,98,100,114-116,118] and between 36 and 48 months (including after exclusion of one trial rated high risk of bias[101])[89,96,101,116] but was substantially less likely with cervical arthroplasty versus ACDF at 60 months (3 RCTs, N=1,010, 2.5% vs. 6.2%, RR 0.39, 95% CI 0.15 to 0.84, I^2=8.7%)[59,68,80] and at the longest followups from 84 to 120 months (6 RCTs, N=1,606, 5.0% vs. 13.5%, RR 0.39, 95% CI 0.25 to 0.56, I^2=1.5%).[60,69,81,85,95,97] However, estimates were somewhat imprecise (Figure 21). Also, across trials, indications for operation at adjacent levels were not consistently described.

Figure 21. Subsequent surgery at adjacent levels: comparison of cervical arthroplasty versus ACDF (1-level interventions)



ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; FDA = Food and Drug Administration; mos. = months; PL = profile likelihood; SSED = Summary of Safety and Effectiveness Data (FDA).

3.9.3.1.3.6 Harms

All 15 RCTs that evaluated cervical arthroplasty and ACDF for single-level disease provided information on adverse events and harms up to 120 months followup.[60,61,69,76,79,82,87,89,90,92,96,98,100,101,116] Information on harms from four NRSIs was used to complement that from RCTs.[106,108,109,120]

3.9.3.1.3.6.1 Neurologic Deficit

There was low-strength evidence of no differences in the likelihood of neurological events or deficits between cervical arthroplasty and ACDF in the short, intermediate, or long term (SOE: Low).

Reporting of neurological events varied across RCT publications. Three publications assessed events from the Bryan IDE trial at different times;[58,85,96] one IDE trial evaluated Mobi-C.[95] One trial[58] described specific, observed neurological events as acute neurological changes, while other trials used various general terms to describe neurologic events (e.g., new deficit, neurological failure, neurological adverse event). The timing of events following surgery was also not clearly reported. Thus, reported proportions of participants who experienced neurological events varied substantially across RCTs, however there were no differences between cervical arthroplasty and ACDF at 0 to 24 months (3.3% vs. 3.2%),[58] between 24 and 48 months (0% vs. 1.0%, WHO grade 3 or 4),[96] up to 84 months (11.4 % vs. 11.5%),[95] or up to 120 months (any: 43.1% vs. 43.8%; WHO grade 3 or 4: 4.5% vs. 6.9%).[85] One prospective NRSI IDE study of cervical arthroplasty that used propensity-matched historical ACDF controls reported no differences in serious device- or procedure-related neurological adverse events between cervical arthroplasty and ACDF (1.3% vs. 1.6%) through 24 months.[120] The same trial study also reported fewer cervical arthroplasty participants experienced neurological decrease from baseline versus ACDF (6.7% vs. 12.8%, RR 0.52, 95% CI 0.25 to 1.07) but results were imprecise.

3.9.3.1.3.6.2 Mortality

There was inadequate evidence to draw conclusions on the likelihood of death in participants undergoing cervical arthroplasty versus ACDF (SOE: Insufficient).

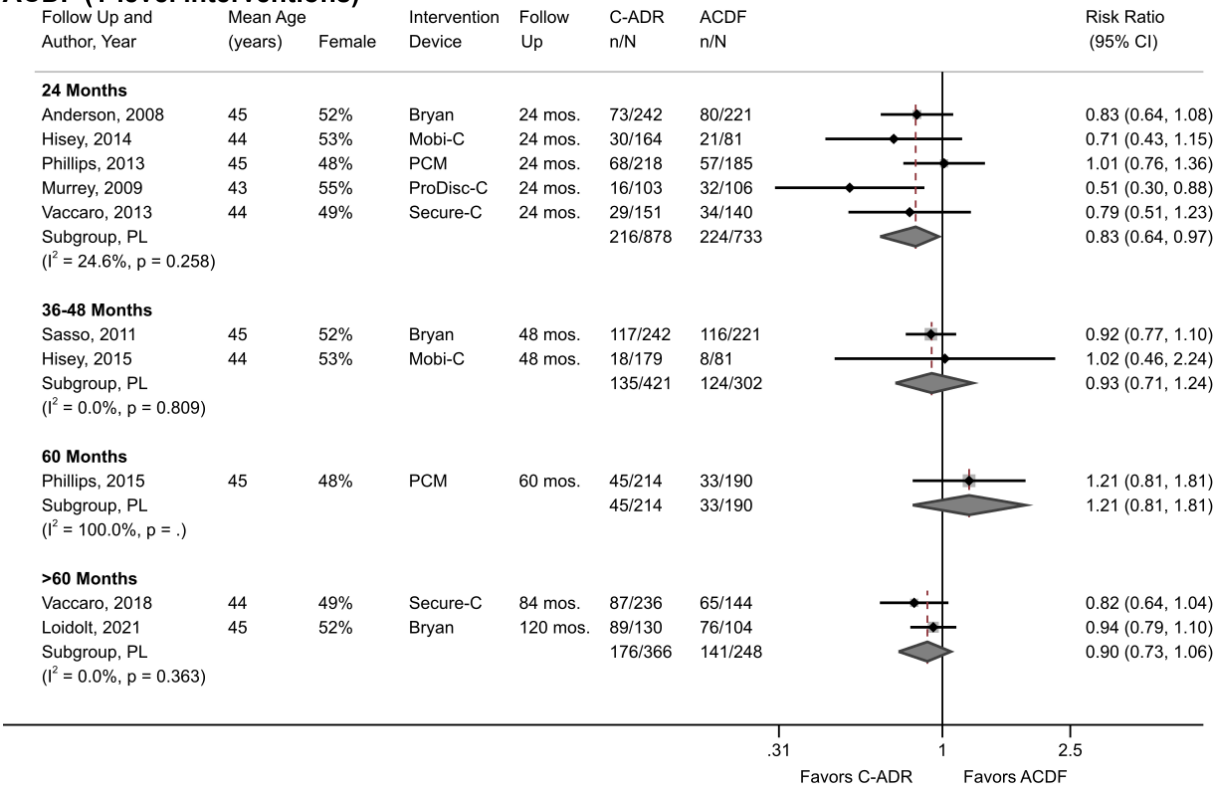
Death was uncommon (<3%) in RCTs and NRSIs, with no reported differences between cervical arthroplasty and ACDF. Across RCTs, no deaths were directly attributed to either procedure, however cause of death was not reported in many trials. For cervical arthroplasty from 0 to 24 months, three of the four deaths were attributed to myocardial infarction or cardiac arrest in one trial;[60] the cause of the fourth death was not reported in another trial.[98] No deaths were observed in one trial.[76] At followup from 0 to 36 months, one cervical arthroplasty participant died of a severe subarachnoid hemorrhage at 6 weeks (relationship to procedures was not stated)[89] and one death in the ACDF group attributed to a motor vehicle accident was observed in another trial.[58] There was no difference in mortality between procedures at 84 months (1 RCT, N=541, 0.9% vs. 2.2%, RR 0.38, 95% CI 0.08 to 1.96)[60] or at 120 months (1 RCT, N=232, 1.4% vs. 2.4%, RR 0.54, 95% CI 0.09 to 3.18),[85] however estimates were imprecise. Findings from one large administrative data NRSI[108] reinforce that death was rare for cervical arthroplasty (0%) and ACDF (0.18%) and that there was no difference between procedures in the likelihood of mortality. One death occurred in the cervical arthroplasty group in one NRSI IDE study using historical controls up to 24 months[120] (Appendix C).

3.9.3.1.3.6.3 Serious Adverse Events

There was low-strength evidence that cervical arthroplasty was associated with a slightly lower likelihood of any serious adverse event in the short term versus ACDF (SOE: Low); there was also low-strength of no differences in the likelihood of experiencing a serious adverse events at greater than 24 months (SOE: Low).

Serious adverse event definitions and types of events varied across RCTs, but often included events that were life threatening, required medical intervention, or resulted in a permanent disability or death. Timing of events was not reported. Events related to participant factors such as comorbidities (e.g., underlying cardiovascular disease) would likely not be different between procedures. Cervical arthroplasty was associated with a slightly lower likelihood of experiencing a serious adverse event up to 24 months across IDE trials (5 RCTs, N=1,611, 24.6% vs. 30.6%, RR 0.83, 95% CI 0.64 to 0.97, I^2= 24.6%)[58,76,87,93,98] compared with ACDF, however across fewer trials at other times, no differences between procedures was seen (Figure 22). No difference in the likelihood of experiencing a serious adverse events was seen between cervical arthroplasty and ACDF (N=349, 9.4% vs. 14.8%, RR 1.97, 95% CI 0.88 to 4.37) in one NRSI IDE study using historical controls up to 24 months.

Figure 22. Any serious adverse events (author defined): comparison of cervical arthroplasty with ACDF (1-level interventions)



ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; mos. = months; PL = profile likelihood.

Dysphagia was reported by six RCTs (N=1,965) (in 8 publications),[58,60,68,69,76,81,85,98] but the severity was unclear in most cases. One trial (N=463) reported no cases of WHO grade 3 or 4 dysphagia in any participant through 24 months followup.[58]

3.9 Results, Key Question 8

NRSIs based on administrative data suggest that serious adverse events are rare and not different between cervical arthroplasty and ACDF. Thrombolic event rates (DVT and/or pulmonary embolism) were similar between cervical arthroplasty (range 0.07% to 0.19%) and ACDF (0.10% to 0.11%) as reported by two large NRSIs.[106,108] One NRSI[108] reported rates of vertebral artery injury and dural tear of less than 1 percent in for each procedure. One NRSI reported low risk of dysphagia (0% vs. 0.13%)[109] but did not report dysphagia severity. Dysphagia was more common in cervical arthroplasty participants versus ACDF participants (9.4% vs. 6.3%) but severity was not described in one prospective NRSI IDE study using historical ACDF controls.[120]

3.9.3.1.3.6.4 Heterotopic Ossification

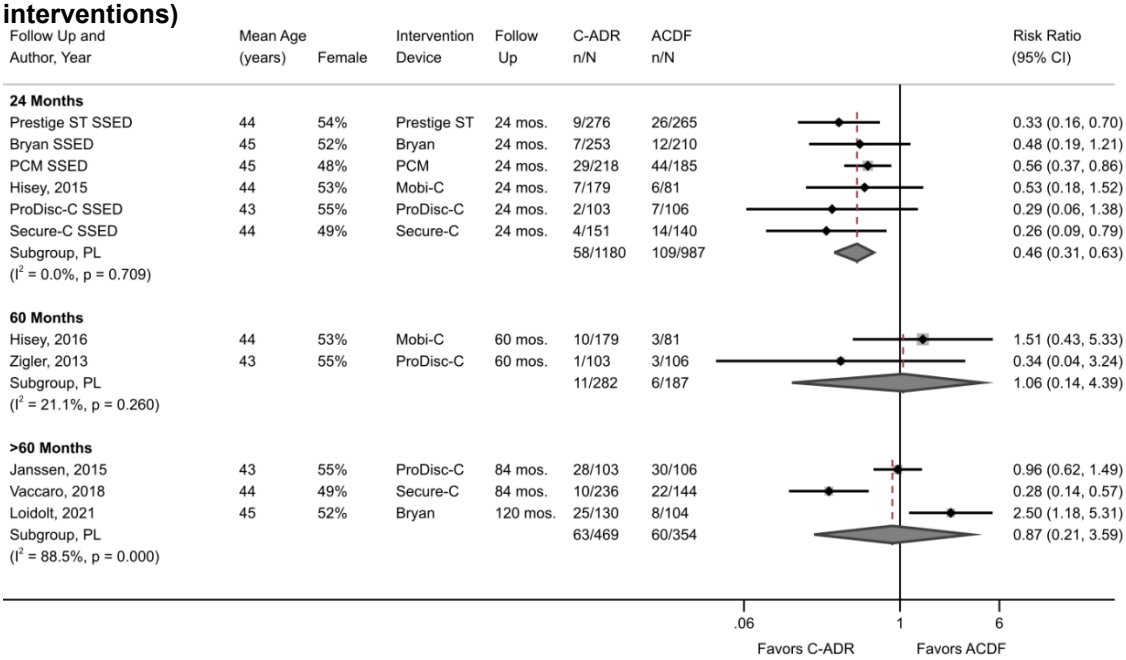
Grade 3 or 4 heterotopic ossification (HO), considered clinically relevant HO by most of the trials, may be of concern with cervical arthroplasty. Across five RCTs (N=525 for cervical arthroplasty arm, range 30 to 182), 9.5 percent of participants (range, 1.8% to 12.8%) developed Grade 3 or 4 HO across 24 to 84 months followup.[61,92,95,97,100] In addition, one FDA IDE NRSI (n=150 in cervical arthroplasty arm) reported rates of grade 3 or 4 HO at 24 months (11.3%; 0.7%, grade 4).[105] Rates of Grade 1 or 2 (or unclear grades) of HO ranged from 0 to 32.7 percent across seven trials (N range for cervical arthroplasty arms, 51 to 201) over 12 to 84 months followup[60,61,76,79,81,100,101] and was 44 percent at 24 months in the NRSI.[105]

3.9.3.1.3.6.5 Device-Related Adverse Events

Device-related adverse event definitions, types of events and adjudication varied across RCTs. Some trials included a range of events such as adjacent-level degenerative joint changes, headache as well as neurological events. Some device-related events may only occur with cervical arthroplasty, others may only occur with ACDF (e.g., nonunion). Some events may not be persistent or serious (e.g., superficial wound infection, dysphagia). Cervical arthroplasty was associated with substantially lower likelihood of device-related events at 24 months (6 RCTs, N=2,167, 4.9% vs. 11%, RR 0.46, 95% CI 0.31 to 0.63, I^2=0%).[77,115-119] No difference was seen across two trials at 60 months,[78,102] but results across three trials at >60 months[81,85,97] were inconsistent (Figure 23).

3.9 Results, Key Question 8

Figure 23. Device-related adverse events: comparison of cervical arthroplasty with ACDF (1-level interventions)



ACDF = anterior cervical discectomy and fusion; CI = confidence interval; mos. = months; PL = profile likelihood; SSED = Summary of Safety and Effectiveness Data (FDA).

3.9.3.1.3.6.6 Differential Effectiveness (Heterogeneity of Treatment Effect [HTE])

None of the included trials that compared single-level cervical arthroplasty and ACDF interventions reported differential effectiveness based on patient or other characteristics.

3.9.3.2 Two-Level Cervical Arthroplasty Versus ACDF

Four RCTs (N=872) (in 11 publications)[63,65,66,71-73,80,83,94,95,99] compared two-level cervical arthroplasty and ACDF, including two FDA IDE trials (in 9 publications)[65,66,71-73,80,83,94,95] and two non-IDE trials.[63,99] One FDA IDE NRSI[104] compared a novel polyetheretherketone (PEEK)-on-ceramic cervical arthroplasty with propensity score-matched historical ACDF controls (structural allograft and plate) from a multicenter RCT initiated in the mid-2000s that was not referenced.

3.9.3.2.1 Fusion

Two RCTs (N=727) (across 4 publications) that compared two-level cervical arthroplasty and ACDF procedures reported fusion success in their ACDF arms.[71,83,94,95] No trials reported short-term fusion success. Two RCTs (N=243) reported intermediate-term fusion success in 92.5 percent (range: 90.5% to 94.0%) of participants.[83,94] Two RCTs (N=196) reported long-term fusion success in 92.6 percent (range: 90.9% to 93.8%) of participants.[71,95] One IDE NRSI[104] comparing a novel cervical arthroplasty versus historical ACDF controls reported pseudarthrosis in 6.5 percent of the ACDF group.

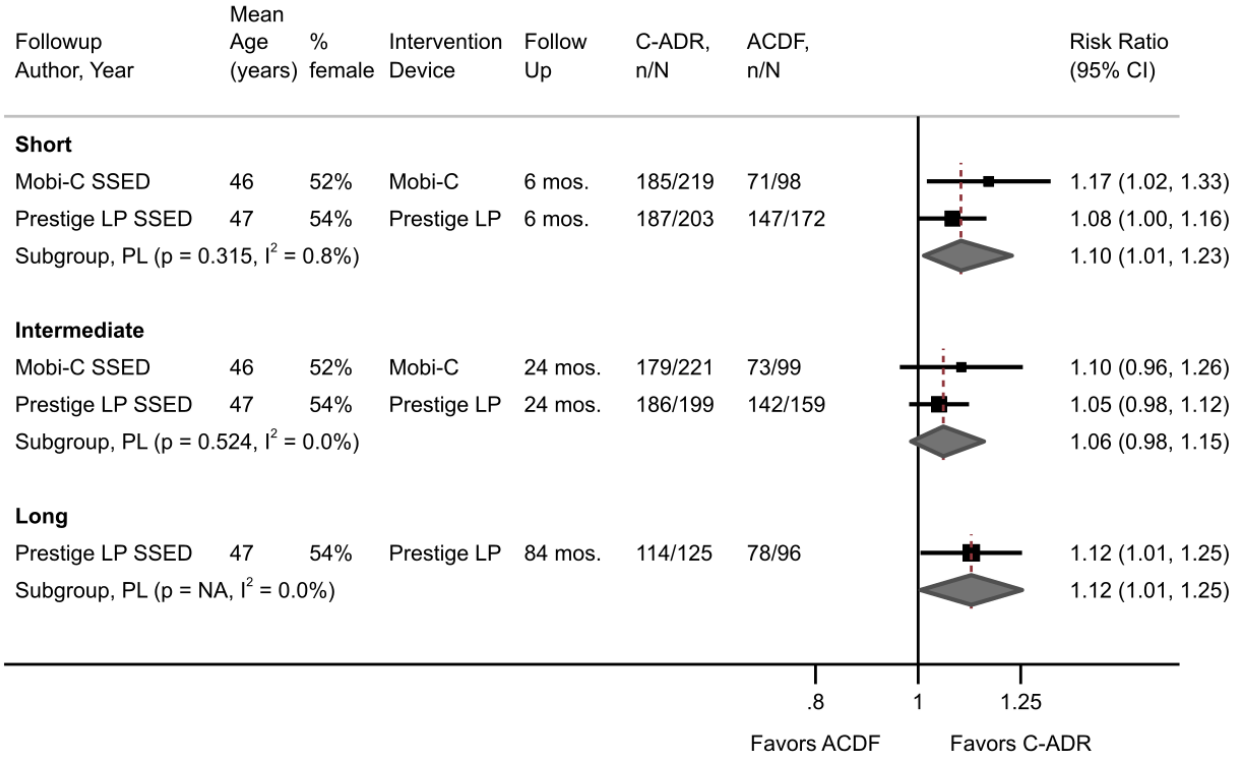
3.9.3.2.2 Pain

3.9.3.2.2.1 Neck Pain

There was moderate-strength evidence of no difference between cervical arthroplasty and ACDF on neck pain (SOE: Moderate).

Two RCTs (N=727)[121,122] that compared cervical arthroplasty with ACDF reported neck pain success (response) defined as postoperative ≥20-point improvement on VAS (0-100 scale). In participants having two-level interventions there were no differences in likelihood of neck pain success between cervical arthroplasty and ACDF in the short term (2 RCTs, N=692, 88% vs. 80.7%, RR 1.10, 95% CI 1.01 to 1.23, I^2= 0.8%),[121,122] intermediate term (2 RCTs, N=678, 86.9% vs. 83.3%, RR 1.06, 95% CI 0.98 to 1.15, I^2=0%),[121,122] and long term (1 RCT, N=221, 91.2% vs. 81.3%, RR 1.12, 95% CI 1.01 to 1.25)[122] as estimates were below the threshold for a small effect (Figure 24). There was also no difference long term between cervical arthroplasty and ACDF in the trial using a threshold of ≥10-point improvement for neck pain success that was not included in the meta-analysis (1 RCT, N=269, 86% vs 77.7%, RR 1.11, 95% CI 0.97 to 1.32).[95]

Figure 24. Neck pain success (≥20-point improvement on VAS): comparison of cervical arthroplasty with ACDF (2-level interventions)

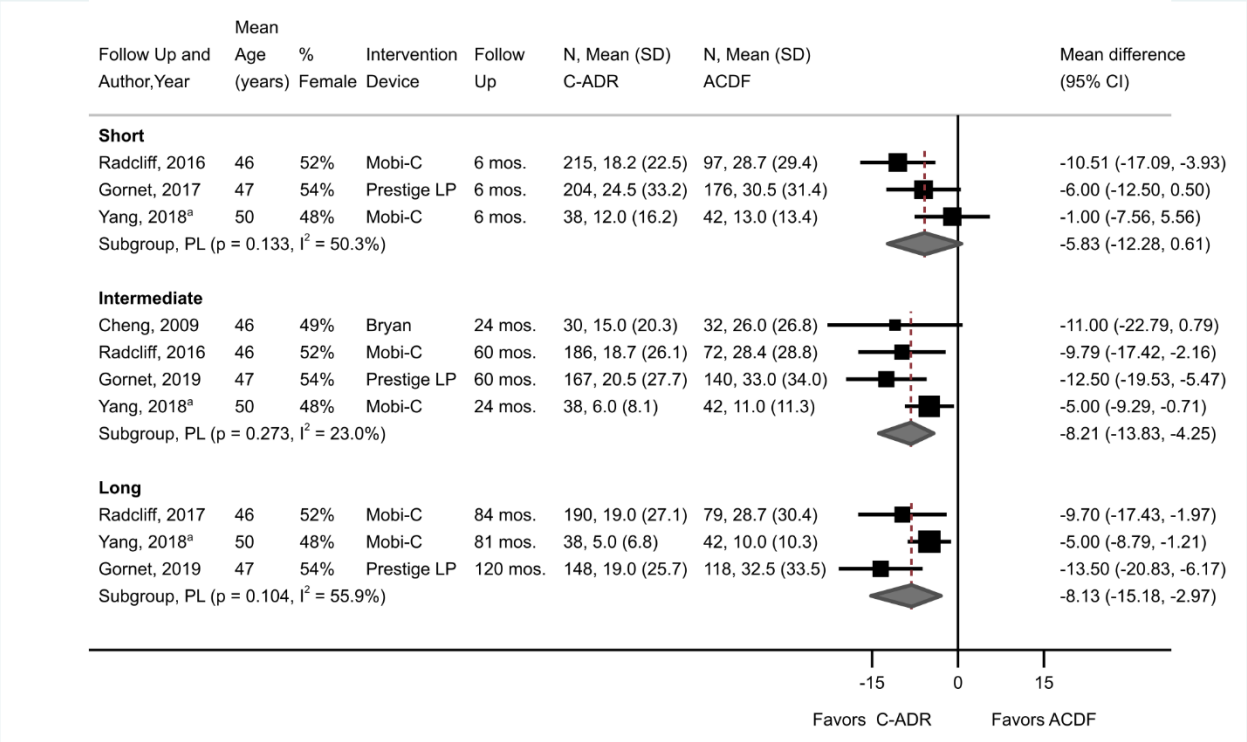


ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; FDA = Food and Drug Administration; mos. = months; PL = profile likelihood; SSED = Summary of Safety and Effectiveness Data (FDA); VAS = visual analogue scale.

There was no difference in VAS neck pain scores (0-100 scale) between cervical arthroplasty and ACDF short term (3 RCTs, N=764, MD -5.83, 95% CI -12.28 to 0.61, I^2=50.3%).[72,94,99] Cervical arthroplasty was associated with a small pain improvement versus ACDF in the intermediate term (4 RCTs, N=707, MD -8.21, 95% CI -13.83 to -4.25, I^2=23%)[63,71,94,99] and

long term (3 RCTs N=615, MD -8.13, 95% CI -15.18 to -2.97, I^2=55.9%)[71,95,99] (Figure 25). One IDE NRSI that compared a novel cervical arthroplasty versus historical ACDF controls reported no differences in mean VAS neck pain intensity at short- or intermediate term (N=352, 1.8 vs. 2.5 at both times, p>0.10).[104]

Figure 25. Neck pain scores (0-100): comparison of cervical arthroplasty with ACDF (2-level interventions)



ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; FDA = Food and Drug Administration; mos. = months; PL = profile likelihood; SD = standard deviation.
[a] Scores estimated from graphs in article.

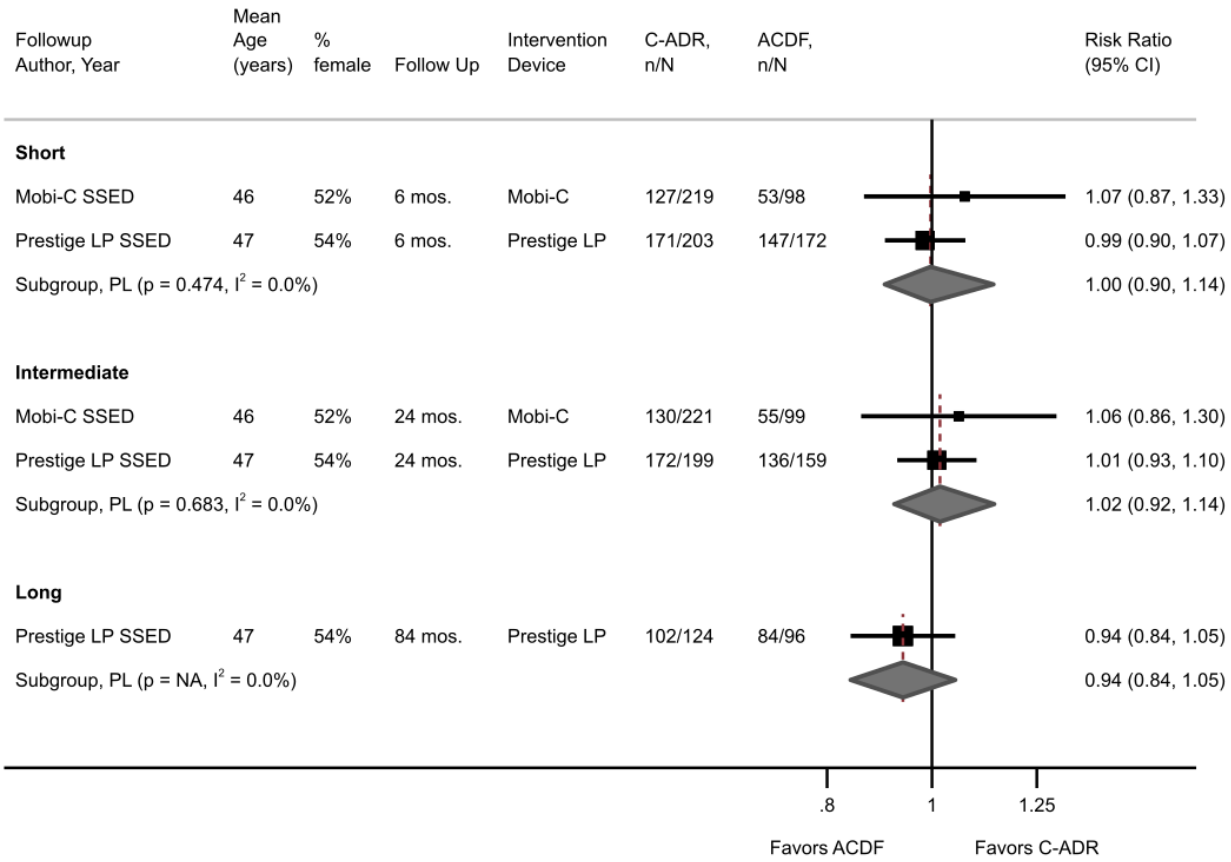
3.9.3.2.2.2 Arm Pain

There was moderate-strength evidence of no difference between cervical arthroplasty and ACDF on arm pain (SOE: Moderate).

Two RCTs (N=727)[121,122] that compared cervical arthroplasty with ACDF reported arm pain success (response) defined as postoperative ≥20-point improvement on VAS (0-100 scale). Some studies reported arm pain success in both arms. Using conservative estimates (the lower risk ratio), there were no differences in likelihood of arm pain success between cervical arthroplasty and ACDF at short term (2 RCTs, N=692, 70.6% vs. 74.1%, RR 1.0, 95% CI 0.90 to 1.14, I^2= 0%),[121,122] intermediate term (2 RCTs, N=678, 71.9% vs.74.0%, RR 1.02, 95% CI 0.92 to 1.14, I^2= 0%),[121,122] or long term (1 RCT, N=220, RR 0.94, 95% CI 0.84 to 1.05)[122] (Figure 26). Estimates and conclusions using the higher risk ratios from the other arm were similar.

3.9 Results, Key Question 8

Figure 26. Arm pain success (≥20-point improvement on VAS): comparison of cervical arthroplasty with ACDF (2-level interventions)

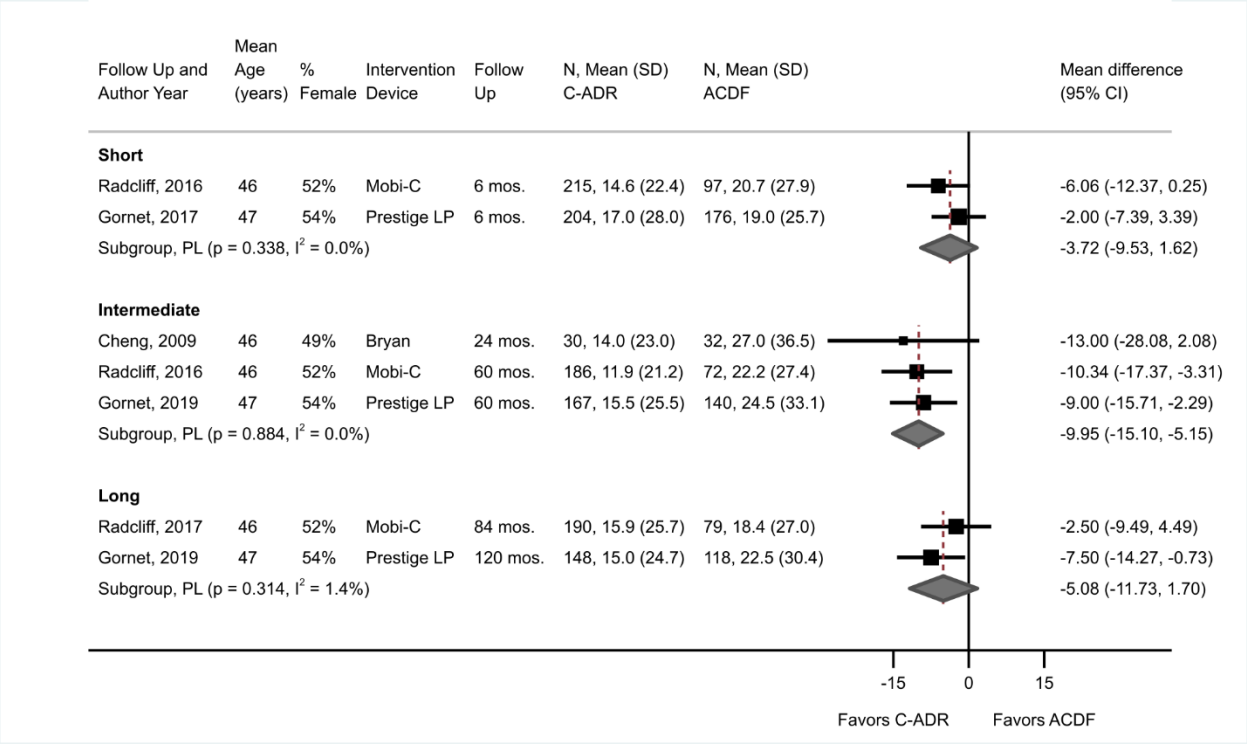


ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; FDA = Food and Drug Administration; mos. = months; PL = profile likelihood; SSED = Summary of Safety and Effectiveness Data (FDA); VAS = visual analogue scale.

Three RCTs (N=792) (in 5 publications)[63,71,72,94,95] reported arm pain scores (0-100). Some trials reported arm pain scores in both arms. Conservative estimates (using the smaller mean differences) are reported here. There was no difference in VAS arm pain scores (0-100 scale) between cervical arthroplasty and ACDF in the short term (2 RCTs, N=692, MD -3.72, 95% CI -9.53 to 1.62, I^2=0%).[72,94] Cervical arthroplasty was associated with a small pain improvement versus ACDF at intermediate term (3 RCTs, N=627, MD -9.95, 95% CI -15.10 to -5.15, I^2=0%)[63,71,94] but not long term (2 RCTs N=535, MD -5.08, 95% CI -11.73 to 1.70, I^2=1.4%)[71,95] (Figure 27). One IDE NRSI (N=352) that compared a novel cervical arthroplasty versus ACDF using historical controls reported no differences in mean VAS arm pain intensity at short (1.6 vs. 1.7) or intermediate term (1.8 vs. 1.6).[104]

3.9 Results, Key Question 8

Figure 27. Arm pain scores (0-100): comparison of cervical arthroplasty with ACDF (2-level interventions)



ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; FDA = Food and Drug Administration; mos. = months; PL = profile likelihood; SD = standard deviation; SSED = Summary of Safety and Effectiveness Data (FDA).

3.9.3.2.3 Function

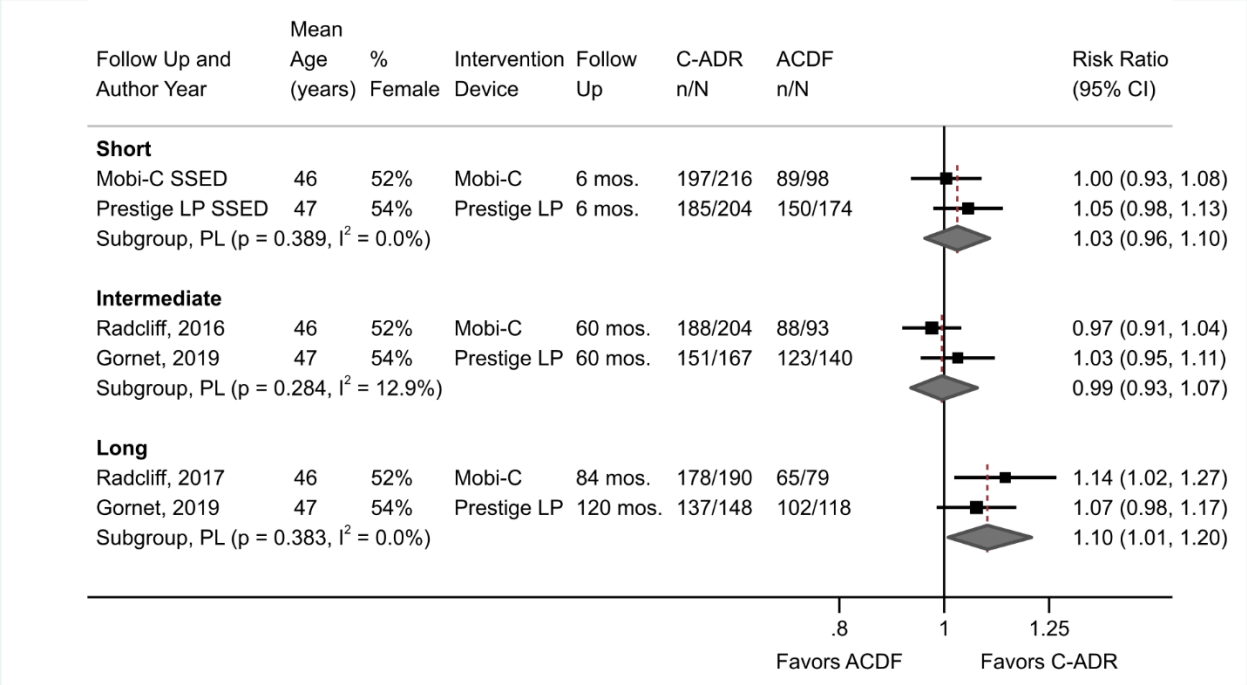
3.9.3.2.3.1 Neurologic Function

There was moderate-strength evidence of no difference between cervical arthroplasty and ACDF on neurologic function (SOE: Moderate).

Two IDE RCTs (N=727) (in 5 publications)[71,94,95,121,122] that compared cervical arthroplasty with ACDF reported neurologic success (response), defined as maintenance or improvement (compared with preoperative status) in motor function, sensory function, and deep tendon reflexes. In participants with two-level interventions, there was no difference in likelihood of neurologic success between cervical arthroplasty and ACDF at short term (2 RCTs, N=692, 91.0% vs. 87.9%, RR 1.03, 95% CI 0.96 to 1.10, I^2= 0%),[121,122] intermediate term (2 RCTs, N=604, 91.4% vs. 90.6%, RR 0.99, 95% CI 0.93 to 1.07, I^2=12.9%)[71,94] or long term (2 RCTs, N=535, 93.2% vs. 84.8%, RR 1.10, 95% CI 1.01 to 1.20, I^2=0%; point estimate below the threshold for a small effect)[71,95] (Figure 28). The likelihood of neurological success, based on motor, sensory, and myelopathic gait assessments, was similar for cervical arthroplasty and ACDF in one IDE NRSI (N=352, 100% vs. 97.7%).[104]

3.9 Results, Key Question 8

Figure 28. Neurologic success: comparison of cervical arthroplasty with ACDF (2-level interventions)



ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; FDA = Food and Drug Administration; mos. = months; PL = profile likelihood; SSED = Summary of Safety and Effectiveness Data (FDA).

Mean JOA scores (0-17 scale) were similar following cervical arthroplasty and ACDF at short term (6 months, 15.2 vs. 14.9, p>0.05), intermediate term (15.4 vs. 15.3, p>0.05), and long term (81 months, 15.4 vs. 15.2, p>0.05) in one RCT (N=96).[99]

3.9.3.2.3.2 General Function

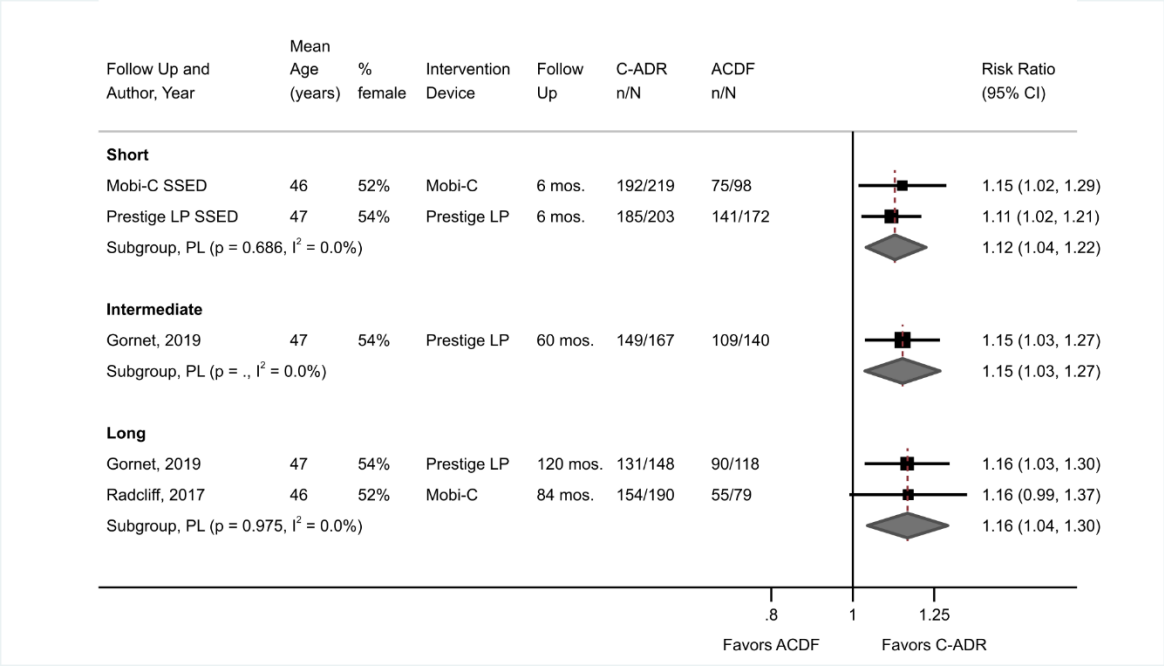
There was moderate-strength evidence of no difference between cervical arthroplasty and ACDF on general function (SOE: Moderate).

3.9.3.2.3.2.1 NDI

Two IDE RCTs (N=727) (in 4 publications)[71,95,121,122] and one IDE NRSI (N=352)[104] that compared cervical arthroplasty with ACDF reported NDI success defined as postoperative NDI score improvement of ≥15 points from baseline. One trial defined NDI success as improvement of ≥30 points from baseline and was not included in the meta-analysis.[66] Based on the threshold of ≥15 points from baseline, there were no differences between cervical arthroplasty and ACDF (i.e., although statistically significant, the differences between treatments were below the threshold for a small effect) at short term (2 RCTs, N=692, 89.3% vs. 80.0%, RR 1.12, 95% CI 1.04 to 1.22, I^2= 0%),[121,122] intermediate term (1 RCT, N=307, 89.2 % vs. 77.9%, RR 1.15, 95% CI 1.03 to 1.27)[71] and long term (2 RCTs, N=535, 84.3% vs. 73.6%, RR 1.16, 95% CI 1.04 to 1.30, I^2= 0%)[71,95] (Figure 29). There was no difference in the likelihood of NDI success between cervical arthroplasty and ACDF in one IDE NRSI (N=352, 92.3% vs. 85.5%, p>0.05).[104]

3.9 Results, Key Question 8

Figure 29. NDI success (≥15-point improvement): comparison of cervical arthroplasty with ACDF (2-level interventions)



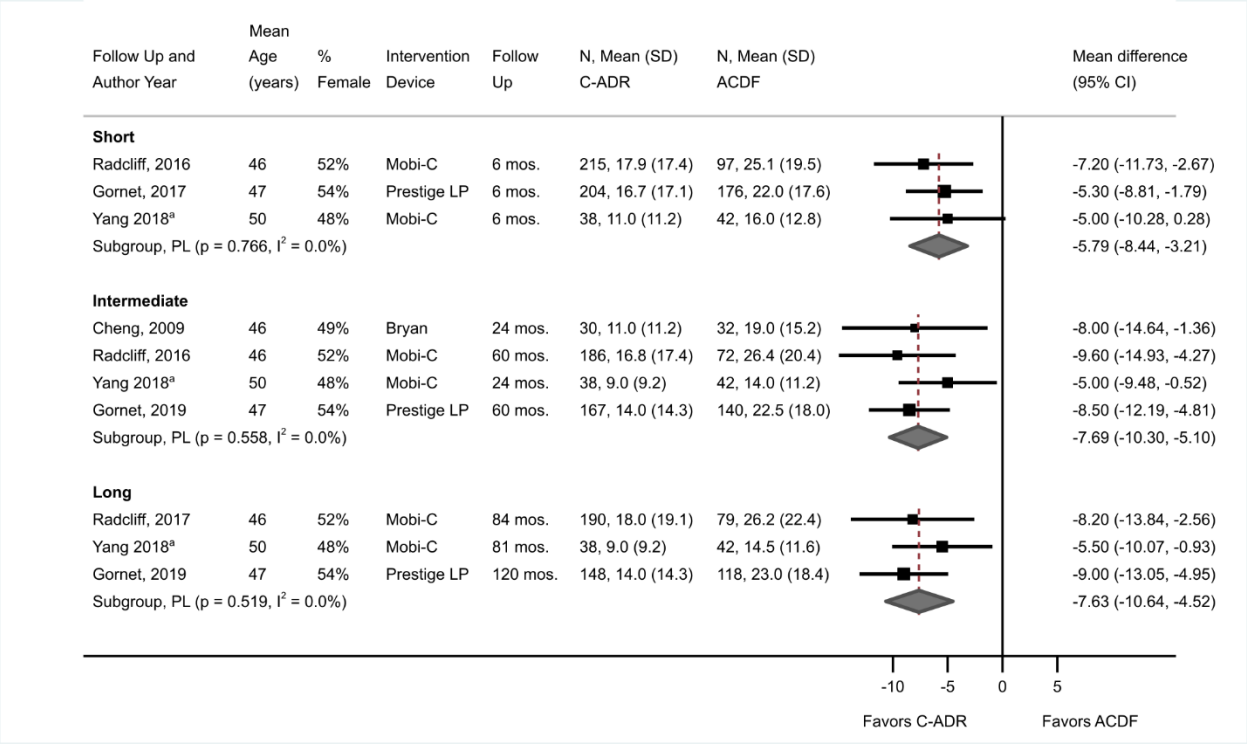
ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; FDA = Food and Drug Administration; mos. = months; NDI = Neck Disability Index; PL = profile likelihood; SSED = Summary of Safety and Effectiveness Data (FDA).

One RCT that defined NDI success as improvement of ≥30 points from baseline found a moderately higher likelihood of NDI success following cervical arthroplasty versus ACDF at intermediate term (1 RCT, N=359, 79.3% vs. 53.4%, RR 1.50, 95% CI 1.21 to 1.86).[66]

Four RCTs (N=872) (in 6 publications)[63,71,72,94,95,99] that compared cervical arthroplasty with ACDF reported NDI scores (0-100, higher score, more limitations). cervical arthroplasty was associated with a small improvement in function based on NDI scores at short (3 RCTs, N=772, MD -5.79, 95% CI -8.44 to -3.21, I^2=0%),[72,94,99] intermediate (4 RCTs, N=707, MD -7.69, 95% CI -10.30 to -5.10, I^2=0%),[63,71,94,99] and long term (3 RCTS, N=615, MD -7.63, 95% CI -10.64 to -4.52, I^2=0%)[71,95,99] (Figure 30).

3.9 Results, Key Question 8

Figure 30. NDI scores (0-100): comparison of cervical arthroplasty with ACDF (2-level interventions)



ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; FDA = Food and Drug Administration; mos. = months; NDI = Neck Disability Index; PL = profile likelihood; SD = standard deviation.
[a] Scores estimated from graphs in article.

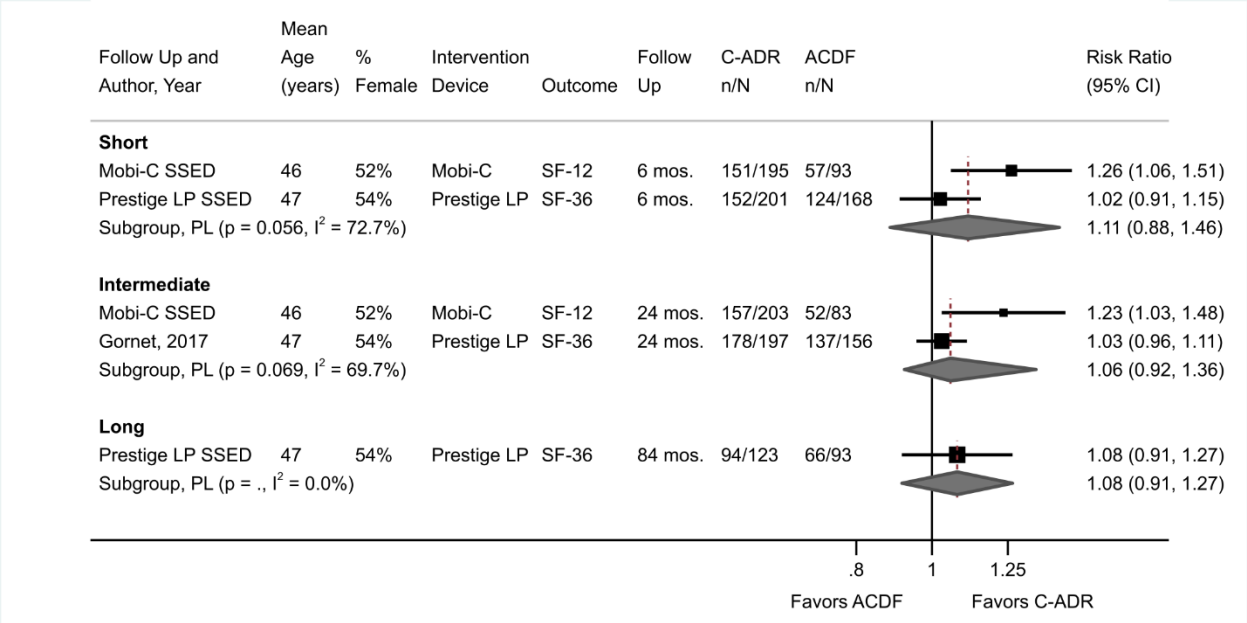
One IDE NRSI (N=352) that compared a novel cervical arthroplasty versus historical ACDF controls found that cervical arthroplasty was associated with a small improvement in function based on the NDI short term (MD 5.7, means 15.1 vs. 20.8, $p<0.05$); this was not sustained to intermediate term (MD 2.9, means 14.3 vs. 17.2, $p>0.05$).[104]

3.9.3.2.3.2.2 SF-36 PCS and MCS

Two IDE RCTs (N=727) (in 3 publications)[72,121,122] compared two-level interventions with cervical arthroplasty and ACDF and reported SF-36 PCS and MCS scores (0-100 scale). Success for these component scores was defined as postoperative score improvement of ≥15 points from baseline scores. There was no difference between cervical arthroplasty and ACDF in the likelihood of improved function based on PCS success short term (2 RCTs, N=657, 76.5% vs. 69.3%, RR 1.11, 95% CI 0.88 to 1.46, I^2= 72.7%),[121,122] intermediate term (2 RCTs, N=639, 83.7% vs. 79.1%. RR 1.06, 95% CI 0.92 to 1.36, I^2=69.7%),[72,121] and long term (1 RCT, N=216, 76.4% vs. 71.0%, RR 1.08, 95% CI 0.91 vs. 1.27)[122] (Figure 31). Similarly, there were no differences between cervical arthroplasty and ACDF in the likelihood of MCS success at short term (2 RCTs, N=657, 50.3% vs. 45.2%, RR 1.08, 95% CI 0.82 to 1.41, I^2= 43.9%),[121,122] intermediate term (2 RCTs, N=639, 62.3% vs. 65.3%, RR 0.98, 95% CI 0.85 to 1.18, I^2=0%),[72,121] and long term (1 RCT, N=216, 53.7% vs. 52.7%, RR 1.02, 95% CI 0.79 to 1.31)[122] (Figure 32).

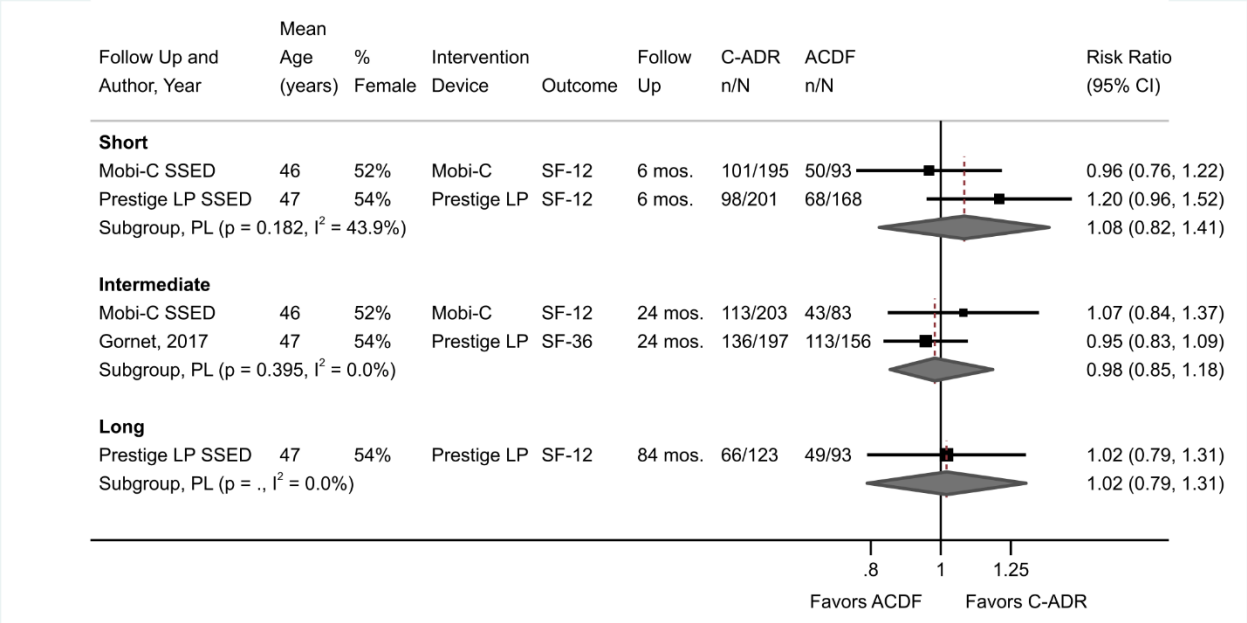
3.9 Results, Key Question 8

Figure 31. SF-36 or SF-12 PCS success (≥15-point improvement): comparison of cervical arthroplasty with ACDF (2-level interventions)



ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; FDA = Food and Drug Administration; mos. = months; PCS = Physical Component Score; PL = profile likelihood; SF-12 = 12-Item Short Form Health Survey; SF-36 = 36-Item Short Form Health Survey; SSED = Summary of Safety and Effectiveness Data (FDA).

Figure 32. SF-36 or SF-12 MCS success (≥15-point improvement): comparison of cervical arthroplasty with ACDF (2-level interventions)

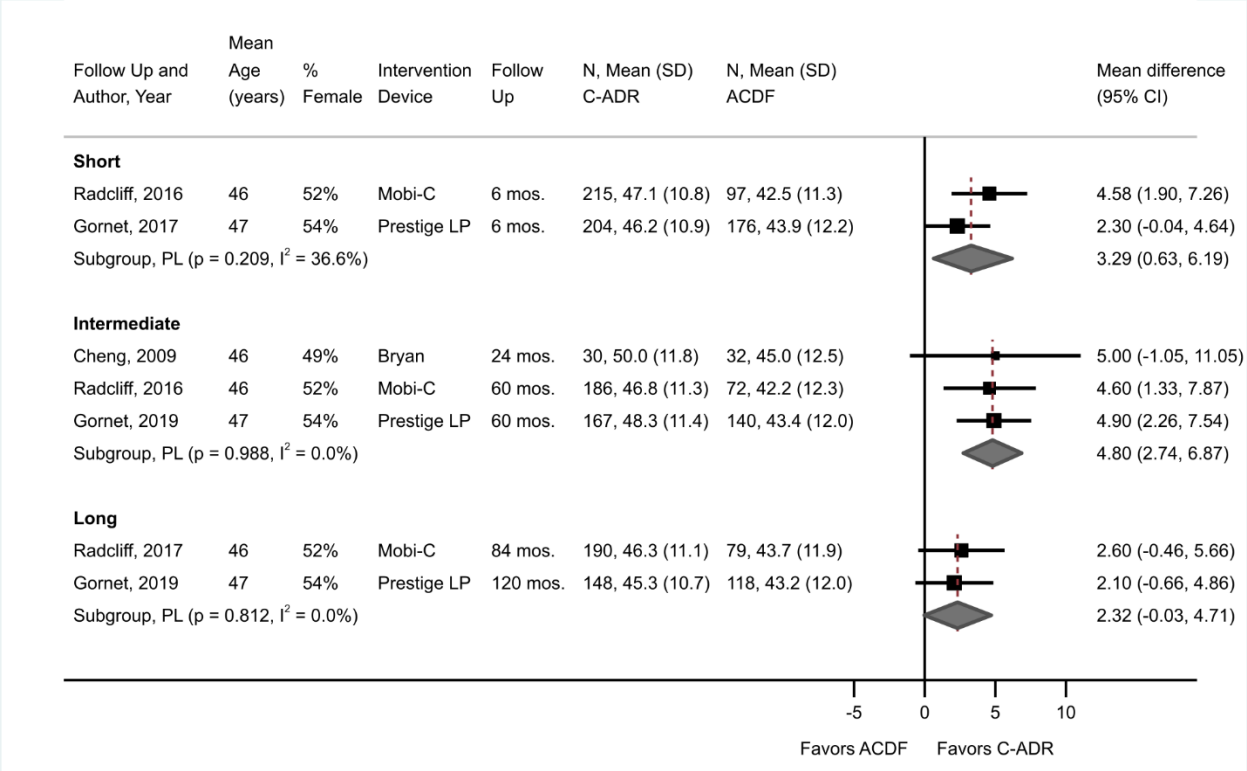


ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; FDA = Food and Drug Administration; MCS = Mental Component Score; mos. = months; PL = profile likelihood; SF-12= 12-Item Short Form Health Survey; SF-36 = 36-Item Short Form Health Survey; SSED = Summary of Safety and Effectiveness Data (FDA).

3.9 Results, Key Question 8

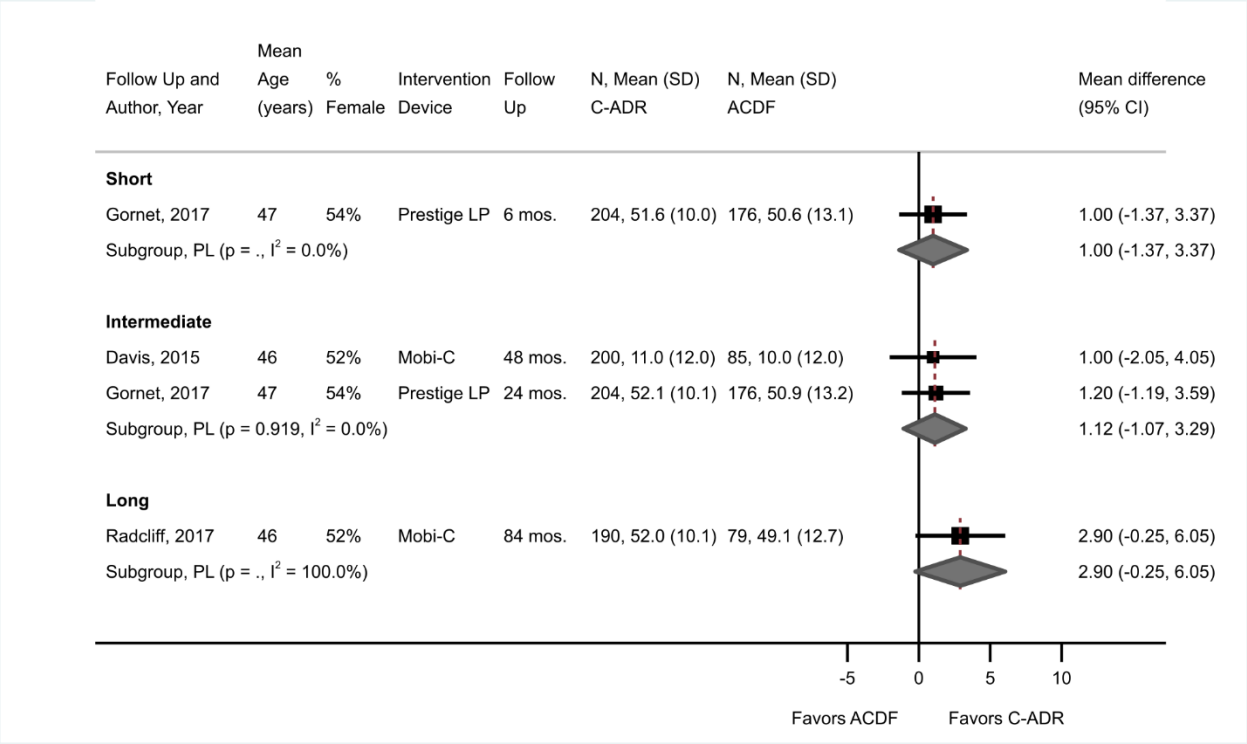
Three RCTs (N=792) (in 5 publications)[63,71,72,94,95] that compared two-level interventions with cervical arthroplasty and ACDF reported SF-36 PCS and MCS scores (0-100 scale). Differences in mean PCS scores did not meet the threshold for a small improvement and were classified as no difference between cervical arthroplasty versus ACDF at short term (2 RCTs, N=692, MD 3.29, 95% CI 0.63 to 6.19, I^2=36.6%),[72,94] intermediate term (3 RCTs, N=627, MD 4.80, 95% CI 2.74 to 6.87, I^2=0%),[63,71,94] and long term (2 RCTs, N=535, MD 2.32, 95% CI -0.03 to 4.71, I^2=0%);[71,95] however, estimates were imprecise (Figure 33). Two RCTs (N=757) reported mean MCS scores which were also not different between groups at short term (1 RCT, N=380, MD 1.00, 95% CI -1.37 to 3.37),[72] intermediate term (2 RCTs, N=665, MD 1.12, 95% CI -1.07 to 3.29, I^2=0%),[66,72] or long term (1 RCT, N=269, MD 2.90, 95% CI -0.25 to 6.05)[95] (Figure 34). One IDE NRSI (N=352) that compared a novel cervical arthroplasty versus matched historical ACDF controls found no difference in mean SF-36 PCS at short (49.2 vs. 46.4, p<0.05) or intermediate term (49.2 vs. 47.9).[104]

Figure 33. SF-36 or SF-12 PCS scores (0-100 scale): comparison of cervical arthroplasty with ACDF (2-level interventions)



ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; mos. = months; PCS = Physical Component Score; PL = profile likelihood; SD = standard deviation; SF-12= 12-Item Short Form Health Survey; SF-36 = 36-Item Short Form Health Survey.

Figure 34. SF-36 or SF-12 MCS scores (0-100 scale): comparison of cervical arthroplasty with ACDF (2-level interventions)



ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; MCS = Mental Component Score; mos. = months; PL = profile likelihood; SD = standard deviation; SF-12= 12-Item Short Form Health Survey; SF-36 = 36-Item Short Form Health Survey.

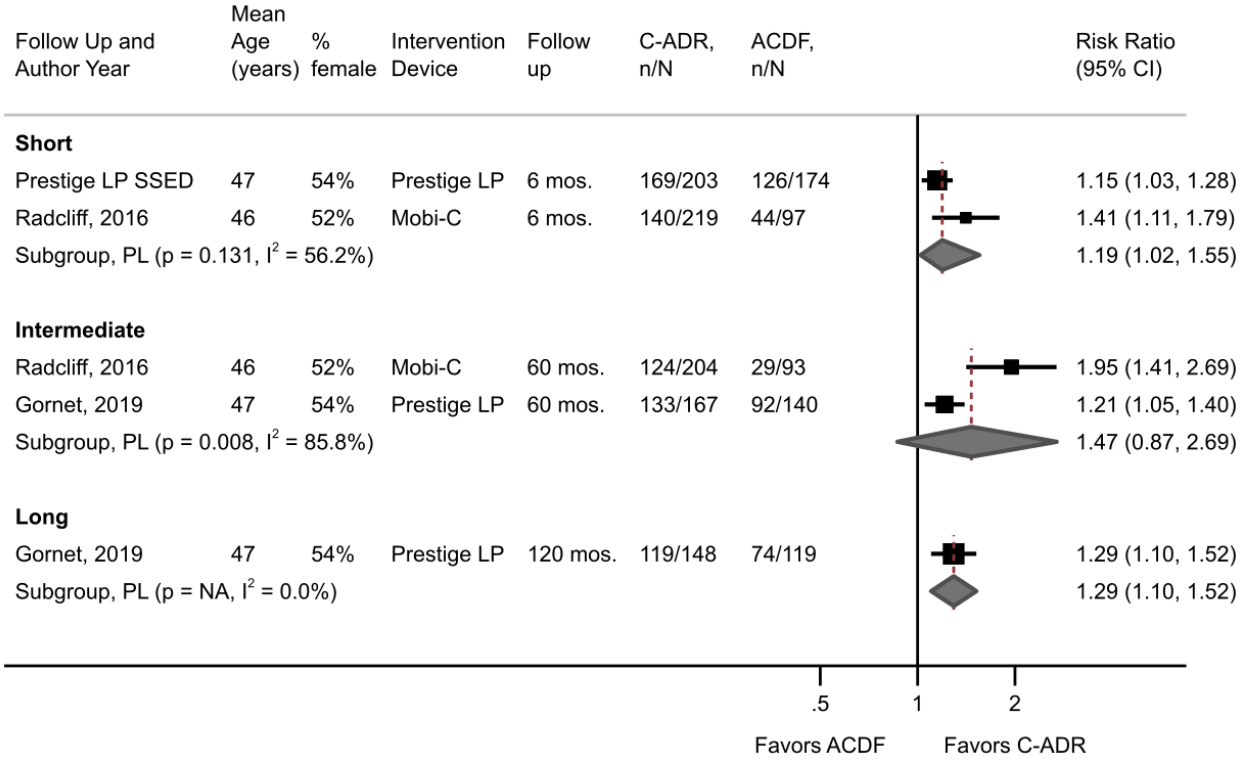
3.9.3.2.3.2.3 Odom's Criteria

There was no difference between cervical arthroplasty and ACDF for the likelihood of scoring excellent or good on Odom's criteria at intermediate term in one RCT (N=62, 96.7% vs. 84.4%, RR 1.15, 95% CI 0.97 to 1.34).[63]

3.9.3.2.4 Overall Success (Composite)

The FDA IDE trials were required to report on overall success, a composite outcome that included a threshold of ≥15-point NDI improvement from baseline, improvement or maintenance of neurologic status, no serious adverse events and no additional surgical procedures that might be considered "failure" (e.g., removal, revision, supplemental fixation). Cervical arthroplasty was associated with a slightly higher likelihood of overall success short term (2 RCTs, N=693, 73.2% vs. 62.7%, RR 1.19, 95% CI 1.02 to 1.56, I^2=56.2%)[94,122] and long term (1 RCT, N=267, 80.4% vs. 62.2%, RR 1.29, 95%CI 1.10 to 1.52).[71] At intermediate term, cervical arthroplasty was also associated with slightly greater likelihood of overall success in two RCTs individually (1 RCT, N=297, 60.1% vs. 31.2%, RR 1.95, 95% CI 1.41 to 2.69 and 1 RCT, N=307, RR 1.21, 95% CI 1.05 to 1.40)[71,94] (Figure 35).

Figure 35. Overall success (composite): comparison of cervical arthroplasty with ACDF (2-level interventions)



ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; FDA = Food and Drug Administration; mos. = months; PL = profile likelihood; SSED = Summary of Safety and Effectiveness Data (FDA).

One IDE RCT defined overall success with different NDI success criteria (improvement from baseline of ≥30-points if baseline score was ≥60 or ≥50% if baseline score was <60), required adjudication of adverse events and added radiographic success to the criteria listed for the other IDE trials. Cervical arthroplasty was associated with slightly higher likelihood of overall success long-term versus ACDF (1 RCT, N= 249, 60.8% vs. 34.6%, RR 1.76, 95% CI 1.27 to 2.44).[95] One IDE NRSI[104] that compared a novel cervical arthroplasty versus historical ACDF controls defined overall success as ≥15-point NDI improvement, maintenance or improvement in neurological status), no serious adverse event (any implant-associated or implant/surgical procedure–associated) and no additional index-level surgical procedure. Authors reported that overall success was more common in cervical arthroplasty participants versus ACDF (N=352, 86.7% vs. 77.1, p<0.05) based on multiple imputation modeling (numerators not reported; effect estimate could not be calculated).

3.9.3.2.5 Quality of Life

None of the included studies reported quality-of-life measures.

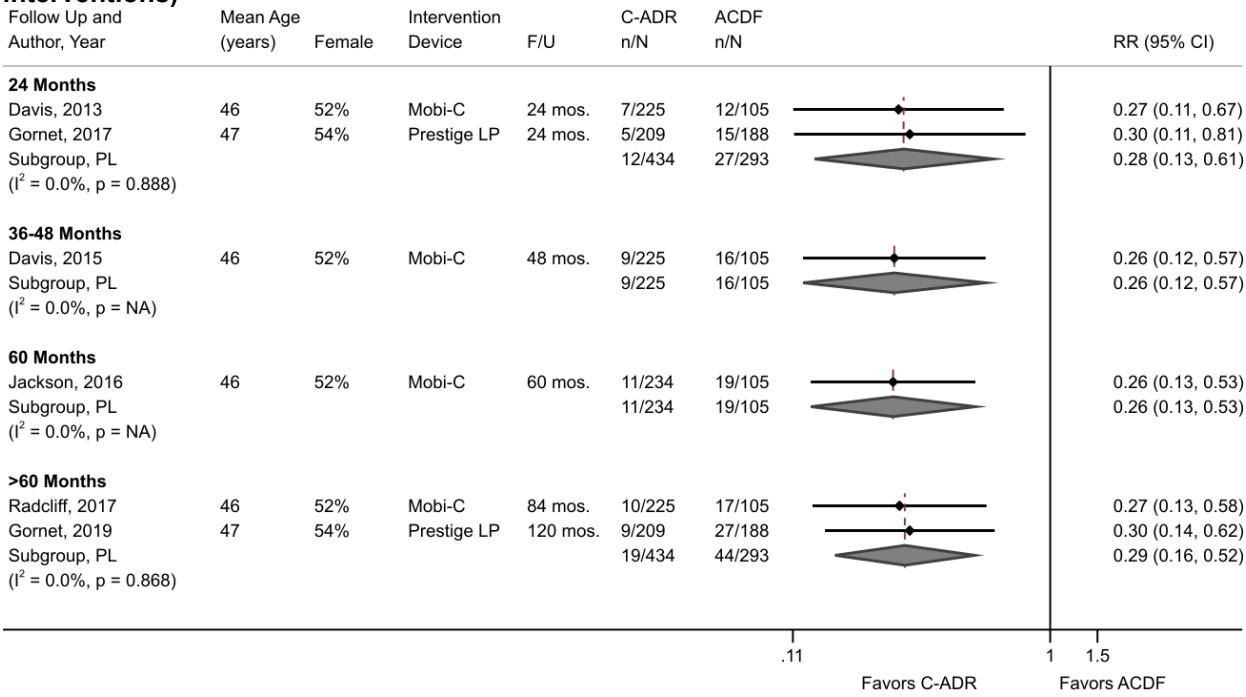
3.9.3.2.6 Reoperation

There was low-strength evidence that reoperation is substantially less likely with cervical arthroplasty compared with ACDF at all time points from 24 months and beyond (SOE: Low). Rates of reoperation for ACDF at the index level may be influenced by removal of an existing plate to treat ASD, rather than the indication for reoperation being driven by an issue at the index

procedure. This may artificially inflate the reported reoperation rate at the index procedure level for ACDR versus cervical arthroplasty. The clinical relevance of removing the plate as a part of a procedure addressing ASD is minimal.

Reoperation included any additional procedure that involved the index level and was substantially less likely with cervical arthroplasty at all times reported across IDE trials, however estimates were imprecise. Effect estimates were consistent across reported times: up to 24 months (2 RCTs, N=727, 2.8% vs. 9.2%, RR 0.28, 95% CI 0.13 to 0.61, I^2=0%),[65,72] 36 to 48 months (1 RCT, N=330, 4.0% vs. 15.2%, RR 0.26, 95% CI 0.12 to 0.57),[66] 60 months (1 RCT, N=330, 4.7% vs. 18.1%, RR 0.26, 95% CI 0.13 to 0.53),[80] and >60 months (2 RCTs, N=727, 4.4% vs. 15.0%, RR 0.29, 95% CI 0.16 to 0.52, I^2=0%)[71,95] (Figure 36). One IDE NRSI that compared a novel cervical arthroplasty versus historical ACDF controls also reported that secondary surgical interventions were less common with cervical arthroplasty (N=352, 2.2% vs. 8.8%).[104]

Figure 36. Reoperation at the index level: comparison of cervical arthroplasty with ACDF (2-level interventions)

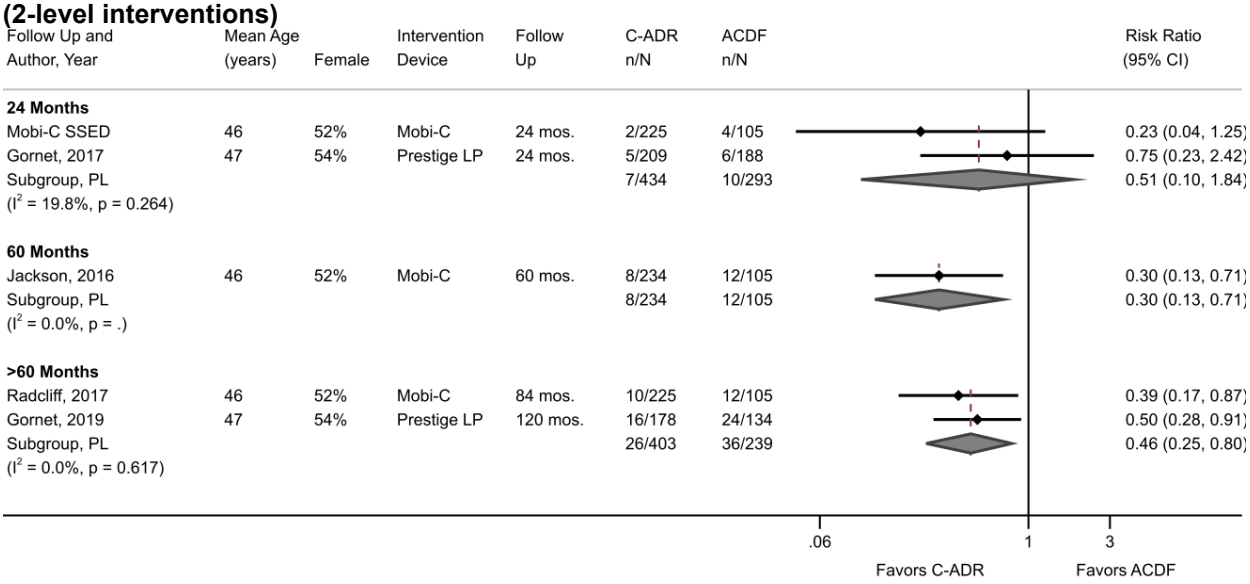


ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; mos. = months; PL = profile likelihood.

Subsequent surgery rates at adjacent levels were similar between cervical arthroplasty and ACDF at 24 months (2 RCTs, N= 727, 1.6% vs. 3.4%, RR 0.51, 95% CI 0.10 to 1.84, I^2=19.8%),[72,121] but substantially less common with cervical arthroplasty versus ACDF at 60 months (1 RCT, N=339, 3.4% vs. 11.4%, RR 0.30, 95% CI 0.13 to 0.71)[80] and >60 months (2 RCTs, N=642, 6.5% vs. 15.1%, RR 0.46, 95% CI 0.25 to 0.80, I^2= 0%).[71,95] Across trials, indications for operation at adjacent levels were not consistently described (Figure 37).

3.9 Results, Key Question 8

Figure 37. Subsequent surgery at adjacent level: comparison of cervical arthroplasty with ACDF (2-level interventions)



ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; mos. = months; PL = profile likelihood.

3.9.3.2.7 Harms

Cervical arthroplasty was associated with a slightly lower likelihood of experiencing any adverse event at 24 months based on low-strength evidence (SOE: Low), but there was no difference between procedures at 120 months for WHO Grade 3 or 4 adverse events (SOE: Low). There was insufficient evidence for neurological deficits or events and for mortality (SOE: Insufficient).

All IDE RCTs and one IDE NRSI provided information on adverse events and harms.

3.9.3.2.7.1 Neurologic Deficit

Two RCTs (N=395) in 3 publications[63,66,95] reported neurologic events using varied terminology. One RCT (N=65)[63] reported that no neurologic complications occurred with cervical arthroplasty or ACDF through 24 months. There was no difference between neurologic deterioration at 48 months (6.2% vs. 7.6%, RR 0.82, 95% CI 0.35 to 1.89) in one IDE trial[66] but a subsequent publication of the trial reported substantially lower incidence of neurological failure, defined as a decrease in sensory, reflex or motor function from preoperative status, with cervical arthroplasty versus ACDF (6.4% vs. 17.1%, RR 0.36, 95% CI 0.19 to 0.70) at 84 months.[95]

3.9.3.2.7.2 Mortality

Cumulative mortality was similar between two-level cervical arthroplasty (2 deaths) and ACDF (3 deaths) through 120 months in one IDE trial, but authors did not provide cause of death (N=397, 1.0% vs. 1.6%; RR 0.60, 95% CI 0.10 to 3.55);[71] there was one death in both groups by 12 months (0.5% vs. 0.5%)[72] and two deaths in both groups by 84 months (1.0% vs. 1.1%).[83]

3.9.3.2.7.3 Serious Adverse Events

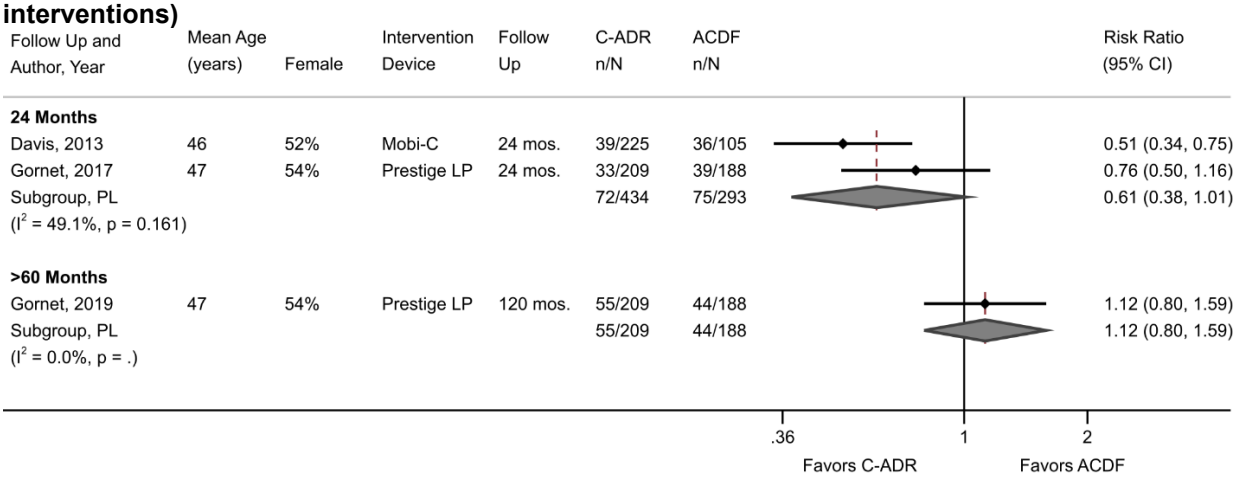
Serious adverse events were reported for two IDE trials (N=727) of different devices (five publications)[65,66,71,72,83] but were defined differently across reports. One trial's initial report found events were common and that fewer cervical arthroplasty (Mobi-C) participants experienced one

or more serious adverse events (23.9% vs. 32.4%)[65] up to 24 months but included events unrelated to the device, surgery, or cervical spine as well as those that may not have required additional medical intervention. In a subsequent report of this trial, following adjudication of events by a clinical events committee, fewer events were considered serious and they continued to be less common with cervical arthroplasty versus ACDF, but effect estimates were imprecise (1 RCT, N=330, 4.0% vs. 7.6%, RR 0.75, 95% CI 0.53 to 1.08) at 24 months.[66] The IDE trial of another device (Prestige-LP), also included a broad range of events and reported fewer Grade 3 or 4 adverse events with cervical arthroplasty at 24 months versus ACDF (1 RCT, N=397, 34.4 % vs. 47.9%).[72] Cervical arthroplasty was associated with slightly lower likelihood of serious adverse events across the two trials at 24 months (2 RCTs, N=727, 29.3% vs. 42.3%, RR 0.73, 95% CI 0.58 to 0.93, I^2=0%)[65,72] using the broad definition of events. There was no difference between groups in the frequency of WHO Grade 3 or 4 adverse events at 120 months in one IDE trial (N=397, 66.7% vs. 70.9%, RR 0.93, 95% CI 0.80 to 1.09).[71]

3.9.3.2.7.4 Device-Related Adverse Events

Device-related adverse event definitions, types of events and adjudication varied across RCTs. One trial included a range of events such as anatomy/technical difficulty, trauma as well as neurological events while others did not provide specifics. Some device-related events may only occur with cervical arthroplasty, others may only occur with ACDF (e.g., nonunion). Some events may not be persistent or serious (e.g., dysphagia or dysphonia). Two-level cervical arthroplasty was associated with a moderately lower likelihood of device-related events at 24 months compared with ACDF (2 RCTs, N=727, 16.6% vs. 25.6%, RR 0.61, 95% CI 0.38 to 1.01, I^2=49.1%)[65,72] but there was no difference between groups at 120 months in one of these trials (N=397, 26.3% vs. 23.4%, RR 1.12, 95% CI 0.80 to 1.59)[71] (Figure 38). When only serious device-related adverse events were considered, as adjudicated by committee or as WHO grade 3 or 4 events, cervical arthroplasty was associated with a substantially lower likelihood of such serious events compared with ACDF at 24 months in one trial (N=397, 1.9% vs. 5.9%, RR 0.33, 95% CI 0.11 to 1.01)[72] but there was no difference between groups at 120 months in this same trial (RR 0.48, 3.8% vs. 8.1%, 95% CI 0.21 to 1.11)[71] or at 60 months in a second trial (N=330, 4.4% vs. 8.6%, RR 0.52, 95% CI 0.22 to 1.24),[94] however, the estimates were very imprecise.

Figure 38. Device-related adverse events: comparison of cervical arthroplasty with ACDF (2-level interventions)



ACDF = anterior cervical discectomy and fusion; C-ADR = cervical artificial disc replacement (cervical arthroplasty); CI = confidence interval; F/U = followup; mos. = months; PL = profile likelihood.

Device-related adverse events were similar for cervical arthroplasty and ACDF in one IDE NRSI (3.8% vs. 3.5%).[104]

3.9.3.2.7.5 Dysphagia

Dysphagia was reported by several RCT publications (N=475), but the severity was unclear in most cases.[63,94,99] Dysphagia rate ranges were broad for cervical arthroplasty (0% to 24%) and for ACDF (0% to 38%) across these publications. One IDE trial (N=397) reported low rates of Grade 3 or 4 dysphagia that differed slightly across two post-FDA approval study publications, possibly reflecting different analytic methods. Rates did not differ by procedure at 84 months (1.3% vs. 0%)[83] or 120 months (0.6% vs. 0.7%).[71]

3.9.3.2.7.6 Heterotopic Ossification

Grade 3 or 4 HO, considered clinically relevant HO, may be of concern with cervical arthroplasty. Across two IDE RCTs evaluating 2-level interventions (N=337, cervical arthroplasty arms), 35.4 percent of participants developed Grade 3 or 4 HO (29.7% at 60 months in 1 RCT and 42.4% at 84 months in 1 RCT).[83,94] One of these trials (N=186, cervical arthroplasty arm)[94] reported Grade 4 HO separately which occurred in 9.7 percent of cervical arthroplasty participants by 60 months.[94] The FDA IDE NRSI (N=182, cervical arthroplasty arm) also reported HO; at the superior index level, grade 3 and 4 HO occurred in 8 participants (5%) each and at the inferior index level, in 17 (10%) and five (3%) participants, respectively, at 24 months.[104] The frequency of Grade 1 or 2 HO was not consistently reported and ranged from 0 to 28.9 percent across three trials (N=278, cervical arthroplasty arms, range 31 to 209) evaluating 2-level interventions.[63,72,99]

3.9.3.2.8 Differential Effectiveness (HTE)

One IDE trial that compared 2-level cervical arthroplasty and ACDF provided subgroup analysis on the presence of radiculopathy alone (N=287) and myelopathy alone or myelopathy with radiculopathy (N=110) for pain, function. and adverse events at 24 and 84 months but did not formally test for interaction.[73] Visual inspection of effect estimates and overlap in estimate variability and subgroup estimates suggest no differential effectiveness or harms, although the study may have been underpowered to evaluate this.

3.9.3.3 Mixed 1-, 2-, or 3-Level Cervical Arthroplasty Versus ACDF

Three RCTs compared 1- 2- or 3-level cervical arthroplasty and ACDF (i.e., mixed levels).[62,64,74] Sample sizes ranged from 53 to 83 (total N=196). Across two trials,[62,64] 54 to 83 percent of participants had single-level procedures, 17 to 37 percent had 2-level procedures, and in one of these trials[62] 8 percent had 3-level procedures; one trial used the Bryan® disc and the other used the Prestige-II® disc, which are both FDA-approved for single-level indications only. The third trial enrolled participants who underwent 1- or 2-level procedures but did not provide the proportions for each.[74] The RCTs were conducted in China, India and Spain. Four additional NRSIs compared harms for mixed-level cervical arthroplasty and ACDF.[107,110-112]

3.9.3.3.1 Fusion

One RCT (N=42) reported intermediate-term fusion success in 90.5 percent of participants in the ACDF arm.[62] This RCT also reported fusion in the cervical arthroplasty arm, but this can be attributed to participant crossover after initial randomization.

3.9.3.3.2 Pain

There was low-strength evidence of no difference between treatment with cervical arthroplasty and ACDF on neck pain (SOE: Low).

There was no difference in median VAS (0 to 10) neck pain scores at 60 months between cervical arthroplasty (3.6, interquartile range [IQR] 3.2 to 4.1) and ACDF (median 3.9, IQR 3.0 to 4.4) at 60 months (p=0.203) in one trial (N=50).[74] No other pain measures were reported.

3.9.3.3.3 Function

3.9.3.3.3.1 Neurologic Function

There was inadequate evidence to determine the effect of cervical arthroplasty versus ACDF on neurologic function (SOE: Insufficient).

Participants who received cervical arthroplasty had higher mean JOA scores (0-17) at 36 months compared with ACDF in one RCT (N=81; 15.4 vs. 14.7 [estimated from graphs in article]; p=0.016).[62]

3.9.3.3.3.2 General Function

There was inadequate evidence to determine the effect of cervical arthroplasty versus ACDF on general function (SOE: Insufficient).

One RCT (N=81) reported three different measures of general function at 36 months.[62] Participants who received cervical arthroplasty had better (i.e., lower) mean NDI scores (12 vs. 18 [estimated from graphs], on a 0 to 50 scale, p<0.001) and better (i.e., higher) mean SF-36 PCS scores (50.5 vs. 44.5 [estimated from graphs], on a 0 to 100 scale, p<0.05) compared with ACDF, but there were no differences between treatments in the proportion of participants who achieved an excellent (58.5% vs. 58.5%, RR 1.02, 95% CI 0.70 to 1.47) or good (34.1% vs. 25%, RR 1.37, 95% CI 0.69 to 2.71) result according to Odom's criteria. A second RCT (N=50) reported no difference between groups in NDI scores (median 7, IQR 6 to 8, for both groups) at 60 months.[74]

3.9.3.3.4 Quality of Life

None of the included studies reported on quality-of-life measures.

3.9.3.3.5 Harms

There was inadequate evidence to determine the effect of cervical arthroplasty and ACDF on harms or adverse events (SOE: Inadequate).

Two RCTs[62,64] and four NRSIs[107,110-112] reported harms and adverse events.

3.9.3.3.5.1 Neurological Complications

One RCT (N=53) reported one case of transient recurrent nerve paralysis in both groups (cervical arthroplasty 4% vs. ACDF 3.6%, RR 1.12, 95% CI 0.07 to 16.98) that resolved within 3-4 weeks and one case of postoperative worsening of arm pain and neurological deficit in the ACDF group (3.6%).[64] A second trial (N=83) reported that no intraoperative neurologic complications occurred in either group.[62] One large NRSI based on administrative data reported no difference between cervical arthroplasty and ACDF in the frequency of neurological complications (cervical arthroplasty 1.6% vs. ACDF 1.7%, adjusted OR 1.18, 95% CI 0.38 to 3.72), however specific types or timing of neurological events were not reported.[107] Another large NRSI (N=1,014) that conducted a propensity score matched analysis reported no

differences between treatment arms in the frequency of limb paralysis through 30 days (2.4% vs. 2.4%) and 12 months (8.9% vs. 7.5%); no other details were provided.[111] This same study reported spinal complications (0% vs. 0.4% at 30 days; 0% vs. 1.0% at 12 months), neurological complications (0% at 30 days; 0.4% vs. 0.2% at 12 months), and nerve root complications (none at any time), but again no specifics were given.

3.9.3.3.5.2 Mortality

One RCT (N=83) reported that no deaths occurred in either group through 90 months.[62] Mortality was rare for both cervical arthroplasty and ACDF across two large NRSIs based on administrative data and there was no difference between procedures: 0.5 and 2.2 percent, respectively, (OR 0.56, 95% CI 0.08 to 4.11) in one NRSI (N=143,060)[107] and 0.6 versus 0 percent through 12 months postoperative in the other (N=1,014 after matching).[111]

3.9.3.3.5.3 Serious Adverse Events

One RCT (N=83) reported one case of DVT (2.4%) in the cervical arthroplasty group.[62] There were no differences between cervical arthroplasty and ACDF in the frequency of pulmonary embolism (0.5% vs. 0.8%, OR 1.43, 95% CI 0.19 to 10.7) or DVT (2.2% vs. 2.4%, OR 1.07, 95% CI 0.33 to 3.40) in one large NRSI (N=143,060).[107] Similarly, there were no differences between cervical arthroplasty and ACDF in the risk of thromboembolic events across two large NRSIs that performed propensity-score matching (N=1,014 and 1,368): pulmonary embolism at 30 days postoperative (0% vs. 0.2%-0.3%, respectively) in both studies[111,112] and through 12 months in one study (1.0% vs. 0.8%)[111] and DVT at 30 days postoperative in one study (0% vs. 0.3%).[112]

One RCT (N=83) reported that no cerebrospinal fluid leakage occurred.[62] Cerebrospinal fluid leak was rare for both cervical arthroplasty (0.5%) and ACDF (0.2%) and there was no difference between procedures (OR 2.19, 95% CI 0.29 to 16.3) in one large NRSI based on administrative data.[107]

In one RCT (N=53), one participant (3.6%) who underwent 2-level ACDF developed a wound hematoma that needed urgent evacuation;[64] another RCT reported that there were no cases of wound hematoma.[62] One of these trials reported that three ACDF participants (10.7%, N=28) had recurrent cervical pain between 3 and 6 months which required local infiltration (not further explained).[64] There were no cases of wound dehiscence at 30 days in one NRSI (N=1,368 after matching)[112] and similar frequencies of wound complications for cervical arthroplasty and ACDF through 12 months in a second NRSI (N=1,014 after matching),[111] but the severity was unclear.

One case (2.4%, N=41) of heterotopic ossification (i.e., spontaneous fusion/bridging bone) was reported in the cervical arthroplasty group in another RCT.[62]

Although dysphagia was reported in one RCT[62] and two NRSIs,[107,111] the severity of dysphagia was unclear. A number of other serious or potentially serious adverse events were reported across the two large NRSIs that conducted propensity score matched analyses (N=2,382). These events were rare and occurred with similar frequency in the cervical arthroplasty and ACDF groups, respectively, through 30 days: cerebrovascular accident (0% vs. 0%-0.6%), sepsis or septic shock (0% vs. 0% to 0.2%), myocardial infarction (0% to 0.1%, both groups), mechanical ventilation (0%; 1 NRSI),[112] unplanned intubation (0.3% vs. 0%; 1 NRSI),[112] deep infection (0%; 1 NRSI),[112] cellulitis (0% vs. 0.2%; 1 NRSI)[111] and dural tear (0.2% vs. 0%; 1 NRSI).[111] One of these trials reported events through 12 months with more cerebrovascular accidents reported in the ACDF group (0% vs. 2.4%, $p<0.001$); there were no

differences between groups for all other adverse events longer term (dural tear, 0.6% vs. 0%; myocardial infarction, 0.4% vs. 0.6%; sepsis, 0.6% vs. 1.0%; cellulitis, 2.0% vs. 2.2%),

3.9.3.3.6 Reoperation and Subsequent Surgery

One RCT (N=53) reported reoperation at the index level in one (4%) cervical arthroplasty and two (7.1%) ACDF participants between 12 and 36 months (RR 0.56, 95% CI 0.05 to 5.81).[64] A second trial (N=83) reported that no participants in either group required reoperation at the index level through 36 months.[62] One NRSI did not provide adjusted effect estimates but reported the proportions of cervical arthroplasty and ACDF patients who required reoperation at the index level at 12 months (1.7% vs. 2.4%) and 24 months (0% vs. 3.6%) and subsequent surgery at adjacent levels at 12 months (1.7% vs. 2.4%) and 24 months (3.3% vs. 5.1%).[110] Across the two NRSIs that did attempt to control for confounding (propensity score adjusted analyses), over the first 30 postoperative days, 0.4 percent of cervical arthroplasty versus 1.0 percent of ACDF underwent any reoperation (not further specified) in one study (N=1,368)[112] and in the second study, 2.8 versus 1.0 percent had a revision surgery, 0.4 versus 0.2 percent had a drainage/evacuation, and no patient had a hardware removal in the other study (N=1,014).[111] At 12 months in the latter study, the proportion of patients requiring revision surgery rose to 10.7 versus 7.1 percent; the need for drainage/evacuation (0.8% for both) and hardware removal (0.2% for both) remained low.

3.9.3.3.7 Differential Effectiveness (HTE)

None of the included trials that compared 1-, 2-, or 3 level cervical arthroplasty and ACDF interventions reported differential effectiveness based on patient or other characteristics.

3.10 Key Question 9: In patients undergoing anterior cervical discectomy and fusion, what are the comparative effectiveness and harms of surgery based on interbody graft material or device type?

3.10.1 Standalone Cage Versus Plate and Cage

3.10.1.1 Key Findings

- There was moderate-strength evidence of no difference in fusion rates between standalone cages versus plate and cage (SOE: Moderate).
- There was low-strength evidence of no differences between standalone cages versus plate and cage on arm pain, function, and quality of life (SOE: Low); there was inadequate evidence for neck pain (SOE: Insufficient).
- There was low-strength evidence of no difference between standalone cage versus plate and cage on adjacent-level ossification (SOE: Low); evidence was inadequate for subsidence (sinking of vertebral endplates around the graft) and other adverse events (SOE: Insufficient).

3.10.1.2 Description of Included Studies

Nine RCTs (N=619)[124-132] compared a standalone device with a traditional plate and cage (Appendix C). The average mean followup duration was 21 months (range immediately postoperative to 36 months). Six trials were conducted in China, two in the United States, and one each in Germany and Japan.

The average study mean age of participants was 52 years (range 41 years to 63 years); the average proportion of females was 42 percent (range 9% to 54%). Few trials reported exact proportions of patients with radiculopathy, myelopathy, or myeloradiculopathy. One trial enrolled only participants with radiculopathy without myelopathy[130] and two trials enrolled only participants with myelopathy but did not report the proportion of participants with radiculopathy.[127,129] Most trials enrolled participants with 1-level disease,[126,128,130] 1- to 2-level disease,[131,132] or 2-level disease.[125] One trial each treated participants with 1- to 3-level disease,[124] 3-level disease,[127] and 2- to 4-level disease.[129]

All studies were rated moderate risk of bias with the exception of one trial that was rated high risk of bias (Appendix D).[126] Methodological limitations included unclear randomization techniques, unclear blinding, and unclear attrition. Evidence for neck pain in standalone devices versus traditional plate and cage was rated insufficient due to conflicting findings. Evidence for harms other than adjacent-level ossification was rated insufficient due to the infrequency of adverse events (Appendix G).

3.10.1.3 Detailed Analysis

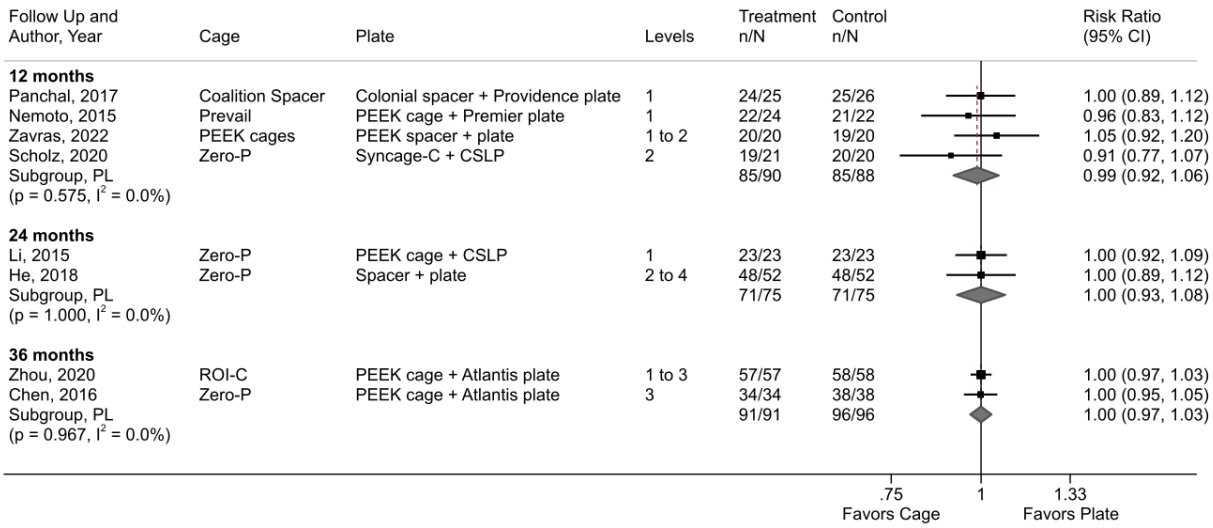
3.10.1.3.1 Fusion

There was moderate-strength evidence of no difference in fusion rates between standalone cages versus plate and cage in participants undergoing ACDF (SOE: Moderate).

Almost all participants who underwent ACDF with either a standalone cage or with a traditional plate and cage (N=515) experienced fusion at 12 months (4 RCTs, N=178, 94% vs. 97%, RR 0.99, 95% CI 0.92 to 1.06, I^2=0%), 24 months (2 RCTs, N=150, 95% vs. 95%, RR

1.00, 95% CI 0.93 to 1.08, I^2=0%) and 36 months (2 RCTs, N=187, 100% vs. 100%, RR 1.00, 95% CI 0.97 to 1.03, I^2=0%) (Figure 39). This was true when fusion was limited to one level or involved multilevel fusion. One trial did not report fusion as an outcome.[131] (SOE: Moderate)

Figure 39. Fusion, standalone cage versus traditional plate and cage



CSLP = cervical spine locking plate; CI = confidence interval; PEEK = polyetheretherketone; PL = profile likelihood; ROI-C = ROI-C implant system; Zero-P = zero-profile

3.10.1.3.2 Pain

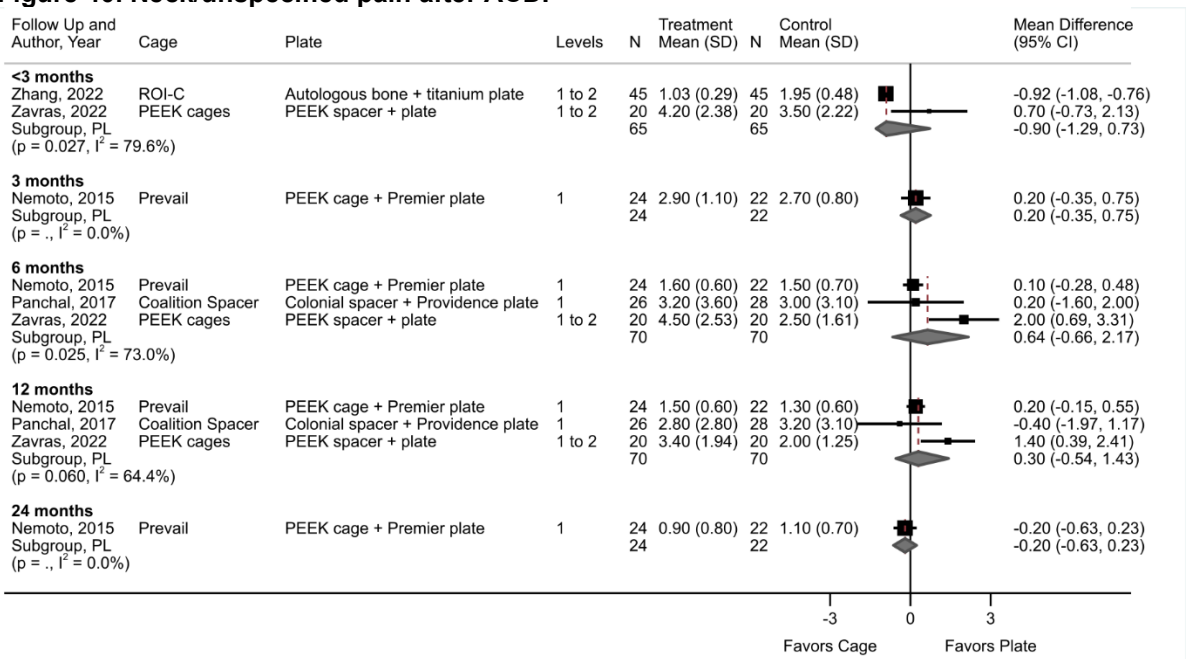
There was low-strength evidence of no difference between standalone cages versus plate and cage on arm pain (SOE: Low), with inadequate evidence to determine the benefits and harms of the two approaches on neck pain (SOE: Insufficient).

Four RCTs (N=230) reported changes in overall pain (pain location not specified) or neck pain using a visual analogue scale (VAS: 0-10 or 0-100) across various followup times ranging from less than 3 months to 24 months (Figure 40). Although neck pain was moderately, though not statistically greater at less than 3 months (MD -0.90, 95% CI -1.29 to 0.73) with a plate and cage compared with a standalone cage, the opposite was true at 6 months , MD 0.64, 95% CI -0.66 to 2.17). When pooled analysis was limited to trials of single-level disease, there were no differences in neck pain between standalone cage and plate and cage (Appendix F, Figure F-6).

Four RCTs (N=186) reported changes in arm pain using a visual analogue scale (VAS: 0-10 or 0-100) across various followup times. There were no differences in arm pain after ACDF between use of a standalone cage and a plate and cage at any time point from less than 3 months (MD -0.24, 95% CI -1.55 to 1.12) to 24 months (MD 0.20, 95% CI -0.09 to 0.49) (Figure 41). When analyses were limited to trials of single-level disease, there remained no difference in arm pain between fusion methods (Appendix F, Figure F-7).

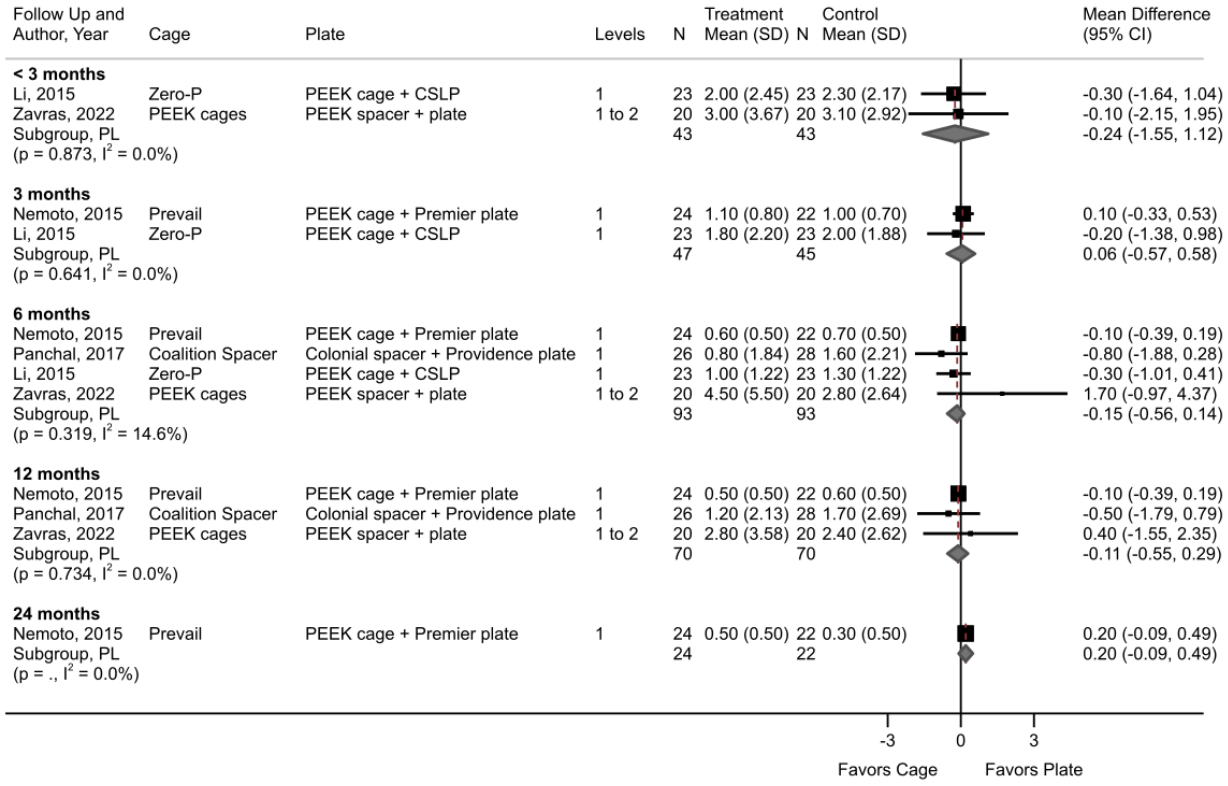
3.10 Results, Key Question 9

Figure 40. Neck/unspecified pain after ACDF



ACDF = anterior cervical discectomy and fusion; CI = confidence interval; PEEK = polyetheretherketone; PL = profile likelihood; ROI-C = ROI-C implant system; SD = standard deviation; Zero-P = zero-profile

Figure 41. Arm pain following ACDF



ACDF = anterior cervical discectomy and fusion; CI = confidence interval; CSLP = cervical spine locking plate; PEEK = polyetheretherketone; PL = profile likelihood; ROI-C = ROI-C implant system; SD = standard deviation; Zero-P = zero-profile

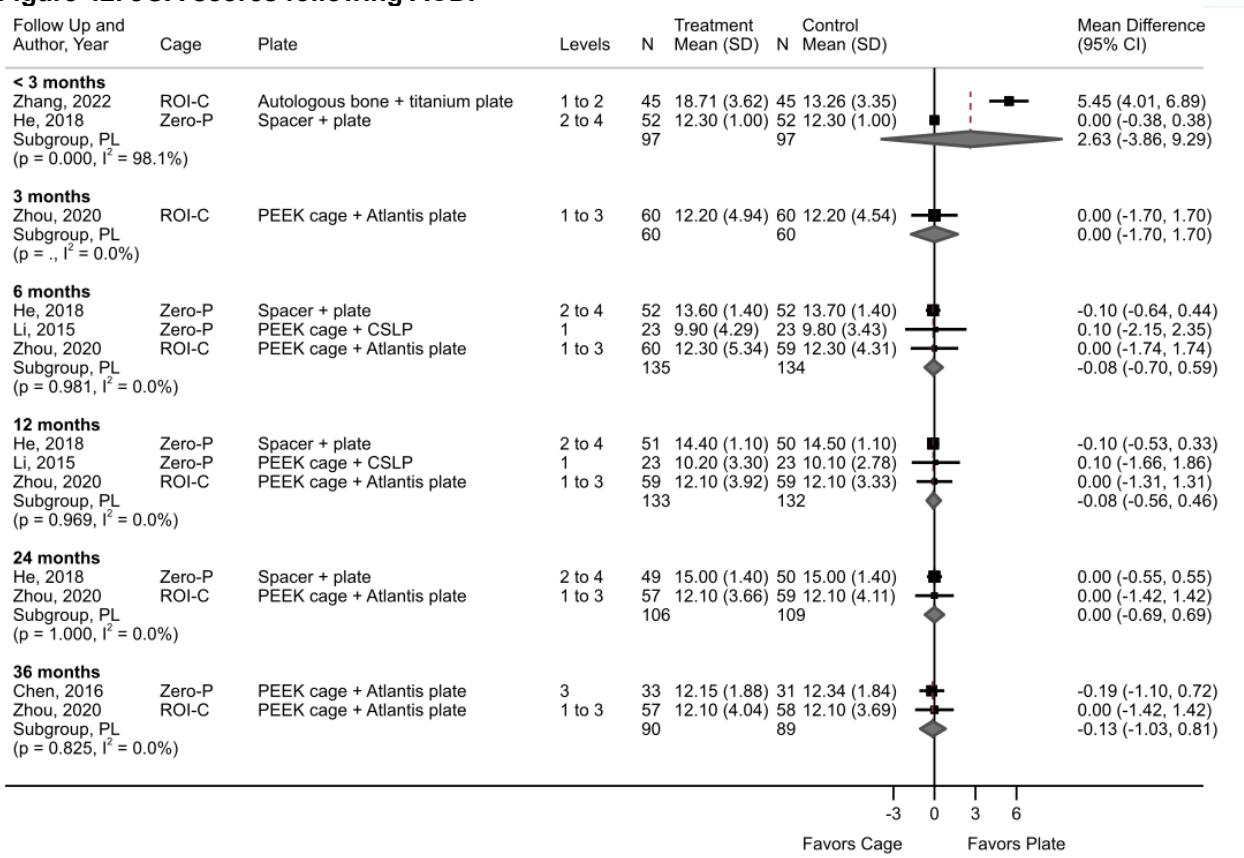
3.10.1.3.3 Function

3.10.1.3.3.1 Neurologic Function

There was low-strength evidence of no difference between standalone cages versus plate and cage in neurologic function (SOE: Low).

Five RCTs (N=424) reported changes on the JOA (lower score = worse disability, score 0 to 17) after ACDF using a standalone cage or a plate and cage (Figure 42). At less than 3 months, pooled analysis of two trials indicated moderately greater, although not statistically significant, JOA scores with a standalone cage versus a plate and cage (MD 2.63, 95% CI -3.86 to 9.29), this effect is driven by 1 of 2 trials, while the other trial found no effect. At longer followup times, there were no differences between treatments on JOA scores.

Figure 42. JOA scores following ACDF



ACDF = anterior cervical discectomy and fusion; CI = confidence interval; CSLP = cervical spine locking plate; JOA = Japanese Orthopaedic Association Scale; PEEK = polyetheretherketone; PL = profile likelihood; ROI-C = ROI-C implant system; SD = standard deviation; Zero-P = zero-profile

Note: Zhou, 2020 values are estimates from Figure 3 within the publication

3.10.1.3.3.2 General Function

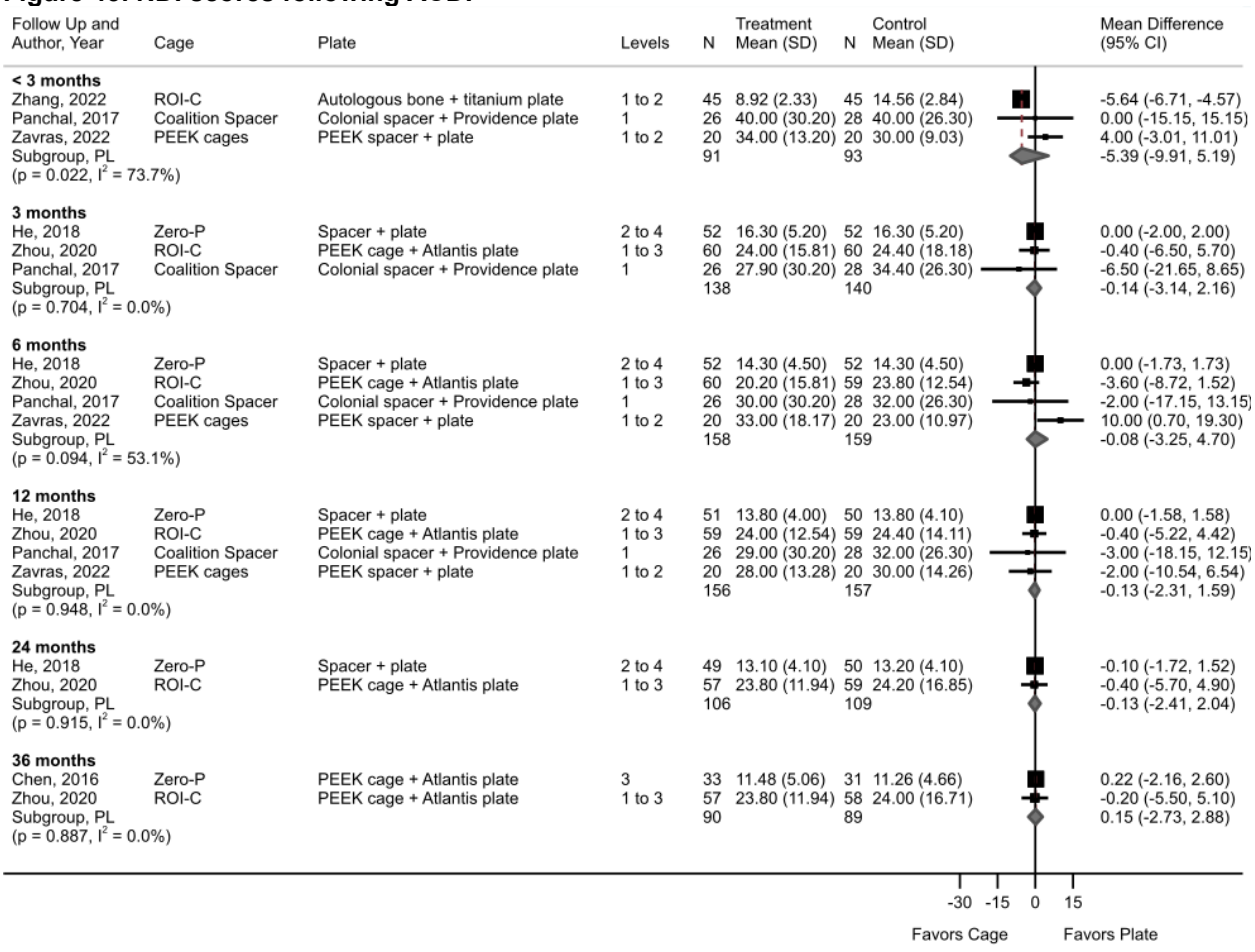
There was low-strength evidence of no difference between standalone cages versus plate and cage in general function (SOE: Low).

Six RCTs (N=472) reported changes on the NDI (higher score = worse disability, 0-50 raw score or 0% to 100%) following ACDF with either a standalone cage or a plate and cage (Figure 43). With the exception of less than 3 months timepoint, there were no differences between

3.10 Results, Key Question 9

ACDF with a standalone cage or plate and cage on NDI scores at other timepoints. At less than 3 months, study findings varied and although the pooled estimate slightly favors the standalone cage (MD -5.39, 95% CI -9.91 to 5.19), it is driven by the largest of the three studies and should interpreted with caution.

Figure 43. NDI scores following ACDF



ACDF = anterior cervical discectomy and fusion; CI = confidence interval; NDI = Neck Disability Index; PEEK = polyetheretherketone; PL = profile likelihood; ROI-C = ROI-C implant system; SD = standard deviation; Zero-P = zero-profile

Note: Zhou, 2020 values are estimates from Figure 2 within the publication

Additionally, one trial (N=41) reported no difference at 24 months between a standalone zero-profile device (Zero-P) and a plate and cage on the German version of the Neck Pain Disability Index (25.8% vs. 22.2%, p-value not reported).[125]

One RCT (N=46) reported no difference between a standalone cage and plate and cage at 24 months on the Odom's criteria (Excellent: 46% vs. 55%; Good: 54% vs. 45%; Fair: 0% vs. 0%; Bad: 0% vs. 0%),[130] while another trial (N=41) reported the mean Odom's Criteria at 24 months was 3.2 with a standalone cage compared with 3.5 with plate and cage (p-value not reported).[125] A third trial (N=115) reported there were no differences between standalone cage versus plate and cage in ratings of "excellent" and "good" overall patient satisfaction (Excellent: 44% vs. 47%, p=0.763; Good: 33% vs. 29%, p=0.835; Fair: 23% vs. 24%, p=0.692; Poor: 0% vs. 0%, p=1.0) at 36 months.[124]

3.10.1.3.4 Quality of Life

There was low-strength evidence of no difference between standalone cages versus plate and cage in quality of life (SOE: Low).

One RCT (N=40) reported no differences in quality of life as assessed with the Veteran's RAND 12-Item Health Survey between treatment with a standalone cage versus a plate and cage at 6 weeks and at 12 months, although participants treated with a standalone cage reported better scores at 6 months postoperatively (38.38 vs. 26.27, p=0.033).[132]

Five RCTs (N=253) assessed swallowing before and after treatment with a standalone cage versus a plate and cage with mixed results.[125-128,132] Two trials used the Swallowing Quality of Life questionnaire,[127,132] two trials rated severity of dysphagia symptoms as "None", "Mild", "Moderate", and "Severe"[125,128] and one trial used the Eating Assessment Tool.[126] No trial reported differences in dysphagia scores between treatments beyond 3 months postoperatively. One trial reported worse dysphagia scores with plate and cage immediately postoperatively, at 1 month, and at 3 months but no difference at 12 months.[128] Another trial reported worse scores with plate and cage at 6 weeks but no differences at 6 and 12 months.[132] There were no differences between dysphagia scores at any time from the postoperative period to 12 month in one RCT[126] and no differences at 36 months (only time reported) in another trial.[127] One trial reported no patient rated dysphagia as "moderate" or "severe" with either treatment[125] and no study reported that dysphagia required medical intervention (e.g., return to the operating room, percutaneous endoscopic gastrostomy tube placement).

One RCT (N=54) rated high risk of bias found no differences on the Voice Handicap Index between treatment with a standalone cage versus plate and cage from discharge to 12 months.[126]

3.10.1.3.5 Harms

There was low-strength evidence of no difference between standalone cage versus plate and cage on adjacent-level ossification (SOE: Low), while evidence for subsidence and other adverse events was inadequate (SOE: Insufficient).

Seven RCTs (N=518) reported adverse events.[124,127-132] Three trials reported substantially less adjacent-level ossification development with a standalone cage than with plate and cage (N=239, 8% vs. 27%, RR 0.25, 95% CI 0.12 to 0.52, I^2=8%). The change in adjacent-level ossification development severity grade (0=no ossification, 3=severe ossification) was reported in one study and favored treatment with the standalone cage (0.208 vs. 0.818, p=0.001).[130] (SOE: Low) However, no patient required reoperation at 36 months in two trials;[124,127] reoperation rates were not reported in the third trial.[130]

One RCT (N=46) reported a small, but not statistically significant difference in subsidence (loss of disc height) rates with a standalone cage compared with a plate and cage at 12 months (12.5% vs. 9.1%, RR 1.38, 95% CI 0.25 to 7.48) and at 24 months (16.7% vs. 13.6%, RR 1.22, 95% CI 0.31 to 4.87).[130]

One trial (N=104) reported few total complications (N=11) in 24 months that included one nerve injury (2%) and no cerebrospinal fluid leaks (0%) with the standalone cage compared with two nerve injuries (4%) and one cerebrospinal fluid leak (2%) with the plate and cage (p=0.999; p=1.00, respectively).[129] One trial (N=90) reported one (2%) incidence of loosening of the internally fixed implant with the standalone cage versus three (7%) with plate and cage (p=0.333).[131] Another trial (N=40) reported participant treated with a standalone cage experienced a screw loosening, interbody subsidence, and C-5 fracture with revision surgery under consideration at trial publication.[132] The same trial also reported one participant treated

with a plate and cage experienced screw fracture, pseudarthrosis and underwent posterior fusion and decompression 14 months after the primary surgery.

3.10.2 Titanium Versus PEEK Cages

3.10.2.1 Key Findings

- There was low-strength of greater likelihood of fusion with a PEEK cage compared with a titanium or titanium-coated PEEK cage (SOE: Low).
- There was low-strength evidence of greater likelihood of improved general function with a PEEK cage versus a titanium cage (SOE: Low); evidence for neurologic function was inadequate (SOE: Insufficient).
- Evidence for subsidence and other adverse events was inadequate (SOE: Insufficient).

3.10.2.2 Description of Included Studies

Three RCTs (N=217) compared ACDF using a titanium cage or titanium covered PEEK cage versus a PEEK cage.[133-135] (Appendix C) The average study mean duration of followup was 45 months (range 12 months to 99.7 months). One study each was conducted in China, Taiwan, and Poland.

The average study mean age of participants was 50 years (range 46 years to 52 years); the average proportion of female participants was 49 and 45 percent, with one trial reporting that 72 percent of 170 disc spaces belonged to women. Two RCTs reported radiculopathy was experienced by 3 and 75 percent, myelopathy by 11 and 57 percent, and myeloradiculopathy by 13 and 40 percent.[133,134] The third trial did not report myeloradicular symptoms. One trial enrolled participants with 1-level (66%) or 2-level (34%) disease,[134] 3-level disease[133] or disease at 1 or more levels[135]

All studies were rated moderate risk of bias (Appendix D). Methodological limitations included unclear randomization techniques, unclear blinding, and lack of intention to treat analysis. No funds were received in one trial[133] and funding was not reported in the other two. Evidence for neurologic function was rated insufficient due to limited evidence from one small trial. Evidence for subsidence was rated insufficient due to conflicting findings, while evidence for other harms was insufficient due to few adverse events (Appendix G).

3.10.2.3 Detailed Analysis

3.10.2.3.1 Fusion

There was low-strength evidence of a greater likelihood of fusion with a PEEK cage compared with a titanium or titanium-coated PEEK cage (SOE: Low)

Three RCTs (N=217) reported ACDF fusion rates at different followup times that were not different between titanium and PEEK cages or that favored PEEK cages.

One trial reported that at a mean of 99.7 months (range 86 to 116 months) all participants (N=60) achieved fusion of their 3-level disease with both the titanium cage and with the PEEK cage (87/87 levels vs. 93/93 levels).[133] However, followup was not available for 25 percent of the original participants. A second trial (N=53) reported a lower likelihood of fusion with the titanium cage (32/37 levels, 86.5%) versus the PEEK cages (34/34 levels, 100%, p=0.0335) after 24 months.[134] The third RCT (N=104) reported a large difference in the likelihood of complete

fusion that favored the PEEK cage with complete fusion achieved in 26 of 59 titanium-covered PEEK cages implanted (44.1%) compared with 75 of 85 PEEK cages implanted (88.2%) at 12 months ($p<0.001$).[135] Partial fusion was achieved by 55.9 percent of participants with titanium-covered PEEK cages and 11.76 percent of participants with PEEK cages.[135] There were no instances of an absence of fusion.[135]

3.10.2.3.2 Function

3.10.2.3.2.1 Neurologic Function

There was inadequate evidence of the benefits and harms of PEEK cage versus titanium cage on neurologic function (SOE: Insufficient).

One RCT (N=60) found JOA scores improved from baseline (baseline: 9.6 vs. 9.8) with both a titanium implant and a PEEK implant, but improvement was moderately greater with the PEEK implant (12.8 vs. 14.2, endpoint difference: -1.4, 95% CI -2.33 to -0.47).[133]

3.10.2.3.2.2 General Function

There was low-strength evidence of improved general function with a PEEK cage compared to a titanium cage (SOE: Low).

The same trial above (N=60) also found moderately improved NDI scores from baseline (baseline: 36.2 vs. 35.4) with both the titanium and the PEEK implant, but improvement was greater with the PEEK implant (21.6 vs. 15.2, endpoint difference: 6.4, 95% CI 5.13 to 7.67).[133]

Two RCTs (N=113) reported results on Odom's criteria that favored PEEK cages, although differences were not statistically significant in one trial.[133,134] One trial (N=60) reported moderately worse clinical status according to Odom's criteria with the titanium cage versus the PEEK cage (Excellent: 24% vs. 35%; Good: 31% vs. 39%; Fair: 28% vs. 16%; Bad: 17% vs. 10%, $p<0.05$).[133] One trial (N=53) reported no difference between treatments on clinical status (Excellent: 21% vs. 28%; Good: 54% vs. 52%; Fair: 14% vs. 8%; Poor: 11% vs. 12% or successful treatment: 75% vs. 80%, $p=0.6642$).[134] In the trial where enrollment was limited to individuals with 3-level disease, treatment with the PEEK cage was associated with better clinical status, whereas in the trial of 1- and 2-level disease, there was no differences between cage materials on perceived improvement. Additionally, the followup times were greatly different between trials (99.7 months vs. 24 months) with the longer followup time associated with better ratings.

3.10.2.3.3 Quality of Life

No studies reported quality of life outcomes.

3.10.2.3.4 Harms

Evidence was inadequate to determine the effect of a PEEK cage versus a titanium cage on subsidence or other adverse events (SOE: Insufficient).

One RCT (N=104) found no difference between a titanium-coated PEEK implant and a PEEK implant on the incidence of subsidence in 166 levels (20.6% vs. 21.4%, $p=0.875$).[135] However, subsidence was reported with 34.5% of titanium cages (87 levels) compared with 5.4% of PEEK cages (93 levels) in a second RCT (N=60, $p<0.05$)[133] and 16.2% of 37 levels versus 0% of 34 levels in a third RCT (N=53, $p<0.001$).[134] All three trials defined subsidence similarly (≥ 3 mm of interspace collapse). It is unclear the reason for the difference in study findings; possibilities include the cage materials (a titanium-coated PEEK cage may perform differently

than a titanium cage) and the duration since ACDF (12 months in the trial that found no difference versus 24 months and 99.7 months in the other two trials) (SOE: Insufficient).

One RCT (N=53) reported that after 24 months, there were no neurovascular injuries and no revision surgeries with either the titanium cage or the PEEK cage, but that one patient, who received the titanium cage, experienced a hematoma that was removed the day after surgery.[134] One RCT (N=60) reported that at a mean of 99.7 months two patients treated with a titanium cage experienced cage dislocation but were asymptomatic.[133]

3.10.3 Autograft, Allograft, and Other Osteogenic Materials

3.10.3.1 Key Findings

- There was inadequate evidence to determine comparative benefits (fusion, pain reduction, improved function, improved quality of life) for any osteogenic material versus any other osteogenic material (SOE: Insufficient).
- There was low-strength evidence that the use of bone morphogenetic protein 2 (BMP-2) in the cervical spine was associated with increased complications compared to no BMP-2 (SOE: Low); evidence was inadequate to determine the comparative harms of other osteogenic materials (SOE: Insufficient).

3.10.3.2 Description of Included Studies

Six RCTs (N=637) compared autologous bone graft, allograft, and/or other materials to support fusion in ACDF (Appendix C).[136-141] The average mean followup duration was 17 months (range 6 months to 24 months). Two trials were conducted in the United States, two in China, and one each in South Korea and India.

The average study sample size was 106 (range 32 to 319); the average study mean age was 49 years (range 43 years to 55 years). One trial did not report age of participants.[139] The mean proportion of females enrolled was 52 percent (range 30% to 66%). The average proportion of patients with radiculopathy was 61 percent (range 28% to 100%), the average proportion of patients with myelopathy was 21 percent (range 0% to 38%), and the average proportion of patients with myeloradiculopathy was 18 percent (range 0% to 34%). One trial reported that all study participants had radiculopathy, myelopathy or both.[140] All participants enrolled had 1-level degenerative disease,[137,141] 1- to 2-level disease[136,138,140] or 1- to 3-level disease.[139]

Additionally, two NRSI (N=944) assessed heterotopic ossification and complications due to neck swelling with the use of BMP-2 compared to anterior cervical fusion without BMP-2.[142,143] The mean age in one NRSI was 51 years with 51 percent female and 24 percent of study participants having myelopathy and 1 or more levels fused.[143] The other nonrandomized study, which took data from multiple investigational device exemption trials, did not report aggregate baseline patient characteristics but used propensity scoring on 28 predefined demographic and preoperative variables.[142]

One RCT was rated high risk of bias[139] and the remaining RCTs were rated moderate risk of bias (Appendix D). Methodological limitations included unclear randomization methods, unclear blinding, and unclear attrition. Both NRSIs were also rated moderate risk of bias and were downgraded due to baseline differences between study groups on prognostic variables and unclear blinding of outcome assessor. Two trials each reported industry funding, nonprofit funding, and grant funding; one trial did not address funding. One NRSI used data from three Investigational Device Exemption (IDE) trials,[142] while the other reported no funds or support

from industry.[143] Evidence comparing allograft, autograft, and other osteogenic materials on likelihood of fusion, pain improvement, function, and overall harms (with the exception of BMP-2 use) was rated insufficient due to limited evidence for each comparison (Appendix G).

3.10.3.3 Detailed Analysis

3.10.3.3.1 Fusion

There was inadequate evidence to determine the comparative benefits and harms of autograft, allograft, or other osteogenic material versus any other osteogenic material on fusion (SOE: Insufficient).

Six RCTs (N=534) assessed ACDF with autograft, allograft, or other materials (e.g., hydroxyapatite, calcium sulphate) and found no differences between materials in achievement of spinal fusion (Table 3). Fusion rates for all materials were high for all trials but only one randomized study was available for each comparison.

Table 3. Fusion with ACDF using various osteogenic materials

Trial (Timepoint)	Intervention A (Sample Size)	Intervention B (Sample Size)	Findings
Arnold, 2018[137] (24 months)	i-Factor + allograft ring (N=117)	Local graft + allograft ring (N=127)	97.30% vs. 94.44%, p=0.2513
Baskin, 2003[140] (24 months)	BMP-2 + allograft ring (N=10)	ICBG + allograft ring (N=10)	100% vs. 100%, p=1.0
Cho, 2005[139] (6 months)	Biphasic calcium phosphate ceramic + PEEK cage (N=50)	ICBG + PEEK cage (N=50)	100% vs. 100%, p=1.0
Kanna, 2021[136] (12 months)	Allograft + patient's blood + titanium cage (N=13)	Local graft + titanium cage (N=14)	100% vs. 100%, p=1.0 Fusion grade: (p=0.73) F: 23.2% vs. 28.6% F+: 38.4% vs. 42.8% F++: 38.4% vs. 28.6%
Xie, 2015[138] (12 months) (24 months)	Calcium sulphate + demineralized bone matrix + PEEK cage (N=34)	Autogenous iliac cancellous bone + PEEK cage (N=32)	12 months 104 levels, 24 months levels NR: 12 months: 94.3% vs. 100%, p=NR 24 months: 100% vs. 100%, p=1.0
Yi, 2015[141] (12 months)	Hydroxyapatite + demineralized bone matrix + PEEK cage (N=38)	B-tricalcium phosphate + hydroxyapatite + PEEK cage (N=39)	X-ray: 87% vs. 87%, p=1.0 CT: 87% vs. 72%, p=0.16

ACDF = anterior cervical discectomy and fusion; BMP-2 = bone morphogenetic protein; CT = computed tomography; ICBG = iliac crest bone graft; i-Factor = biologic bone graft made of a small peptide bound to an anorganic bone mineral; NR = not reported; PEEK = polyetheretherketone

3.10.3.3.2 Pain

There was inadequate evidence to determine the comparative benefits and harms of autograft, allograft, or other osteogenic material versus any other osteogenic material on neck or arm pain (SOE: Insufficient).

Five RCTs (N=440) assessed neck and arm pain using a VAS or a numerical (pain) rating scale (Tables 4 and 5). One small trial (N=27) reported a moderately greater decrease in neck pain 12 months after ACDF with a local graft and titanium cage than with allograft and titanium cage (MD -6.15 vs. -5.09, $p<0.05$).[136] Another trial (N=20) found a moderate, though not statistically significant, improvement in neck pain with BMP-2 and allograft ring versus iliac

crest bone graft and an allograft ring on a 20-point numerical rating scale (MD 13.0 vs. MD 9.0, p>0.05).[140]

One trial (N=27) also found a substantially greater decrease in arm pain with local graft and a titanium cage compared with allograft and the same cage (MD -7.24 vs. MD -4.55, p<0.05)[136] (Table 5). However, these results should be interpreted with caution due to the trial's small sample size. One RCT (N=26) reported a substantially greater reduction in arm pain at 24 months with BMP-2 and allograft ring compared with iliac crest bone graft and allograft ring on a 20-point numerical rating scale (-14 vs. -8.5, p<0.03).[140] However, as above, these results should be interpreted with caution due to the small sample size. One RCT (N=244) found that ACDF with i-Factor (bone graft made of a peptide bound to an inorganic bone mineral) and an allograft ring was associated with improved VAS arm pain scores at 24 months (1.56 v s. 1.95, p=0.0306) compared with local graft and an allograft ring.[137] However, this small difference in scores is below the threshold for a small effect and may not be clinically meaningful. One RCT (N=77) found a small, although not statistically significant, improvement in arm pain at 12 months with hydroxyapatite, demineralized bone matrix and a PEEK cage compared with β-tricalcium phosphate, hydroxyapatite and a PEEK cage (VAS: MD -4.2 vs. MD -3.6, p=0.27).[141]

There were no differences in neck or arm pain with other comparisons.

Table 4. Neck pain with ACDF using various osteogenic materials

Trial (Timepoint)	Intervention A (Sample Size)	Intervention B (Sample Size)	Findings
Arnold, 2018[137] (24 months)	i-Factor + allograft ring (N=117)	Local graft + allograft ring (N=127)	VAS endpoint: 1.79, 95% CI 1.33 to 2.24 vs. 2.25, 95% CI 1.78 to 2.72, p=0.4619
Baskin, 2003 (24 months)[140]	BMP-2 + allograft ring (N=14)	ICBG + allograft ring (N=12)	20-point NRS: MD 13.0 vs. MD 9.0, p>0.05
Kanna, 2021[136] (12 months)	Allograft + patient's blood + titanium cage (N=13)	Local graft + titanium cage (N=14)	0-10 NPRS: MD -5.09 vs. MD -6.15, p<0.05
Xie, 2015[138] (24 months)	Calcium sulphate + demineralized bone matrix + PEEK cage (N=34)	Autogenous iliac cancellous bone + PEEK cage (N=32)	Improved VAS neck pain: 69% vs. 68%, p>0.05
Yi, 2015[141] (12 months)	Hydroxyapatite + demineralized bone matrix + PEEK cage (N=38)	B-tricalcium phosphate + hydroxyapatite + PEEK cage (N=39)	VAS: MD -1.6 vs. -1.8, p=0.82

ACDF = anterior cervical discectomy and fusion; BMP-2 = bone morphogenetic protein; CI = confidence interval; ICBG = iliac crest bone graft; i-Factor = biologic bone graft made of a small peptide bound to an anorganic bone mineral; MD = mean difference; N(P)RS = Numeric Pain Rating scale; PEEK = polyetheretherketone; VAS = visual analogue scale

Table 5. Arm pain with ACDF using various osteogenic materials

Trial (Timepoint)	Intervention A (Sample Size)	Intervention B (Sample Size)	Findings
Arnold, 2018[137] (24 months)	i-Factor + allograft ring (N=117)	Local graft + allograft ring (N=127)	VAS endpoint: 1.56, 95% CI 1.06 to 2.05 vs. 1.95, 95% CI 1.51 to 2.39, p=0.0306
Baskin, 2003[140] (24 months)	BMP-2 + allograft ring (N=14)	ICBG + allograft ring (N=12)	20-point NRS: MD -14.0 vs. -8.5, p<0.03
Kanna, 2021[136] (12 months)	Allograft + patient's blood + titanium cage (N=13)	Local graft + titanium cage (N=14)	0-10 NPRS: MD -4.55 vs. -7.24, p<0.05

3.10 Results, Key Question 9

Trial (Timepoint)	Intervention A (Sample Size)	Intervention B (Sample Size)	Findings
Xie, 2015[138] (24 months)	Calcium sulphate + demineralized bone matrix + PEEK cage (N=34)	Autogenous iliac cancellous bone + PEEK cage (N=32)	Improved VAS arm pain: 70% vs. 68%, p>0.05
Yi, 2015[141] (12 months)	Hydroxyapatite + demineralized bone matrix + PEEK cage (N=38)	B-tricalcium phosphate + hydroxyapatite + PEEK cage (N=39)	VAS: MD -4.2 vs. -3.6, p=0.27

ACDF = anterior cervical discectomy and fusion; BMP-2 = bone morphogenetic protein; CI = confidence interval; ICBG = iliac crest bone graft; i-Factor = biologic bone graft made of a small peptide bound to an anorganic bone mineral; MD = mean difference; N(P)RS = Numeric Pain Rating scale; PEEK = polyetheretherketone; VAS = visual analogue scale

3.10.3.3.3 Function

3.10.3.3.3.1 Neurologic Function

There was inadequate evidence to determine the comparative benefits and harms of autograft, allograft, or other osteogenic material versus any other osteogenic material on neurologic function (SOE: Insufficient).

Four RCTs (N=436) reported changes in neurological status after ACDF (Table 6). One trial (N=100) found no differences between use of biphasic calcium phosphate ceramic plus a PEEK cage compared with iliac crest bone graft plus a peek cage on JOA score, or JOA recovery rate at 6 months post ACDF.[139] One trial (N=66) reported no difference between calcium sulphate plus demineralized bone matrix plus a PEEK cage versus autogenous iliac cancellous bone plus a PEEK cage in JOA scores at 24 months.[138] One trial (N=26) reported neurologic success (i.e., maintenance or improvement in sensory and motor function) in all remaining participants at 24 months,[140] while another trial (N=244) reported that almost all participants (94.87% vs. 93.70%) experienced neurologic success, also at 24 months.[137]

Table 6. Neurologic function with ACDF using various osteogenic materials

Trial (Timepoint)	Intervention A (Sample Size)	Intervention B (Sample Size)	Findings
Arnold, 2018[137] (24 months)	i-Factor + allograft ring (N=117)	Local graft + allograft ring (N=127)	Neurologic success: 94.87% vs. 93.70%, p=0.6944
Baskin, 2003[140] (24 months)	BMP-2 + allograft ring (N=14)	ICBG + allograft ring (N=12)	Neurologic success: 100% vs. 100%, p=1.0
Cho, 2005[139] (6 months)	Biphasic calcium phosphate ceramic + PEEK cage (N=50)	ICBG + PEEK cage (N=50)	JOA score: MD 2.84 vs. 2.48, p=0.17 JOA recovery rate: 86.51% vs. 83.48%, p=0.22
Xie, 2015[138] (24 months)	Calcium sulphate + demineralized bone matrix + PEEK cage (N=34)	Autogenous iliac cancellous bone + PEEK cage (N=32)	JOA score: MD 3.62 vs. 3.22, p>0.05

ACDF = anterior cervical discectomy and fusion; BMP-2 = bone morphogenetic protein; ICBG = iliac crest bone graft; i-Factor = biologic bone graft made of a small peptide bound to an anorganic bone mineral; JOA = Japanese Orthopaedic Association; MD = mean difference; PEEK = polyetheretherketone

3.10.3.3.3.2 General Function

There was inadequate evidence to determine the comparative benefits and harms of autograft, allograft, or other osteogenic material versus any other osteogenic material on general function (SOE: Insufficient).

3.10 Results, Key Question 9

Four RCTs (N=374) assessed post ACDF neck disability with the NDI (Table 7). One RCT (N=244) found that treatment with i-Factor plus an allograft ring in ACDF resulted in slightly, though not statistically significant, improvement on NDI endpoint scores at 24 months compared with local graft and allograft ring (22.33 vs. 25.66, p=0.5607).[137] One small trial (N=26) reported moderately greater improvement on the NDI after 24 months with BMP-2 and allograft ring compared with iliac crest bone graft and allograft ring (52.7 vs. 36.9, p<0.03).[140] Another small trial (N=27) reported moderately greater improvement on NDI scores after 12 months with local graft plus a titanium cage versus allograft plus titanium cage (MD 56.5 vs. MD 41.4, p<0.05).[136] There was no difference in improvement in NDI scores with hydroxyapatite/demineralize bone matrix plus PEEK cage versus β-tricalcium phosphate/hydroxyapatite plus PEEK cage at 12 months.[141]

Three RCTs (N=357) assessed general function using the SF-36 or the 2-item SF-12 (Table 7). Two trials found no difference in function on the SF-36 after ACDF using an allograft ring with either i-Factor or local graft[137] or using an allograft with either BMP-2 or an iliac crest bone graft.[140] One small trial (N=27) reported moderately better function at 12 months using the 2-item SF-12 with local graft plus a titanium cage compared with the same cage and allograft infused with the participant's blood (MD 48.7 vs. 65.9, p<0.05).[136] However, care should be used in interpreting these results due to the small study sample size.

Table 7. General function with ACDF using various osteogenic materials

Trial (Timepoint)	Intervention A (Sample Size)	Intervention B (Sample Size)	Findings
Arnold, 2018[137] (24 months)	i-Factor + allograft ring (N=117)	Local graft + allograft ring (N=127)	NDI endpoint: 22.33, 95% CI 18.90 to 25.76 vs. 25.66, 95% CI 22.55 to 28.78, p=0.5607
Baskin, 2003[140] (24 months)	BMP-2 + allograft ring (N=14)	ICBG + allograft ring (N=12)	NDI improvement from preoperative scores: 52.7 vs. 36.9, p<0.03
Kanna, 2021[136] (12 months)	Allograft + patient's blood + titanium cage (N=13)	Local graft + titanium cage (N=14)	NDI: MD 41.4 vs. MD 56.5, p<0.05
Yi, 2015[141] (12 months)	Hydroxyapatite + demineralized bone matrix + PEEK cage (N=38)	B-tricalcium phosphate + hydroxyapatite + PEEK cage (N=39)	NDI: MD 22 vs. MD 20, p=0.62
Arnold, 2018[137] (24 months)	i-Factor + allograft ring (N=117)	Local graft + allograft ring (N=127)	SF-36 PCS endpoint: 45.40, 95% CI 43.60 to 47.20 vs. 44.47, 95% CI 42.70 to 46.24, p=0.6461 SF-36 MCS endpoint: 48.43, 95% CI 46.43 to 50.44 vs. 48.41, 95% CI 46.42 to 50.40, p=0.9040
Baskin, 2003[140] (24 months)	BMP-2 + allograft ring (N=14)	ICBG + allograft ring (N=12)	SF-36 PCS: MD 16.7 vs. MD 14.7, p>0.05 SF-36 MCS: MD 21.8 vs. MD 7.2, p>0.05
Kanna, 2021[136] (12 months)	Allograft + patient's blood + titanium cage (N=13)	Local graft + titanium cage (N=14)	2-item SF-12: MD 48.7 vs. MD 65.9, p<0.05

ACDF = anterior cervical discectomy and fusion; BMP-2 = bone morphogenetic protein; CI = confidence interval; ICBG = iliac crest bone graft; i-Factor = biologic bone graft made of a small peptide bound to an anorganic bone mineral; MCS = mental component summary score; MD = mean difference; NDI = Neck Disability Index; PCS = physical component summary score; PEEK = polyetheretherketone; SF-12 = 12-Item Short Form Health Survey; SF-36 = 36-Item Short Form Health Survey

3.10.3.3.4 Harms

There was low-strength evidence that the use of BMP-2 in cervical spine fusion is associated with increased complications compared to the use of no BMP-2 (SOE: Low), while evidence was inadequate to determine the comparative harms of other osteogenic materials (SOE: Insufficient).

Four RCTs (N=520) and 2 NRSI studies (N=944) reported harms with ACDF using various graft materials (Table 8). There were few differences between treatments reported in the RCTs in the likelihood of various harms. One trial (N=319) reported a moderately greater likelihood of experiencing a new radiculopathy with an allograft ring with local graft than with i-Factor (13.66% vs. 25.00%, p=0.0142) but there were no differences in new intractable neck pain or progression of neuropathy.[137] One trial (N=100) reported a shorter hospital stay with a biphasic calcium phosphate ceramic combined with a PEEK cage compared with a PEEK cage with iliac crest bone graft.[139] Reasons for the difference in hospital stay were not provided.

Two retrospective NRSI of BMP-2 compared with no BMP-2 in ACDF (N=944) reported a greater likelihood of heterotopic ossification (78.6% vs. 59.2%, p<0.001)[142] and complications associated with neck swelling[143] with the use of BMP-2 (Table 8). In one NRSI, participants were 10 times more likely to have a neck swelling complication if BMP-2 was used in anterior cervical fusion, even after controlling for potential confounding variables (e.g., age, gender, presence of myelopathy, levels fused, smoking).[143]

Table 8. Adverse events with ACDF using various graft materials

Trial (Timepoint)	Intervention A (Sample Size)	Intervention B (Sample Size)	Findings
Arnold, 2018[137] (24 months)	i-Factor + allograft ring (N=165)	Local graft + allograft ring (N=154)	Pseudarthrosis: 12.73% vs. 16.23%, p=0.3790 New intractable neck pain: 44.72% vs. 42.11%, p=0.1149 New radiculopathy: 13.66% vs. 25.00%, p=0.0142 Adjacent segment degeneration: 13.04% vs. 16.45%, p=0.4274 Retropharyngeal hematoma/airway obstruction: 0% vs. 0.66%, p=0.4856 Progression of myelopathy: 0.62% vs. 0%, p=1.0 Additional cervical spine surgery: 7.45% vs. 10.53%, p=0.34
Baskin, 2003[140] (24 months)	BMP-2 + allograft ring (N=18)	ICBG + allograft ring (N=15)	Additional cervical spine surgery: 5.6% vs. 0%, p>0.05
Cho, 2005[139] (6 months)	Biphasic calcium phosphate ceramic + PEEK cage (N=50)	ICBG + PEEK cage (N=50)	Hospital stay (days): 4.43 vs. 7.00, p=0.02
Xie, 2015[138] (24 months)	Calcium sulphate + demineralized bone matrix + PEEK cage (N=35)	Autogenous iliac cancellous bone + PEEK cage (N=33)	Major complications: 0% vs. 0%, p=1.0 Additional cervical spine surgery: 0% vs. 0%, p=1.0
Arnold, 2016[142] (Retrospective; used propensity scoring)	BMP-2 + PEEK cage + titanium plate (N=224)	Cortical allograft ring + local bone + Atlantis Plate (N=486)	Heterotopic ossification 24 months postoperatively: 78.6% vs. 59.2%, p<0.001

Smucker, 2006[143] (Retrospective: adjusted for potential confounders)	BMP-2 (N=69)	No BMP-2 (N=165)	Neck swelling complications: 27.5% vs. 3.6%, p<0.001 Delay in discharge: 13% vs. 3%, p=NR Severe dysphagia: 7% vs. 1%, p=NR Reintubation: 3% vs. 0%, p=NR PEG placement: 1% vs. 1%, p=NR Tracheostomy: 1% vs. 0.6%, p=NR Incision and drainage of swollen surgical site: 4% vs. 0%, p=NR Readmission to manage swelling: 3% vs. 0%, p=NR

ACDF = anterior cervical discectomy and fusion; BMP-2 = bone morphogenetic protein; ICBG = iliac crest bone graft; i-Factor = biologic bone graft made of a small peptide bound to an anorganic bone mineral; NR = not reported; PEEK = polyetheretherketone; PEG = percutaneous endoscopic gastrostomy

3.11 Key Question 10: In patients with pseudarthrosis after prior anterior cervical fusion surgery, what are the comparative effectiveness and harms of posterior approaches compared to revision anterior arthrodesis?

No studies met eligibility criteria for Key Question 10.

3.12 Key Question 11: In patients with cervical spondylotic myelopathy, what is the prognostic utility of preoperative magnetic resonance imaging (MRI) findings for neurologic recovery after surgery?

3.12.1 Key Findings

- There was low-strength evidence that multisegmental T2-weighted-increased signal intensity (ISI) and sharp T2-weighted-ISI on preoperative MRI was associated with poorer outcomes (SOE: Low).
- There was low-strength evidence that increased signal intensity ratio (SIR) was associated with poorer neurologic recovery (SOE: Low).
- Evidence for other MRI findings was inadequate (SOE: Insufficient).

3.12.2 Description of Included Studies

MRI of the cervical spine is a common imaging procedure performed prior to cervical spine surgery. To identify whether MRI findings can predict neurologic recovery after surgery, we identified one relevant systematic review[144] (that included 22 studies) and 17 additional studies[145-163] that were not included in the systematic review or published subsequent to the review's search dates that provided evidence for this question (Appendix C). Studies were conducted in the United States, China, Taiwan, United Kingdom, Spain, Italy, Greece, India, Korea, and Japan. Most studies were small, with sample sizes ranging from 19 to 861 (mean 162) participants. Mean age of participants ranged from 47 to 70 years (overall mean: 53.9 years), and the proportion of females ranged from 7 to 50 percent (mean 38%). The systematic review and 14 of the 17 primary studies were rated moderate risk of bias, with 3 studies rated high risk of bias (Appendix D). Evidence was insufficient for MRI findings other than ISI and SIR due to limited available data for other outcomes (Appendix G).

3.12.3 Detailed Analysis

3.12.3.1 Fusion

No studies reported fusion outcomes.

3.12.3.2 Pain

No studies reported pain outcomes.

3.12.3.3 Function

3.12.3.3.1 Systematic Review Evidence

A 2013 systematic review that assessed the prognostic utility of preoperative MRI for neurologic recovery after surgery included 22 studies (N=1,508).[144] The included studies evaluated preoperative MRI in patients undergoing cervical disc surgery using a posterior approach (k=7), ACDF (k=5), mixed approaches (k=9), or an unspecified procedures (k=1) over followup ranging from 1.5 to 60.6 months (mean 27.8; standard deviation 4.6 months). The majority of patients in the included studies were male (mean proportion of females: 27.1%), and the mean age (from 20 studies reporting age) was 57.4 (standard deviation, 1.0) years. Heterogeneity of study designs, methods, and outcomes (JOA in 17 studies, Nurick grade in 5

studies, NDI in one study, and Neurosurgical Cervical Spine Score in one study) of the included studies precluded pooling of study findings, and the mixed results were reported narratively. Presence of multisegmental T2-weighted increased signal intensity (ISI) was associated with worse functional outcomes in five studies, not associated with outcomes in four other studies, and lack of T2-weighted ISI was associated with better outcomes in three studies; qualitative classification of T2-weighted ISI was associated with poorer functional status in six studies, not associated with functional outcomes in one study, and lack of T2-weighted ISI associated with better outcomes in one study. Snake-eye appearance on axial T2-weighted MRI, ISI in gray and white matter, and increased SIR were associated with poorer surgical outcomes in one study each.

3.12.3.3.2 Primary Study Evidence

We identified four relevant studies (N=326) that were not included in the systematic review,[156,157,159,160] as well as 13 studies (in 15 publications) that were published subsequent to the review search dates.[145-155,158,161-163] Of these studies, two assessed presence of segmental abnormalities (endplate abnormalities, modic changes, and Cobb angle/loss of lordosis),[146,147,152] six assessed qualitative differences in ISI intensity,[145,149-151,154,157] three assessed SIR,[148,153,155] one evaluated presence or absence of signal changes,[159] two evaluated diffusion tensor tractography grading,[158,162] one (in 2 publications) evaluated diffusion-based spectrum imaging,[161,162] one evaluated a radiomic-based extra tree model,[163] one evaluated the size of the transverse area at the compression site,[160] and one evaluated size, extent, and qualitative intensity.[151] The study (N=55) that assessed the size of the transverse area reported significant associations with postoperative JOA scores (r=0.298) and with JOA recovery (r=0.295) (both $p<0.05$).[160] The study (N=56) that evaluated size, extent, and intensity of ISI reported no association of size or extent of ISI with functional outcomes;[151] one other study of qualitative imaging signal intensity also reported no association of intensity changes with recovery (mJOA score ≥16, RR 1.71; 95% CI 0.90 to 3.24),[145] while four studies (N=714) did find qualitative intensity associated with reduced recovery ratio, lower likelihood of optimal surgical outcome, or change in JOA or NDI scores.[149-151,154] One study (N=52) reported improved JOA recovery rate (54.3% vs. 27.3%) in patients without ISI compared to those with ISI.[156] Another study (N=146) that assessed presence or absence of imaging signal changes reported that patients without imaging signal changes were more likely to have improvement in Nurick grade (OR 5.1; 95% CI, 1.87 to 25.1); however, there was no difference between patients without imaging signal changes and those with only T2-weighted signal changes.[159] Another study (N=73) found that the combination of T1-weighted hypointensity and T2-weighted hyperintensity was associated with poorer JOA recovery than T2-weighted hyperintensity alone or no ISI changes (JOA recovery 48% vs. 19% vs. 60.7%; T1- and T2-weighted ISI changes vs. T2-weighted ISI change only, $p=0.0259$).[157] Two studies of SIR (N=220) reported increased T2-weighted SIR associated with JOA recovery;[148,155] one study (N=148)[153] reported no association between T2-weighted SIR and outcomes, while lower T1-weighted SIR was associated with poorer neurological outcomes assessed with the JOA. One study (N=129)[158] found that diffusion tensor tractography grading using MRI images was associated with JOA score changes ($r= -0.813$, $p<0.001$) and JOA recovery ($r= -0.429$, $p<0.001$), while conventional MRI ISI grading was associated with JOA score changes ($r= -0.674$, $p<0.001$) but not with JOA recovery ($r= -0.197$, $p=0.058$). However, another study (N=42) comparing diffusion-based spectrum imaging to diffusion tensor grading reported that no diffusion tensor metrics were associated with neurological (mJOA) or general

function (SF-36, NDI, and Myelopathy Disability Index) outcomes.[162] The study found that preoperative diffusion-based spectrum imaging intra-axonal axial diffusivity and anisotropic fraction correlated with improved mJOA scores (r=0.37, p=0.02 and r=0.34, p=0.03, respectively).[162] Another analysis of most of these same patients (N=50)[161] compared diffusion-based spectrum imaging to clinical features and found greater prognostic utility with diffusion-based spectrum imaging (area under the curve [AUC] 75.3%) and the combination of diffusion-based spectrum imaging with clinical features (AUC 98.0%) than with assessment of clinical features alone (AUC 59.4%) for mJOA scores. The study reported similar findings for the prognostic utility of diffusion-based spectrum imaging (AUC 54.6%) or the combination of diffusion-based spectrum imaging and clinical features (AUC 65.3%) versus clinical features alone (AUC 48.8%) for NDI.

One study (N=151) evaluated a novel radiomic-based extra tree model of MRI data for predicting neurological outcomes following surgery for CSM.[163] The study reported that their radiomic-based model (AUC 75%) and the combination of their radiomic-based model with clinical assessment (AUC 71%) were superior to radiological assessment (AUC 43%) and the combination of radiological and clinical assessment (AUC 40%) for predicting neurologic recovery assessed using mJOA.

One study (N=121) reported a novel classification system for reporting loss of cervical lordosis following laminoplasty was predicted by an interplay of preoperative Cobb angle, T1 slope, and dynamic extension reserve.[152] One study (N=861) reported Modic changes, defined as "subchondral vertebral bone marrow lesions of the endplate" on preoperative MRI and found that while modic changes were associated with greater postoperative disability, modic changes were also associated with older age, greater number of levels fused, and a longer duration of symptoms.[146]

Comparing findings across studies was difficult due to the various study methods used (e.g., different type and basis of classification of T2 weighted ISI [single segment, multisegment, L2 classification, Q3 classification, SIR], different outcomes assessed [JOA, NDI, Nurick grade], and different methods to analyze the data [correlation, linear regression, multivariable regression, Student's *t* test]). Preoperative MRI also preceded different types of surgery (e.g., ACDF, laminoplasty, posterior-anterior decompression), which reduces the generalizability of findings.

3.12.3.3.3 Synthesis of Systematic Review and Primary Study Findings

There was low-strength evidence that multisegmental T2-weighted-increase signal intensity and sharp T2-weighted-increased signal intensity on preoperative MRI was associated with poorer neurologic outcomes (SOE: Low); there was also low-strength evidence that increased SIR of preoperative MRI was associated with poorer neurologic recovery (SOE: Low)

In total, presence of ISI was associated with poorer neurologic outcomes (e.g., JOA recovery, Nurick grade, NDI) in 7 studies and absence of ISI was associated with better neurologic outcomes (e.g., JOA, Nurick grade) in 4 studies but was not associated with changes in neurologic outcomes in 5 studies. Qualitative grading (increased intensity) of ISI was associated with worse neurologic outcomes (e.g., JOA, NDI) in 11 studies, absence of T2-weighted intensity associated with a better neurologic outcome (Nurick grade) in 1 study, and not associated with neurologic outcomes in 3 studies. Higher SIR was associated with poorer recovery in 3 studies (AUCs ranged from 78.6% to 87.3% in the two studies that reported accuracy results); one study reported lower SIR on T1 weighted associated with poorer neurological outcomes (e.g., JOA), while T2-weighted SIR was not associated with outcomes.

3.12 Results, Key Question 11

One study reported that diffusion tensor tractography grading was more closely associated with neurological outcomes and recovery (e.g., JOA) than conventional ISI grading; however, another study found no association of diffusion tensor grading with neurological outcomes. One study of diffusion-based spectrum imaging found the imaging modality superior to diffusion tensor grading and assessment using clinical features. One study found a novel radiomic-based extra tree model to be superior to both radiological and clinical assessment (SOE for ISI and SIR: Low).

3.12.3.4 Quality of Life

No studies reported quality of life outcomes.

3.12.3.5 Harms

No studies reported harms or adverse events.

3.13 Key Question 12: What are the sensitivity and specificity of imaging assessment for identifying symptomatic pseudarthrosis after prior cervical fusion surgery?

3.13.1 Key Findings

- There is low-strength evidence that postoperative ACDF dynamic radiographs can predict pseudarthrosis in a largely asymptomatic population (SOE: Low) and a largely symptomatic population (SOE: Low).
- Evidence was inadequate for use of an angular method measurement in postoperative ACDF dynamic radiographs in predicting pseudarthrosis in an undefined population (SOE: Insufficient).

3.13.2 Description of Included Studies

Three nonrandomized studies (N=758)[164-166] assessed diagnostic accuracy of radiographs in predicting pseudarthrosis after prior cervical fusion surgery (Appendix C). All studies were conducted in the United States. The mean ages of participants was 52 years; the proportion of females ranged from 42 to 62 percent. No studies reported race or ethnicity. In all studies, enrolled patients had undergone ACDF as the index surgery, and revision surgery included anterior or posterior approaches.

Two studies were rated moderate risk of bias [164,165] and one high risk of bias[166] (Appendix D). Methodological limitations included lack of clarity on the number and characteristics of patients missing imaging studies; high attrition and lack of clarity on reference standard accuracy and assessor blinding. No studies reported receiving funding. Evidence for a novel measurement method in predicting pseudarthrosis was rated insufficient due to the small sample size, study quality, and reference standard (Appendix G).

3.13.3 Detailed Analysis

There is low-strength evidence that postoperative ACDF dynamic radiographs can predict pseudarthrosis in a largely asymptomatic and a largely symptomatic population (SOE: Low), while evidence was inadequate to determine the comparative accuracy of using angular versus linear measurement methods in postoperative dynamic radiographs for predicting pseudarthrosis (SOE: Insufficient).

One study (N=125) reported diagnostic accuracy of dynamic radiographs and computed tomography (CT) scans for identifying pseudarthrosis in patients who had undergone revision surgery for pseudarthrosis or adjacent segment pathology, using surgical exploration of fusion as the reference standard.[165] Medical records were retrospectively reviewed for patients operated on from January 2004 through December 2011. There were 262 levels evaluated (109 fused and 153 with pseudarthrosis). Most patients (84%) had revision surgery due to suspected pseudarthrosis, although it is unclear if patients were symptomatic. In dynamic radiographs magnified 150 percent, the optimal cutoff in interspinous motion to predict pseudarthrosis was 0.9 mm (AUC 0.899). Using cutoff criteria of interspinous motion ≥1 mm and superadjacent interspinous motion ≥4 mm resulted in similar values for diagnostic accuracy in dynamic radiographs versus a CT scan: sensitivity (86.3% vs. 87.2%), specificity (96.1% vs. 97.4%), positive predictive value (96.9% vs. 97.9%) and negative predictive value (83.4% vs. 84.4%) (SOE: Low).

3.13 Results, Key Question 12

One study (N=597, levels=1,203) assessed diagnostic accuracy of dynamic radiographs for predicting symptomatic pseudarthrosis in patients who were largely asymptomatic but required revision surgery.[164] Medical records from 2010 to 2019 were reviewed for eligible patients. The reference standard was intraoperative documentation of pseudarthrosis (36% of the patient sample); only 4.9 percent of patients required pseudarthrosis revision.[164] Pseudarthrosis rates increased as the number of operative levels increased from 22.2 percent with 1-level to 75 percent with 4-level surgery. In radiographs taken 1 year post-primary surgery, using an optimal cutoff of 1 mm interspinous motion (AUC 0.868) had high negative predictive value (99.6%) and sensitivity (89.7%); moderate specificity (81%); and low positive predictive value (13.7%) in identifying patients requiring revision surgery due to pseudarthrosis. Adding superadjacent interspinous motion ≥4 mm to 1 mm interspinous motion to the model, versus 1 mm alone,[165] reduced the number of patients and levels included in the authors' analysis but resulted in similar AUC. The positive predictive value was also decreased without improving the negative predictive value (SOE: Low).

One study rated high risk of bias (N=143 enrolled; 36 analyzed) validated an angular measurement method for predicting pseudarthrosis in patients with 10 months' minimum postoperative radiographic followup.[166] Medical records were retrospectively reviewed for eligible patients (years not reported); 1-year postoperative CTs (n=36) were used as the reference standard. Authors did not report whether patients were symptomatic or asymptomatic at the time of imaging. In dynamic radiographs at 150 percent magnification, the angle measurement method was calculated as the difference in angles between lines from specific landmarks in the spinous processes, while the standard linear method calculated differences in interspinous process distance between flexion and extension radiographs. Using 1 mm linear measurement cutoffs as reported in prior studies, suspected pseudarthrosis rates were lower using angular versus linear methods (N=143; 18.5% [45/242 levels] vs. 28% [68/242 levels], p=not reported).[166] In 1-year validation CTs (n=36; 66 levels), pseudarthrosis was identified in 13 patients (13 levels), of whom 5 underwent revision surgery; use of the angle method resulted in similar sensitivity (85%) but higher specificity (96%) versus the linear method (85% and 87%, respectively).[166] (SOE: Insufficient)

3.14 Key Question 13: In patients with cervical spondylotic myelopathy, what are the comparative effectiveness and harms of intraoperative neuromonitoring (e.g., with somatosensory or motor evoked potential measurements) versus no neuromonitoring on clinical outcomes in patients undergoing surgery?

3.14.1 Key Findings

- There was low-strength evidence of a similar likelihood of neurological complications with or without the use of intraoperative neuromonitoring (IONM) in ACDF for cervical myelopathy and radiculopathy (SOE: Low). This evidence only applies to patients undergoing ACDF and only one study reported the proportion of patients with myelopathy.

3.14.2 Description of Included Studies

Two retrospective NRSIs utilized large US claims databases (National Inpatient Sample [NIS]) of the Healthcare Cost and Utilization Project from 2009 to 2013 (N=141,007)[167] and PearlDiver from 2007 to 2014 (N=15,395)[168] to examine the effects of IONM versus no IONM in patients undergoing ACDF.

In the NIS study, 1:1 propensity score-matching, controlling for age, sex, indication, number of levels fused, Charlson Comorbidity Index (CCI) and admission type (elective, nonelective) was used (N=18,760).[167] There was no adjustment for confounders in the PearlDiver study.[168] The NIS data included inpatient data with no outpatient followup; the PearlDiver data included followup out to 30 days postoperatively. All data were collected from claims in the United States.

The mean age of participants was 54 years in the NIS study and reported by categories in the PearlDiver study (<45 years, 45-54, 55-64, 65-74, and >75; with the largest number of patients in the 45-54 age category). The average proportion of females was 51 and 52 percent, respectively. The NIS study enrolled a majority of White participants (80%), while the PearlDiver study did not report race/ethnicity (Appendix C).

Of patients with degenerative disease in the entire NIS, 42 percent of participants had radiculopathy alone and 31 percent had myelopathy (these proportions were not reported in the propensity score-matched NIS). Additionally, 66 percent of participants in the NIS study had a CCI of 0 (3.4% with a CCI of 3 or higher) and 84 percent had 1-2 level fusion, whereas the PearlDiver study did not report proportions with baseline radiculopathy, myelopathy, comorbidities, or levels fused.

The NIS study was rated moderate risk of bias due to study design.[167] The PearlDiver study was rated high risk of bias due to study design and lack of adjustment for potential confounders[168] (Appendix D). Concerns with these studies include the use of International Classification of Diseases codes to determine utilization, reliance on data from paid or adjusted claims rather than all claims, and changes in medical coverage policies.

3.14.3 Detailed Analysis

3.14.3.1 Outcomes

No studies reported fusion outcomes, pain, function, or quality of life.

3.14.3.2 Harms

There was low-strength evidence of a similar likelihood of neurological complications with or without the use of intraoperative neuromonitoring in ACDF (SOE: Low).

The NIS study included 18,760 patients who underwent ACDF in the propensity score-matched analyses from 2009 to 2013 and found no differences between IONM and no IONM in the rate of neurological complications (0.22% vs. 0.17%, p=0.41) or in the proportion of patients who required a hospital stay greater than 2 days (17.8% vs. 18.6%, p=0.15).[167]

The PearlDiver database study included 15,395 patients who underwent ACDF from 2007 to 2014 for degenerative radiculopathy or myelopathy (IONM was used for 17.1% of patients, N=2627).[168] Although there was no propensity score matching or adjustments made for confounding variables, the results were similar to the NIS study. There was no difference in rate of neurologic complication within 30 days of the index procedure between IONM and no IONM (0.23% vs. 0.27%, p=0.84). However, younger patients were more likely to receive IONM (20.3% in patients less than 45 years of age compared to 13.6% in patients >75 years).

3.15 Contextual Question 1: What is the prevalence of cervical degenerative disease with spinal cord compression in asymptomatic patients?

Not all individuals with CDD that includes spinal cord compression experience pain, radiculopathy, myelopathy or other symptoms. A 2021 systematic review and meta-analysis rated moderate risk of bias included 11 studies (N=3,686) that reported cervical MRI results in healthy individuals.[169] In pooled analysis, the prevalence of asymptomatic spinal cord compression was 24.2 percent (range 5.3% to 59%; 95% CI 12.4% to 36%, I^2=88).

To help explain the high statistical heterogeneity in pooled analysis, studies of asymptomatic participants were stratified based on mean age (less than or equal to 60 years versus greater than 60 years). The prevalence of spinal cord compression was lower in the younger subgroup (7 studies, N=1841, prevalence 7.4%, 95% CI 2.8% to 12%, I^2=40%) versus the older subgroup (4 studies, N=1845, prevalence 35.3%, 95% CI 14.1% to 56.5%, I^2=94%). Studies were also stratified based on study location: America/Europe (6 studies, N=390, prevalence of spinal cord compression 39.7%, 95% CI 21.0% to 58.3%, I^2=64%) versus Asia (5 studies, N=3296, prevalence of spinal cord compression 11.1%, 95% CI 1.6% to 20.5%, I^2=83%). The study with the largest number of participants (N=1211) was conducted in Japan, enrolled younger participants (mean age 50 years) and reported the lowest prevalence of spinal cord compression (5.3%).[170] In this study, spinal cord compression was defined as when "the AP (anteroposterior) diameter of the spinal canal at its narrowest was less than or equal to the AP diameter of the spinal cord at the C5 vertebral level."[170] This is in contrast to the study with the highest prevalence of participants with spinal cord compression (59%, N=183) that enrolled older participants (mean 66 years) and was conducted in the Czech Republic.[171] The definition of spinal cord compression in this study was more liberal and was diagnosed when "a change in spinal cord contour at the level of an intervertebral disc on axial or sagittal MRI compared with that at the midpoint level of neighboring vertebrae."[171] In both studies, as expected, the prevalence of spinal cord compression increased with age.

3.16 Contextual Question 2: What is the natural history of untreated spinal cord compression in patients with cervical degenerative disease?

The natural history of degeneration of the cervical spine progressing to nonmyelopathic spinal cord compression (NMSCC) and ultimately CSM is a continuum of disease that remains poorly understood. Untreated spinal cord compression is most studied in the context of CSM. There is a subset of patients with spinal cord compression found on imaging who are asymptomatic. A recent systematic review by Nouri et al (2022)[172] found the prevalence of asymptomatic spinal cord compression in healthy volunteers to be 24.2 percent (range 5.3% to 59%). A small series by Martin et al (2018)[173] looking at 20 asymptomatic patients with MRI evidence of spinal cord compression revealed that 2 (10%) developed symptoms of myelopathy at a median followup of 21 months. The largest prospective study evaluating the transition from NMSCC to CSM by Bednarik et al (2008) revealed that among 199 patients enrolled with NMSCC, 8 percent developed CSM at 1-year followup and 22.6 percent of patients developed CSM at median followup of 44 months (range 1-12 years).[174] Factors found to independently predict the development of myelopathy in a multivariate analysis included presence of radiculopathy, spinal cord cross-sectional area and compression ratio.[175]

CSM is the leading cause of spinal cord dysfunction among adults worldwide.[176] The pathogenesis of CSM is due to both mechanical and neuropathic changes to the spinal cord and blood spinal cord barrier generated by compression on the spinal cord.[177-180] The compressed cervical spinal cord is subjected to chronic hypoxic conditions due to dysfunction of endothelial cells as well as flattening and consequent loss of surrounding vessels.[178]

While the natural history of CSM in patients varies greatly, it is generally thought of as a progressive disorder. This was confirmed in a recent systematic review[181] that found moderate evidence from small prospective and retrospective studies that the proportion of patients who deteriorate by at least 1 point in the JOA scale ranged from 20 to 60 percent. It is important to point out that these studies did not consider the minimal detectible difference to define deterioration, which is >1 point based on reliability studies.[182,183] The overall lack of large, well designed and controlled studies evaluating the natural history of untreated spinal cord compression in patients with CDDs impairs clinicians' ability to counsel patients. A recent clinical practice guideline provided by AO Spine suggested that either surgery or clinical observation are reasonable initial treatment options in mild CSM (e.g., mJOA score greater than or equal to 15).[184,185]

Shimomura et al[186] evaluated prognostic factors for deterioration of patients with CSM treated nonoperatively. Their prospective study included 56 patients with mild CSM, 11 (20%) had clinical deterioration over a mean followup period of 35.6 months. Age, gender, followup period, developmental or dynamic canal factors (e.g., canal size of < 12mm) of cervical spine on plane lateral radiographs, presence of high intensity of the cord on T2 weighted MRI and circumferential spinal cord compression on axial MRI were all evaluated as possible predictors for progression of myelopathy. However, they found the only predictive factor was presence of circumferential spinal cord compression on axial MRI (adjusted OR 26.6, 95% CI 1.7 to 421.5).[186] More studies are needed to better define the natural history of untreated spinal cord compression in the setting of degenerative changes along with predictors of progression.

4. Discussion

4.1 Findings in Relation to the Decisional Dilemmas

Cervical degenerative disease (CDD), which affects millions of older Americans, may lead to neck pain, radiculopathy, and myelopathy. Treatment of CDD, initially limited to conservative therapies (e.g., neck collar, traction, physiotherapy), has evolved to include instrumented and noninstrumented surgeries to decompress nerve roots and/or the spinal cord. Decisional dilemmas concerning best management of CDD include determination of whether one or more nonoperative treatments instead of surgery or in addition to surgery is preferred, and, if surgery is indicated, the determination of the most effective operative approaches and techniques for each individual patient. The key findings and strength of the evidence (SOE) are summarized in Table 9.

Fifty-seven randomized controlled trials (RCTs) (in 82 publications), 56 nonrandomized studies (in 57 publications), and 1 systematic review provided evidence for this review. The highest-quality evidence was for cervical arthroplasty versus anterior cervical discectomy and fusion (ACDF) in patients with cervical radiculopathy and/or myelopathy. Evidence for nonsurgical interventions was particularly limited. Similarly, there was no evidence to guide treatment for asymptomatic patients with radiographic spinal cord compression.

Conservative (nonoperative) therapy or operative treatment. There was insufficient evidence to determine the effectiveness of nonoperative compared with operative treatment for CDD, and limited evidence to suggest no important difference in pain beyond two weeks when a postoperative cervical collar was added to laminoplasty (SOE: Low). Post-operative pulsed electro-magnetic field stimulation in addition to ACDF was associated with a greater likelihood of fusion than ACDF alone (SOE: Low). Evidence for exercise therapy was insufficient.

Anterior or posterior surgery. Anterior approaches were primarily ACDF and included anterior cervical foraminotomy and anterior decompression without fusion; posterior approaches included posterior cervical discectomy and fusion, laminoplasty and posterior cervical foraminotomy. Single-level surgery was performed in patients with radiculopathy and two or more levels in patients with myelopathy. There was low strength of evidence of no difference between these approaches for improvement in pain, function, quality of life, or reoperation in patients with fewer than three operated levels (SOE: Low). There was limited evidence to suggest that a posterior approach is associated with increased likelihood of experiencing any serious adverse event in patients with greater than or equal to 3-level disease (SOE: Low). Selection bias, inadequate adjustment for potential confounding factors (e.g. age, comorbidities), confounding by indication, and other methodological limitations in nonrandomized studies of interventions (NRSIs) resulted in low or insufficient SOE for all outcomes, particularly in patients with ≥3-level diseases.

Laminoplasty or laminectomy and fusion. In patients with cervical spondylotic myelopathy, there was moderate strength evidence indicating similar benefits on postoperative function between laminectomy and fusion compared with laminoplasty and no important difference in reoperation rates, although limited evidence suggests laminoplasty may be associated with fewer complications than laminectomy and fusion (SOE: Low).

Disc replacement or fusion. In patients with radiculopathy and/or myelopathy at one level, there was moderate strength evidence of no important difference between cervical arthroplasty and ACDF in pain or function. Cervical arthroplasty was associated with substantially decreased likelihood of reoperation (SOE: High) and slightly lower likelihood of any serious adverse event

in the short term (SOE: Low), but there was no important difference between cervical arthroplasty and ACDF in serious adverse events longer term (SOE: Low). However, index level reoperation rates for ACDF may be influenced by removal an existing plate to treat adjacent segment disease. This may artificially inflate the reported reoperation rate for ACDF versus cervical arthroplasty. Studies did not consistently specify reasons for revision. Additionally, magnetic resonance imaging (MRI) artifact created by the artificial disc may obscure pathology while concerns related to fusion may be more apparent, leading to more revisions with ACDF vs. arthroplasty. The actual impact of these factors on reported reoperation rates is unclear.

Study findings were similar in patients with 2-level cervical arthroplasty or ACDF in pain and function and likelihood of reoperation at the index level, but the likelihood of an adverse event was slightly lower at 24 with months with cervical arthroplasty and no different at 120 months (SOE: Low). Evidence was sparse for this comparison beyond two levels. The majority of these cervical arthroplasty were industry funded and were frequently authored by individuals with industry-related conflicts of interest.

In patients with pseudarthrosis after ACDF, evidence on comparative effectiveness and harms of revision anterior arthrodesis versus a posterior approach was lacking.

ACDF graft choices. In patients undergoing ACDF, there was moderate strength evidence of no important difference between use of a standalone cage or a plate and cage in fusion rate, postoperative arm pain, function, quality of life, or subsidence. In a comparison of titanium/titanium-coated cages versus polyetheretherketone (PEEK) cages in ACDF, there was limited evidence to suggest that use of a PEEK cage results in a greater likelihood of fusion and function improvement than use of a titanium/titanium-coated cage (SOE: Low). In patients undergoing ACDF, there was also low strength evidence to suggest an increased risk of complications with the use of bone morphogenetic protein 2 (BMP-2) in the cervical spine compared with fusion without the use of BMP-2 (i.e., use of other osteogenic materials).

Other decisional dilemmas included the use of pre- and post-operative imaging findings and associations with better or worse outcomes, and the use or nonuse of intraoperative neuromonitoring on patients undergoing cervical spine surgery.

Role of imaging. Evidence for imaging to predict neurologic recovery was heterogeneous, as various study methods were used (e.g., different type and basis of classification of increased signal intensity, different outcomes, and different statistical analysis methods), thus making comparisons across studies challenging. In patients with cervical myelopathy, there was limited evidence to suggest that multisegmental T2-weighted increased signal intensity, sharp T2-weighted increased signal intensity, and increased signal intensity ratio are associated with poorer neurologic recovery (SOE: Low).

In an asymptomatic and symptomatic populations, there was limited evidence suggesting that postoperative ACDF dynamic radiographs can predict pseudarthrosis with surgical exploration used as the gold standard (SOE: Low).

Intraoperative neuromonitoring or no monitoring. There was limited evidence to suggest that patients undergoing anterior cervical discectomy and fusion with intraoperative neuromonitoring (IONM) had similar likelihood of neurological complications as patients undergoing surgery without IONM (SOE: Low). Two databases (National Inpatient Sample [NIS] and PearlDiver) were included, but only the NIS analysis used propensity score matching. The PearlDiver study did not match or control for confounders, but had similar results. In the total NIS sample, 42 percent of participants had radiculopathy alone and 31 percent had myelopathy (proportions not reported in the matched sample), 66 percent had a Charlson

4. Discussion

Comorbidity Index of 0, and 84 percent had 1-2 level fusion. The PearlDiver study did not report baseline radiculopathy, myelopathy, comorbidities or levels fused. These findings apply only to ACDF procedures; neither study evaluated posterior cervical procedures. Both studies relied on claims data to distinguish patients that had IONM versus those who did not, which may significantly underreport the number who received IONM.

Table 9. Summary of findings: cervical degenerative disease treatment

Key Question	Comparison	Fusion; Effect (SOE)	Pain; Effect (SOE)	Function; Effect (SOE)	Quality of Life; Effect (SOE)	Adverse Events; Effect (SOE)
KQ 1. Radiographic spinal cord compression, no myelopathy	Surgery vs. nonoperative treatment	No evidence	No evidence	No evidence	No evidence	No evidence
KQ 2. Radiographic spinal cord compression, mild to severe myelopathy	Surgery vs. nonoperative treatment	No evidence	No evidence	Insufficient	No evidence	Insufficient
KQ 3. CDD	Surgery vs. nonoperative treatment	No evidence	Insufficient	Insufficient	No evidence	No evidence
KQ 4. CDD	ACDF vs. ACDF + collar	Insufficient	Insufficient	Insufficient	No evidence	No evidence
	ACDF vs. ACDF + EMS	Small, favors ACDF + EMS (+)	Insufficient	Insufficient	No evidence	No evidence
	Laminoplasty vs. Laminoplasty + collar	NA	Similar (+)	Similar (+)	No evidence	No evidence
	Laminoplasty vs. laminoplasty + exercise	NA	Insufficient	No evidence	No evidence	No evidence
KQ 5. Cervical radiculopathy	Anterior vs. posterior surgery	Insufficient	Neck and Arm pain: Similar (+)	Similar (+)	Similar (+)	Reoperation: Similar (+)
KQ 6. CDD with ≥3 level disease	Anterior vs. posterior surgery	Insufficient	Neck pain: Similar (+) Arm pain: Insufficient	Similar (+)	Insufficient	Mortality, severe dysphagia: Similar (+) Reoperation Insufficient SAE: Moderate to Large, favors anterior (+)

4. Discussion

Key Question	Comparison	Fusion; Effect (SOE)	Pain; Effect (SOE)	Function; Effect (SOE)	Quality of Life; Effect (SOE)	Adverse Events; Effect (SOE)
KQ 7. Cervical myelopathy	Laminectomy and fusion vs. Laminoplasty	NA	Insufficient	Similar (++)	No evidence	Reoperation: Similar (++) AEs: Moderate to Large, favors laminoplasty (+)
KQ 8. CDD	Cervical arthroplasty vs. ACDF	NA	Similar (++)	Similar (++)	No evidence	Reoperation: Large, favors cervical arthroplasty: 1-level: (+++) 2-level: (+) SAE: Small, favors cervical arthroplasty (+) Neurological events: Similar 1-level: (+) 2-level: Insufficient
KQ9. ACDF	Standalone cage vs. plate and cage	Similar (++)	Neck pain: Similar (+) Arm pain: Insufficient	Similar (+)	Similar (+)	Adjacent level ossification: Similar (+)
	Titanium/titanium -coated vs. PEEK cage	Small, favoring PEEK (+)	Insufficient	Small, favoring PEEK (+)	No evidence	Insufficient
	Autograft vs. allograft vs. other osteogenic materials	Insufficient	Insufficient	Insufficient	Insufficient	AEs: Large, favors nonuse of BMP-2 (+)
KQ 10. Pseudarthrosis prior anterior fusion surgery	Posterior approach vs. revision anterior arthrodesis	No evidence	No evidence	No evidence	No evidence	No evidence
KQ 11. Myelopathy, prognostic utility of MRI	T2-weighted increased signal intensity and intensity ratio, sharp signal intensity	No evidence	No evidence	No evidence	No evidence	Neurologic recovery: favors no signal, less sharp signal, increased signal intensity ratio (+)

Key Question	Comparison	Fusion; Effect (SOE)	Pain; Effect (SOE)	Function; Effect (SOE)	Quality of Life; Effect (SOE)	Adverse Events; Effect (SOE)
	Segmental abnormalities, diffusion tensor tactography, diffusion-based spectrum imaging, radionomic-based extra tree model	No evidence	No evidence	No evidence	No evidence	Neurologic recovery: Insufficient
KQ 12. Imaging to detect pseudarthrosis	Dynamic radiographs (asymptomatic)	Predicts pseudarthrosis (+)	NA	NA	NA	NA
	Dynamic radiographs (symptomatic)	Predicts pseudarthrosis (+)	NA	NA	NA	NA
	Angular measurement in dynamic radiographs (population NR)	Insufficient	NA	NA	NA	NA
KQ 13. CDD and ACDF	IONM vs. no IONM	NA	No evidence	No evidence	No evidence	Neurologic complications: Similar (+)

ACDF = anterior cervical discectomy and fusion; AE = adverse event; BMP-2 = bone morphogenetic protein 2; CDD = cervical degenerative disease; EMS = electromagnetic stimulation; IONM = intraoperative neuromonitoring; KQ = Key Question; MRI = magnetic resonance imaging; NA = not applicable; NR = not reported; PEEK = polyetheretherketone; SAE = serious adverse event; SOE = strength of evidence; T2 = T2 weighted image
Strength of Evidence: low (+), moderate (++), high (+++)

4.2 Implications for Clinical and Policy Decisions

This review was sponsored by the Congress of Neurological Surgeons (CNS) to update their 2009 guidelines on the management of CDD. Our review provides additional evidence that operative approaches to management of CDD generally result in improvement in pain, function, and quality of life postoperatively, as well as successful fusion (if a fusion surgery). In many cases patient-centered benefit outcomes between compared operative approaches and techniques were similar. The likelihood of general or specific adverse events, such as need for reoperation/revision surgery, were where most differences between therapies were observed and may help guide decision making regarding best operative approach for any given patient.

Our review provides additional support to the 2009 finding that preoperative MRI can help predict better or worse outcomes and to the 2009 recommendation discouraging use of BMP-2 in the cervical spine. Standalone cages for cervical fusion represent a newer design (Zero-P approved for use in the United States in 2008) and not covered in the 2009 guidelines. Although a more modern design, we did not find it superior to the use of anterior plating for most outcomes.

Gaps in the evidence make it difficult to create recommendations and inform policy. For example, challenges remain in determining the preferred course of action in patients with

incidental findings of spinal cord compression on MRI. Although the natural history of non-myelopathic spinal cord compression is poorly understood, limited evidence suggests that some patients develop myelopathy over time, but it is not clear if any treatment provided prior to the development of symptoms results in better outcomes than treating symptomatic disease. Another challenge remaining is determining when conservative treatment may be preferred and what therapies are most effective compared with operative management or result in better outcomes when added to surgery. Good quality comparative evidence on conservative treatment was sparse in this review.

4.3 Strength and Limitations of the Systematic Review Process

Strengths. This review appears to provide the most comprehensive synthesis of evidence related to the comparative effectiveness of surgical treatment of CDD and identifies important gaps in the comparative evidence for many of them. Important strengths of this review include the use of a "best evidence" approach, where we focused our efforts on studies with least risk of bias, particularly RCTs when available and supplemented with nonrandomized studies that adjusted for potential prognostic variables where appropriate. We avoided use of nonrandomized studies that did not adjust for potential confounding (e.g., propensity score matching, statistical control for confounding variables) as the conclusion from such studies may differ from RCT evidence and are more likely to suffer from various important biases (see below). Another strength is our focus on outcomes of primary importance to patients including pain, function, and quality of life as improved patient outcomes may lead to higher quality patient care, as well as patient satisfaction with care. Additionally, interpretation of clinically important differences in mean change for continuous variables is challenging. A strength of our review is our categorization of the magnitude of effects for function and pain outcomes using the system described in our previous reviews to facilitate interpretation of results across trials and interventions by providing a level of consistency and objective benchmarks for comparison. We also added two Contextual Questions (on the natural history of untreated spinal cord compression and on the prevalence of CDD with spinal cord compression in asymptomatic patients) to provide context for this review.

Limitations. For many Key Questions, quantitative synthesis of evidence was not possible due to the poor quality of evidence available and lack of comparative evidence for some Key Questions. For some Key Questions evidence was limited to one study per comparison, making it difficult to draw conclusions about any specific treatment. While we did include NRSIs that made comparisons of interest, results from such studies should be interpreted cautiously. Limitations of these studies generally led to determination of insufficient evidence for many outcomes. Confounding by indication, lack of adequate control for confounding on important prognostic factors, as well as failure to adequately account for selection of patients and loss to followup in NRSIs were common methodologic concerns. For subjective patient-reported outcomes such as pain, NRSI results may be misleading due to the subjective nature of pain and the impact of nonspecific effects related to patient expectations regarding treatment and attention received. Analysis of data from large administrative claims-based databases present additional methodological challenges. Coding related to conditions, procedures and outcomes in such databases is focused on optimizing billing and there is a potential for misclassification of exposures and outcomes. Such databases are unable to account for some potential confounders or for factors that may impact decision-making regarding the appropriateness of a given procedure

(e.g., use of an anterior versus posterior procedure). The large sample sizes available for administrative data may facilitate evaluation of rare outcomes and may demonstrate statistical significance when results may be of unclear clinical importance.

Other limitations of our review include the following:

1) Lack of RCT data for many comparisons and small sample sizes in most trials that precluded analyses on differential effectiveness and harms of interventions based on patient demographics, social determinants of health, severity of radiculopathy or myelopathy, number of vertebral levels involved, and other factors;

2) Poor reporting of adverse events in many studies and heterogeneity in what harms and adverse events were described;

3) Studies reporting vertebral levels affected (e.g., number of levels with pseudarthrosis, subsidence, needing reoperation) while not reporting the number of individuals experiencing a specific adverse event such as pseudarthrosis, thereby limiting the ability to use such studies in a pooled analysis in conjunction with studies reporting results in people rather than vertebral levels;

4) Heterogeneity in research design, interventions, and reported outcomes for several Key Questions that limit ability to draw conclusions on effectiveness across studies;

5) In most cases we were not able to assess for publication bias using graphical or statistical methods to evaluate any potential impact of small sample sizes due to insufficient number of studies per comparison; and

6) Limiting the evidence to English-language publications is a potential limitation, however we did not identify large numbers of non-English-language articles in our review of bibliographies.

4.4 Applicability

According to a NIS trend study of patients who underwent cervical fusion in 2013 for cervical spondylotic myelopathy (N=8181), the average patient was 60.6 years, slightly more likely to be male (54.3%), White (71.5%), with a CCI ≤ 2 (65.7%), have Medicare (44.6%) or private insurance (39.6%), and live in the South (43.8%).[187] In the absence of more recent data, this represents a "best guess" at defining the typical patient seen in clinical practice today. There were similarities and differences between the typical study participant in our review and the typical patient as described above.

Reasons for greater applicability of this body of evidence to clinical practice include: (1) many studies required enrolled study participants to have failed several weeks or months of conservative therapies, which is considered a valid approach to the management of mild degenerative cervical myelopathy (as is an operative approach);[184] (2) studies enrolled a balance of males and females; (3) most studies did not limit the upper age of enrollment and included individuals in their 60s or 70s (although the mean age of participants in most studies was in the 40s and 50s); and (4) studies often enrolled patients with a combination of radiculopathy and myelopathy, likely reflecting the condition of many US patients. Additionally, approximately 45 percent of studies included in this review were conducted in the United States.

Reasons for lower applicability to clinical practice include the exclusion of participants with a variety of common health conditions such as inflammatory arthritis, obesity, and diabetes. The risk of CDD increases with age and so do many other health conditions and comorbidities. For example, a large proportion of the US population is overweight or obese and an increasing proportion have diabetes. Excluding these populations from surgical intervention studies,

because postoperative improvement may be reduced, decreases the applicability of study findings to many US patients needing operative management of their CDD. Additionally, few studies reported race or ethnicity. While those that did tended to enroll white participants, it is unclear how differences in access in populations of color may impact results.

4.5 Future Research

While it may not always be feasible to perform RCTs for surgical procedures, well-designed prospective comparative NRSIs with protocols using methods for patient selection and treatment allocation that mitigate possible selection bias and imbalances in prognostic factors and that follow protocols established *a priori* for comparable evaluation, measurement and treatment of groups would provide a valuable contribution to the evidence base. In order to evaluate the differential impact of patient characteristics and other factors, adequately powered RCTs are needed. Additionally, more explicit evaluation of procedure-specific (or device-specific) harms and adverse events is needed in future studies; ideally such studies would be powered to detect rare events. Future studies should also report the proportion of patients who experience a clinically important improvement in pain or function. This would provide valuable insight to complement data on average changes in continuous measures of pain, function, and quality of life for which there is difficulty describing clinically important effects. Studies should also estimate the minimally important between-group differences for included outcomes to facilitate interpretation of study findings.

4.6 Conclusions

There were generally similar benefits between surgical approaches, devices, and techniques compared in included studies for the treatment of CDD. However, there were some differences in the frequency of adverse events for some comparisons. Evidence indicates that the risk of reoperation is lower for artificial disc replacement than ACDF; however, indication for reoperation was not consistently described and the potential impact on re-operation at index level for plate removal to treat adjacent segment disease is unknown. Limited evidence also suggests a lower likelihood of experiencing any serious adverse event with ACDF than posterior cervical decompression and fusion and a lower risk for any complication with laminoplasty compared with laminectomy and fusion. There was limited evidence on the role of nonoperative management instead of surgery or in addition to surgery to treat CDD, and no evidence to determine benefits and harms of a revision anterior arthrodesis or posterior approach in patients with pseudarthrosis after prior anterior cervical fusion.

References

1. Parenteau CS, Lau EC, Campbell IC, et al. Prevalence of spine degeneration diagnosis by type, age, gender, and obesity using Medicare data. Sci Rep. 2021 Mar 8;11(1):5389. doi: 10.1038/s41598-021-84724-6. PMID: 33686128.
2. Buser Z, Ortega B, D'Oro A, et al. Spine degenerative conditions and their treatments: national trends in the United States of America. Global spine j. 2018 Feb;8(1):57-67. doi: 10.1177/2192568217696688. PMID: 29456916.
3. Schiedo RM, Narain A, Adams S, et al. 101. Prospective evaluation of degenerative cervical myelopathy in asymptomatic patients over 60 years. Spine Journal. 2020;20(9):S50-S1. doi: 10.1016/j.spinee.2020.05.207.
4. Banerjee A, Mowforth OD, Nouri A, et al. The prevalence of degenerative cervical myelopathy-related pathologies on magnetic resonance imaging in healthy/asymptomatic individuals: a meta-analysis of published studies and comparison to a symptomatic cohort. J Clin Neurosci. 2022 2022/05/01/;99:53-61. doi: 10.1016/j.jocn.2022.03.002. PMID: 35255357.
5. Broekema AEH, Groen RJM, Simoes de Souza NF, et al. Surgical interventions for cervical radiculopathy without myelopathy: a systematic review and meta-analysis. J Bone Joint Surg Am. 2020 Dec 16;102(24):2182-96. doi: 10.2106/JBJS.20.00324. PMID: 32842045.
6. Mummaneni PV, Kaiser MG, Matz PG, et al. Cervical surgical techniques for the treatment of cervical spondylotic myelopathy. J Neurosurg Spine. 2009 Aug;11(2):130-41. doi: 10.3171/2009.3.SPINE08728. PMID: 19769492.
7. Carette S, Fehlings MG. Clinical practice. Cervical radiculopathy. N Engl J Med. 2005 Jul 28;353(4):392-9. doi: 10.1056/NEJMcp043887. PMID: 16049211.
8. Yoshimatsu H, Nagata K, Goto H, et al. Conservative treatment for cervical spondylotic myelopathy. prediction of treatment effects by multivariate analysis. Spine J. 2001 Jul-Aug;1(4):269-73. doi: 10.1016/s1529-9430(01)00082-1. PMID: 14588331.
9. Nouri A, Martin AR, Mikulis D, et al. Magnetic resonance imaging assessment of degenerative cervical myelopathy: a review of structural changes and measurement techniques. Neurosurg Focus; 2016. p. E5.
10. Boden SD, McCowin PR, Davis DO, et al. Abnormal magnetic-resonance scans of the cervical spine in asymptomatic subjects. A prospective investigation. J Bone Joint Surg Am. 1990 Sep;72(8):1178-84. PMID: 2398088.
11. Fehlings MG, Arvin B. Surgical management of cervical degenerative disease: the evidence related to indications, impact, and outcome. J Neurosurg Spine. 2009 Aug;11(2):97-100. doi: 10.3171/2009.5.SPINE09210. PMID: 19769487.
12. Matz PG, Anderson PA, Kaiser MG, et al. Introduction and methodology: guidelines for the surgical management of cervical degenerative disease. J Neurosurg Spine. 2009 Aug;11(2):101-3. doi: 10.3171/2009.1.SPINE08712. PMID: 19769488.
13. Congress of Neurological Surgeons. Guideline for the Surgical Management of Cervical Degenerative Disease. Congress of Neurological Surgeons; 2009. https://www.cns.org/guidelines/browse-guidelines-detail/surgical-management-of-cervical-degenerative-disea2022.
14. Surgical Management of Cervical Degenerative Disease. Rockville, MD: Effective Health Care Program, Agency for Healthcare Research and Quality; Content last reviewed June 2021. https://effectivehealthcare.ahrq.gov/get-involved/nominated-topics/cervical-degenerative-disease
15. Agency for Healthcare Research and Quality. Methods guide for effectiveness and comparative effectiveness reviews Agency for Healthcare Research and Quality. Rockville, MD: 2020. https://effectivehealthcare.ahrq.gov/products/collections/cer-methods-guide.
16. Furlan AD, Malmivaara A, Chou R, et al. 2015 Updated Method Guideline for Systematic Reviews in the Cochrane Back and Neck Group. Spine (Phila Pa 1976). 2015 Nov;40(21):1660-73. doi: 10.1097/BRS.0000000000001061. PMID: 26208232.

17. US Preventive Services Task Force. Methods and Processes. Rockville, MD: 2019. https://www.uspreventiveservicestaskforce.org/uspstf/about-uspstf/methods-and-processes Accessed December 10, 2021.
18. Hardy RJ, Thompson SG. A likelihood approach to meta-analysis with random effects. Stat Med. 1996 Mar 30;15(6):619-29. doi: 10.1002/(sici)1097-0258(19960330)15:6<619::Aid-sim188>3.0.Co;2-a. PMID: 8731004.
19. Higgins JP, Thompson SG, Deeks JJ, et al. Measuring inconsistency in meta-analyses. BMJ. 2003 Sep 6;327(7414):557-60. doi: 10.1136/bmj.327.7414.557. PMID: 12958120.
20. Sterne JA, Sutton AJ, Ioannidis JP, et al. Recommendations for examining and interpreting funnel plot asymmetry in meta-analyses of randomised controlled trials. BMJ. 2011 Jul 22;343:d4002. doi: 10.1136/bmj.d4002. PMID: 21784880.
21. Kadanka Z, Mares M, Bednaník J, et al. Approaches to spondylotic cervical myelopathy: conservative versus surgical results in a 3-year follow-up study. Spine (Phila Pa 1976). 2002 Oct 15;27(20):2205-10; discussion 10-1. doi: 10.1097/01.Brs.0000029255.77224.Bb. PMID: 12394893.
22. Kadanka Z, Mares M, Bednaník J, et al. Predictive factors for mild forms of spondylotic cervical myelopathy treated conservatively or surgically. Eur J Neurol. 2005 Jan;12(1):16-24. doi: 10.1111/j.1468-1331.2004.00947.x. PMID: 15613142.
23. Kadanka Z, Bednařík J, Novotný O, et al. Cervical spondylotic myelopathy: conservative versus surgical treatment after 10 years. Eur Spine J. 2011 Sep;20(9):1533-8. doi: 10.1007/s00586-011-1811-9. PMID: 21519928.
24. Colamaria A, Ciappetta P, Fochi NP, et al. Anterior cervical corpectomy for treatment of spondylotic myelopathy. Results of a prospective double-armed study with a three-year follow-up. J Neurosurg Sci. 2022 Apr 13;13:13. doi: 10.23736/S0390-5616.22.05608-9. PMID: 35416453.
25. Persson LC, Lilja A. Pain, coping, emotional state and physical function in patients with chronic radicular neck pain. A comparison between patients treated with surgery, physiotherapy or neck collar--a blinded, prospective randomized study. Disabil Rehabil. 2001 May 20;23(8):325-35. doi: 10.1080/09638280010005567. PMID: 11374522.
26. Persson LC, Moritz U, Brandt L, et al. Cervical radiculopathy: pain, muscle weakness and sensory loss in patients with cervical radiculopathy treated with surgery, physiotherapy or cervical collar. A prospective, controlled study. Eur Spine J. 1997;6(4):256-66. doi: 10.1007/bf01322448. PMID: 9294750.
27. Abbott A, Halvorsen M, Dedering A. Is there a need for cervical collar usage post anterior cervical decompression and fusion using interbody cages? A randomized controlled pilot trial. Physiother. 2013 May;29(4):290-300. doi: 10.3109/09593985.2012.731627. PMID: 23074995.
28. Cheung JPY, Cheung PWH, Law K, et al. Postoperative rigid cervical collar leads to less axial neck pain in the early stage after open-door laminoplasty-a single-blinded randomized controlled trial. Neurosurgery. 2019;85(3):325-34p. doi: 10.1093/neuros/nyy359.
29. Foley KT, Mroz TE, Arnold PM, et al. Randomized, prospective, and controlled clinical trial of pulsed electromagnetic field stimulation for cervical fusion. Spine J. 2008 May-Jun;8(3):436-42. doi: 10.1016/j.spinee.2007.06.006. PMID: 17983841.
30. Hida T, Sakai Y, Ito K, et al. Collar fixation is not mandatory after cervical laminoplasty: a randomized controlled trial. Spine. 2017 Mar;42(5):E253-E9. doi: 10.1097/BRS.0000000000001994. PMID: 27879567.
31. Uehara T, Tsushima E, Yamada S, et al. A randomized controlled trial for the intervention effect of early exercise therapy on axial pain after cervical laminoplasty. Spine surgery and related research. 2022;6(2):123-32. doi: 10.22603/SSRR.2021-0110.
32. Ebrahim KS, El-Shehaby A, Darwish A, et al. Anterior or posterior foraminotomy for unilateral cervical radiculopathy. Pan arab journal of neurosurgery. 2011;15(2):34-46p.
33. Ruetten S, Komp M, Merk H, et al. Full-endoscopic cervical posterior foraminotomy for the operation of lateral disc herniations using 5.9-mm endoscopes: a prospective, randomized, controlled study. Spine (Phila Pa 1976). 2008 Apr 20;33(9):940-8. doi:

10.1097/BRS.0b013e31816c8b67. PMID: 18427313.
34. Wirth FP, Dowd GC, Sanders HF, et al. Cervical discectomy. A prospective analysis of three operative techniques. Surg Neurol. 2000 Apr;53(4):340-6; discussion 6-8. doi: 10.1016/s0090-3019(00)00201-9. PMID: 10825519.
35. Broekema AEH, Simoes de Souza NF, Soer R, et al. Noninferiority of posterior cervical foraminotomy vs anterior cervical discectomy with fusion for procedural success and reduction in arm pain among patients with cervical radiculopathy at 1 year: the FACET randomized clinical trial. JAMA Neurol. 2023 Jan 1;80(1):40-8. doi: 10.1001/jamaneurol.2022.4208. PMID: 36409485.
36. Alvin MD, Lubelski D, Abdullah KG, et al. Cost-utility analysis of anterior cervical discectomy and fusion with plating (ACDFP) versus posterior cervical foraminotomy (PCF) for patients with single-level cervical radiculopathy at 1-year follow-up. Clin Spine Surg. 2016 Mar;29(2):E67-72. doi: 10.1097/BSD.0000000000000099. PMID: 26889994.
37. Lubelski D, Healy AT, Silverstein MP, et al. Reoperation rates after anterior cervical discectomy and fusion versus posterior cervical foraminotomy: a propensity-matched analysis. Spine J. 2015 Jun 01;15(6):1277-83. doi: 10.1016/j.spinee.2015.02.026. PMID: 25720729.
38. Foster MT, Carleton-Bland NP, Lee MK, et al. Comparison of clinical outcomes in anterior cervical discectomy versus foraminotomy for brachialgia. Br J Neurosurg. 2019 Feb;33(1):3-7. doi: 10.1080/02688697.2018.1527013. PMID: 30450995.
39. Witiw CD, Smieliauskas F, O'Toole JE, et al. Comparison of anterior cervical discectomy and fusion to posterior cervical foraminotomy for cervical radiculopathy: utilization, costs, and adverse events 2003 to 2014. Neurosurgery. 2019 02 01;84(2):413-20. doi: 10.1093/neuros/nyy051. PMID: 29548034.
40. Jiang YQ, Li XL, Zhou XG, et al. A prospective randomized trial comparing anterior cervical discectomy and fusion versus plate-only open-door laminoplasty for the treatment of spinal stenosis in degenerative diseases. Eur Spine J. 2017 04;26(4):1162-72. doi: 10.1007/s00586-016-4878-5. PMID: 27885472.
41. Asher AL, Devin CJ, Kerezoudis P, et al. Comparison of outcomes following anterior vs posterior fusion surgery for patients with degenerative cervical myelopathy: an analysis from quality outcomes database. Neurosurgery. 2019 04 01;84(4):919-26. doi: 10.1093/neuros/nyy144. PMID: 29741718.
42. Badhiwala JH, Ellenbogen Y, Khan O, et al. Comparison of the inpatient complications and health care costs of anterior versus posterior cervical decompression and fusion in patients with multilevel degenerative cervical myelopathy: a retrospective propensity score-matched analysis. World Neurosurg. 2020 Feb;134:e112-e9. doi: 10.1016/j.wneu.2019.09.132. PMID: 31574327.
43. Cole T, Veeravagu A, Zhang M, et al. Anterior versus posterior approach for multilevel degenerative cervical disease: a retrospective propensity score-matched study of the marketscan database. Spine. 2015 Jul 01;40(13):1033-8. doi: 10.1097/BRS.0000000000000872. PMID: 25768690.
44. Fehlings MG, Barry S, Kopjar B, et al. Anterior versus posterior surgical approaches to treat cervical spondylotic myelopathy: outcomes of the prospective multicenter aospine north america csm study in 264 patients. Spine. 2013;38(26):2247-52. doi: 10.1097/BRS.0000000000000047. PMID: 24108289.
45. Joo PY, Jayaram RH, McLaughlin WM, et al. Four-level anterior versus posterior cervical fusions: perioperative outcomes and five-year reoperation rates: outcomes after four-level anterior versus posterior cervical procedures. N Am Spine Soc J. 2022 Jun;10:100115. doi: 10.1016/j.xnsj.2022.100115. PMID: 35392022.
46. Lee NJ, Boddapati V, Mathew J, et al. What is the impact of surgical approach in the treatment of degenerative cervical myelopathy in patients with OPLL? a propensity-score matched, multi-center analysis on inpatient and post-discharge 90-day outcomes. Global spine j. 2021 Feb 19:2192568221994797. doi: 10.1177/2192568221994797. PMID: 33601898.

47. Lee NJ, Kim JS, Park P, et al. A comparison of various surgical treatments for degenerative cervical myelopathy: a propensity score matched analysis. Global spine j. 2022 Jul;12(6):1109-18. doi: 10.1177/2192568220976092. PMID: 33375849.
48. Nunna RS, Khalid S, Chiu RG, et al. Anterior vs posterior approach in multilevel cervical spondylotic myelopathy: a nationwide propensity-matched analysis of complications, outcomes, and narcotic use. Int J Spine Surg. 2022 Feb;16(1):88-94. doi: 10.14444/8198. PMID: 35314510.
49. Wadhwa H, Sharma J, Varshneya K, et al. Anterior cervical discectomy and fusion versus laminoplasty for multilevel cervical spondylotic myelopathy: a national administrative database analysis. World Neurosurg. 2021 08;152:e738-e44. doi: 10.1016/j.wneu.2021.06.064. PMID: 34153482.
50. Elmallawany M, Kandel H, Soliman MAR, et al. The safety and efficacy of cervical laminectomy and fusion versus cervical laminoplasty surgery in degenerative cervical myelopathy: a prospective randomized trial. Open Access Maced J Med Sci. 2020;8:807-14. doi: 10.3889/oamjms.2020.4841.
51. Manzano GR, Casella G, Wang MY, et al. A prospective, randomized trial comparing expansile cervical laminoplasty and cervical laminectomy and fusion for multilevel cervical myelopathy. Neurosurgery. 2012 Feb;70(2):264-77. doi: 10.1227/NEU.0b013e3182305669. PMID: 22251974.
52. Blizzard DJ, Caputo AM, Sheets CZ, et al. Laminoplasty versus laminectomy with fusion for the treatment of spondylotic cervical myelopathy: short-term follow-up. Eur Spine J. 2017 01;26(1):85-93. doi: 10.1007/s00586-016-4746-3. PMID: 27554354.
53. Fehlings MG, Santaguida C, Tetreault L, et al. Laminectomy and fusion versus laminoplasty for the treatment of degenerative cervical myelopathy: results from the AOSpine North America and International prospective multicenter studies. Spine J. 2017 01;17(1):102-8. doi: 10.1016/j.spinee.2016.08.019. PMID: 27597512.
54. He X, Zhang JN, Liu TJ, et al. Is laminectomy and fusion the better choice than laminoplasty for multilevel cervical myelopathy with signal changes on magnetic resonance imaging? A comparison of two posterior surgeries. BMC Musculoskelet Disord. 2020 Jul 02;21(1):423. doi: 10.1186/s12891-020-03435-7. PMID: 32615953.
55. McDonald CL, Hershman SH, Hogan W, et al. Cervical laminoplasty versus posterior laminectomy and fusion: trends in utilization and evaluation of complication and revision surgery rates. J Am Acad Orthop Surg. 2022 May 30;30(17):30. doi: 10.5435/JAAOS-D-22-00106. PMID: 35640093.
56. Mesregah MK, Formanek B, Liu JC, et al. Perioperative complications of surgery for degenerative cervical myelopathy: a comparison between 3 procedures. Global spine j. 2021 Mar 12:2192568221998306. doi: 10.1177/2192568221998306. PMID: 33709809.
57. Woods BI, Hohl J, Lee J, et al. Laminoplasty versus laminectomy and fusion for multilevel cervical spondylotic myelopathy. Clin Orthop. 2011 Mar;469(3):688-95. doi: 10.1007/s11999-010-1653-5. PMID: 21089002.
58. Anderson PA, Sasso RC, Riew KD. Comparison of adverse events between the Bryan artificial cervical disc and anterior cervical arthrodesis. Spine. 2008 May 20;33(12):1305-12. doi: 10.1097/BRS.0b013e31817329a1. PMID: 18496341.
59. Burkus JK, Haid RW, Traynelis VC, et al. Long-term clinical and radiographic outcomes of cervical disc replacement with the Prestige disc: results from a prospective randomized controlled clinical trial. J Neurosurg Spine. 2010 Sep;13(3):308-18. doi: 10.3171/2010.3.SPINE09513. PMID: 20809722.
60. Burkus JK, Traynelis VC, Haid RW, Jr., et al. Clinical and radiographic analysis of an artificial cervical disc: 7-year follow-up from the Prestige prospective randomized controlled clinical trial: Clinical article. J Neurosurg Spine. 2014 Oct;21(4):516-28. doi: 10.3171/2014.6.SPINE13996. PMID: 25036218.
61. Chen X, Shi L, Yu X, et al. Comparative study of artificial cervical disc replacement and anterior cervical discectomy/fusion in the treatment of cervical spondylotic myelopathy. Int J Clin Exp Med. 2019;12(8):10597-604p.

62. Cheng L, Nie L, Li M, et al. Superiority of the Bryan(R) disc prosthesis for cervical myelopathy: a randomized study with 3-year followup. Clin Orthop. 2011 Dec;469(12):3408-14. doi: 10.1007/s11999-011-2039-z. PMID: 21997779.
63. Cheng L, Nie L, Zhang L, et al. Fusion versus Bryan Cervical Disc in two-level cervical disc disease: a prospective, randomised study. Int Orthop. 2009 Oct;33(5):1347-51. doi: 10.1007/s00264-008-0655-3. PMID: 18956190.
64. Cincu R, Lorente Fde A, Gomez J, et al. Long term preservation of motion with artificial cervical disc implants: a comparison between cervical disc replacement and rigid fusion with cage. Asian J Neurosurg. 2014 Oct-Dec;9(4):213-7. doi: 10.4103/1793-5482.146608. PMID: 25685218.
65. Davis RJ, Kim KD, Hisey MS, et al. Cervical total disc replacement with the Mobi-C cervical artificial disc compared with anterior discectomy and fusion for treatment of 2-level symptomatic degenerative disc disease: a prospective, randomized, controlled multicenter clinical trial: clinical article. J Neurosurg Spine. 2013 Nov;19(5):532-45. doi: 10.3171/2013.6.SPINE12527. PMID: 24010901.
66. Davis RJ, Nunley PD, Kim KD, et al. Two-level total disc replacement with Mobi-C cervical artificial disc versus anterior discectomy and fusion: a prospective, randomized, controlled multicenter clinical trial with 4-year follow-up results. J Neurosurg Spine. 2015 Jan;22(1):15-25. doi: 10.3171/2014.7.SPINE13953. PMID: 25380538.
67. Delamarter RB, Murrey D, Janssen ME, et al. Results at 24 months from the prospective, randomized, multicenter Investigational Device Exemption trial of ProDisc-C versus anterior cervical discectomy and fusion with 4-year follow-up and continued access patients. Sas J. 2010;4(4):122-8. doi: 10.1016/j.esas.2010.09.001. PMID: 25802660.
68. Delamarter RB, Zigler J. Five-year reoperation rates, cervical total disc replacement versus fusion, results of a prospective randomized clinical trial. Spine. 2013 Apr 20;38(9):711-7. doi: 10.1097/BRS.0b013e3182797592. PMID: 23124255.
69. Donk RD, Verbeek ALM, Verhagen WIM, et al. What's the best surgical treatment for patients with cervical radiculopathy due to single-level degenerative disease? A randomized controlled trial. PLoS ONE. 2017;12(8):e0183603. doi: 10.1371/journal.pone.0183603. PMID: 28850600.
70. Ghobrial GM, Lavelle WF, Florman JE, et al. Symptomatic adjacent level disease requiring surgery: Analysis of 10-year results from a prospective, randomized, clinical trial comparing cervical disc arthroplasty to anterior cervical fusion. Neurosurgery. 2018 02 01;84(2):347-54. doi: 10.1093/neuros/nyy118. PMID: 29635520.
71. Gornet MF, Lanman TH, Burkus JK, et al. Two-level cervical disc arthroplasty versus anterior cervical discectomy and fusion: 10-year outcomes of a prospective, randomized investigational device exemption clinical trial. J Neurosurg Spine. 2019 Jun 21;31(4):1-11. doi: 10.3171/2019.4.SPINE19157. PMID: 31226684.
72. Gornet MF, Lanman TH, Burkus JK, et al. Cervical disc arthroplasty with the Prestige LP disc versus anterior cervical discectomy and fusion, at 2 levels: results of a prospective, multicenter randomized controlled clinical trial at 24 months. J Neurosurg Spine. 2017 Jun;26(6):653-67. doi: 10.3171/2016.10.SPINE16264. PMID: 28304237.
73. Gornet M, McConnell J, Riew K, et al. Treatment of cervical myelopathy: long-term outcomes of arthroplasty for myelopathy versus radiculopathy, And arthroplasty versus arthrodesis for myelopathy. Clin Spine Surg. 2018 Dec;31(10):420-7. doi: 10.1097/BSD.0000000000000744. PMID: 30371602.
74. Gupta VK, Basantani N, Carvalho AS, et al. Long-term clinicoradiological outcomes of cervical fusion with polyether ether ketone versus cervical disc arthroplasty in a double-blinded randomized control trial. Asian J Neurosurg. 2021 Oct-Dec;16(4):725-31. doi: 10.4103/ajns.AJNS_345_20. PMID: 35071069.
75. Heller JG, Sasso RC, Papadopoulos SM, et al. Comparison of BRYAN cervical disc

arthroplasty with anterior cervical decompression and fusion: clinical and radiographic results of a randomized, controlled, clinical trial. Spine. 2009 Jan 15;34(2):101-7. doi: 10.1097/BRS.0b013e31818ee263. PMID: 19112337.
76. Hisey MS, Bae HW, Davis R, et al. Multi-center, prospective, randomized, controlled investigational device exemption clinical trial comparing Mobi-C Cervical Artificial Disc to anterior discectomy and fusion in the treatment of symptomatic degenerative disc disease in the cervical spine. Int J Spine Surg. 2014;8:7. doi: 10.14444/1007. PMID: 25694918.
77. Hisey MS, Bae HW, Davis RJ, et al. Prospective, randomized comparison of cervical total disk replacement versus anterior cervical fusion: results at 48 months follow-up. J Spinal Disord Tech. 2015 May;28(4):E237-43. doi: 10.1097/BSD.0000000000000185. PMID: 25310394.
78. Hisey MS, Zigler JE, Jackson R, et al. Prospective, randomized comparison of one-level mobi-c cervical total disc replacement vs. anterior cervical discectomy and fusion: Results at 5-year follow-up. Int J Spine Surg. 2016;10:10. doi: 10.14444/3010. PMID: 27162712.
79. Hou Y, Nie L, Pan X, et al. Effectiveness and safety of Mobi-C for treatment of single-level cervical disc spondylosis: a randomised control trial with a minimum of five years of follow-up. Bone Joint J. 2016 Jun;98-B(6):829-33. doi: 10.1302/0301-620X.98B6.36381. PMID: 27235528.
80. Jackson RJ, Davis RJ, Hoffman GA, et al. Subsequent surgery rates after cervical total disc replacement using a Mobi-C Cervical Disc Prosthesis versus anterior cervical discectomy and fusion: a prospective randomized clinical trial with 5-year follow-up. J Neurosurg Spine. 2016 May;24(5):734-45. doi: 10.3171/2015.8.SPINE15219. PMID: 26799118.
81. Janssen ME, Zigler JE, Spivak JM, et al. ProDisc-C total disc replacement versus anterior cervical discectomy and fusion for single-level symptomatic cervical disc disease: seven-year follow-up of the prospective randomized u.S. Food and drug administration investigational device exemption study. J Bone Joint Surg Am. 2015 Nov 04;97(21):1738-47. doi: 10.2106/JBJS.N.01186. PMID: 26537161.
82. Karabag H, Cakmak E, Celik B, et al. Arthroplasty versus fusion for single-level cervical disc disease. JPMA J Pak Med Assoc. 2014 Dec;64(12):1348-51. PMID: 25842575.
83. Lanman TH, Burkus JK, Dryer RG, et al. Long-term clinical and radiographic outcomes of the Prestige LP artificial cervical disc replacement at 2 levels: results from a prospective randomized controlled clinical trial. J Neurosurg Spine. 2017 Jul;27(1):7-19. doi: 10.3171/2016.11.SPINE16746. PMID: 28387616.
84. Lavelle WF, Riew KD, Levi AD, et al. Ten-year outcomes of cervical disc replacement with the bryan cervical disc: results from a prospective, randomized, controlled clinical trial. Spine. 2019 May 01;44(9):601-8. doi: 10.1097/BRS.0000000000002907. PMID: 30325888.
85. Loidolt T, Kurra S, Riew KD, et al. Comparison of adverse events between cervical disc arthroplasty and anterior cervical discectomy and fusion: a 10-year follow-up. Spine J. 2021 02;21(2):253-64. doi: 10.1016/j.spinee.2020.10.013. PMID: 33080376.
86. Mummaneni PV, Burkus JK, Haid RW, et al. Clinical and radiographic analysis of cervical disc arthroplasty compared with allograft fusion: a randomized controlled clinical trial. J Neurosurg Spine. 2007 Mar;6(3):198-209. doi: 10.3171/spi.2007.6.3.198. PMID: 17355018.
87. Murrey D, Janssen M, Delamarter R, et al. Results of the prospective, randomized, controlled multicenter Food and Drug Administration investigational device exemption study of the ProDisc-C total disc replacement versus anterior discectomy and fusion for the treatment of 1-level symptomatic cervical disc disease. Spine J. 2009 Apr;9(4):275-86. doi: 10.1016/j.spinee.2008.05.006. PMID: 18774751.
88. Nabhan A, Steudel WI, Nabhan A, et al. Segmental kinematics and adjacent level degeneration following disc replacement versus fusion: RCT with three years of follow-up. J Long Term Eff Med Implants. 2007;17(3):229-36. doi: 10.1615/jlongtermeffmedimplants.v17.i3.60. PMID: 19023947.

89. Nabhan A, Ahlhelm F, Shariat K, et al. The ProDisc-C prosthesis: clinical and radiological experience 1 year after surgery. Spine. 2007 Aug 15;32(18):1935-41. doi: 10.1097/BRS.0b013e31813162d8. PMID: 17700437.
90. Nabhan A, Ishak B, Steudel WI, et al. Assessment of adjacent-segment mobility after cervical disc replacement versus fusion: RCT with 1 year's results. Eur Spine J. 2011 Jun;20(6):934-41. doi: 10.1007/s00586-010-1588-2. PMID: 21221666.
91. Peng-Fei S, Yu-Hua J. Cervical disc prosthesis replacement and interbody fusion: a comparative study. Int Orthop. 2008 Feb;32(1):103-6. doi: 10.1007/s00264-006-0287-4. PMID: 17180356.
92. Phillips FM, Geisler FH, Gilder KM, et al. Long-term outcomes of the US FDA IDE prospective, randomized controlled clinical trial comparing PCM cervical disc arthroplasty with anterior cervical discectomy and fusion. Spine. 2015 May 15;40(10):674-83. doi: 10.1097/BRS.0000000000000869. PMID: 25955086.
93. Phillips FM, Lee JY, Geisler FH, et al. A prospective, randomized, controlled clinical investigation comparing PCM cervical disc arthroplasty with anterior cervical discectomy and fusion. 2-year results from the US FDA IDE clinical trial. Spine. 2013 Jul 01;38(15):E907-18. doi: 10.1097/BRS.0b013e318296232f. PMID: 23591659.
94. Radcliff K, Coric D, Albert T. Five-year clinical results of cervical total disc replacement compared with anterior discectomy and fusion for treatment of 2-level symptomatic degenerative disc disease: a prospective, randomized, controlled, multicenter investigational device exemption clinical trial. J Neurosurg Spine. 2016 Aug;25(2):213-24. doi: 10.3171/2015.12.SPINE15824. PMID: 27015130.
95. Radcliff K, Davis RJ, Hisey MS, et al. Long-term evaluation of cervical disc arthroplasty with the Mobi-C cervical disc: a randomized, prospective, multicenter clinical trial with seven-year follow-up. Int J Spine Surg. 2017 Netherlands ISASS (E-mail: info@ISASS;11(4):244-62. doi: 10.14444/4031.
96. Sasso RC, Anderson PA, Riew KD, et al. Results of cervical arthroplasty compared with anterior discectomy and fusion: four-year clinical outcomes in a prospective, randomized controlled trial. J Bone Joint Surg Am. 2011 Sep 21;93(18):1684-92. doi: 10.2106/JBJS.J.00476. PMID: 21938372.
97. Vaccaro A, Beutler W, Peppelman W, et al. Long-term clinical experience with selectively constrained SECURE-C cervical artificial disc for 1-level cervical disc disease: results from seven-year follow-up of a prospective, randomized, controlled investigational device exemption clinical trial. Int J Spine Surg. 2018 Jun;12(3):377-87. doi: 10.14444/5044. PMID: 30276095.
98. Vaccaro A, Beutler W, Peppelman W, et al. Clinical outcomes with selectively constrained SECURE-C cervical disc arthroplasty: two-year results from a prospective, randomized, controlled, multicenter investigational device exemption study. Spine. 2013 Dec 15;38(26):2227-39. doi: 10.1097/BRS.0000000000000031. PMID: 24335629.
99. Yang W, Si M, Hou Y, et al. Superiority of 2-level total disk replacement using a cervical disk prosthesis versus anterior cervical diskectomy and fusion. Orthopedics. 2018 Nov 01;41(6):344-50. doi: 10.3928/01477447-20180815-01. PMID: 30125034.
100. Zhang X, Zhang X, Chen C, et al. Randomized, controlled, multicenter, clinical trial comparing BRYAN cervical disc arthroplasty with anterior cervical decompression and fusion in China. Spine (Phila Pa 1976). 2012 Mar 15;37(6):433-8. doi: 10.1097/BRS.0b013e31822699fa. PMID: 21673620.
101. Zhang HX, Shao YD, Chen Y, et al. A prospective, randomised, controlled multicentre study comparing cervical disc replacement with anterior cervical decompression and fusion. Int Orthop. 2014 Dec;38(12):2533-41. doi: 10.1007/s00264-014-2497-5. PMID: 25209344.
102. Zigler JE, Delamarter R, Murrey D, et al. ProDisc-C and anterior cervical discectomy and fusion as surgical treatment for single-level cervical symptomatic degenerative disc disease: five-year results of a Food and Drug Administration study. Spine. 2013 Feb 01;38(3):203-9. doi:

10.1097/BRS.0b013e318278eb38. PMID: 23080427.
103. Donk RD, Arnts H, Verhagen WIM, et al. Cervical sagittal alignment after different anterior discectomy procedures for single-level cervical degenerative disc disease: randomized controlled trial. Acta Neurochir (Wien). 2017 12;159(12):2359-65. doi: 10.1007/s00701-017-3312-z. PMID: 28887690.
104. Coric D, Guyer RD, Bae H, et al. Prospective, multicenter study of 2-level cervical arthroplasty with a PEEK-on-ceramic artificial disc. J Neurosurg Spine. 2022 Apr 01;37(3):1-11. doi: 10.3171/2022.1.SPINE211264. PMID: 35364570.
105. Phillips FM, Coric D, Sasso R, et al. Prospective, multicenter clinical trial comparing M6-C compressible six degrees of freedom cervical disc with anterior cervical discectomy and fusion for the treatment of single-level degenerative cervical radiculopathy: 2-year results of an FDA investigational device exemption study. Spine J. 2020 02;21(2):239-52. doi: 10.1016/j.spinee.2020.10.014. PMID: 33096243.
106. Ostrov PB, Reddy AK, Ryoo JS, et al. Anterior cervical discectomy and fusion versus cervical disc arthroplasty: a comparison of national trends and outcomes. World Neurosurg. 2022 Apr;160:e96-e110. doi: 10.1016/j.wneu.2021.12.099. PMID: 34973439.
107. Nandyala SV, Marquez-Lara A, Fineberg SJ, et al. Comparison between cervical total disc replacement and anterior cervical discectomy and fusion of 1 to 2 levels from 2002 to 2009. Spine. 2014 Jan 01;39(1):53-7. doi: 10.1097/BRS.0000000000000044. PMID: 24108292.
108. Kelly MP, Eliasberg CD, Riley MS, et al. Reoperation and complications after anterior cervical discectomy and fusion and cervical disc arthroplasty: a study of 52,395 cases. Eur Spine J. 2018 06;27(6):1432-9. doi: 10.1007/s00586-018-5570-8. PMID: 29605899.
109. Bhashyam N, De la Garza Ramos R, Nakhla J, et al. Thirty-day readmission and reoperation rates after single-level anterior cervical discectomy and fusion versus those after cervical disc replacement. Neurosurg Focus. 2017 Feb;42(2):E6. doi: 10.3171/2016.11.Focus16407. PMID: 28142261.
110. Grob D, Porchet F, Kleinstuck FS, et al. A comparison of outcomes of cervical disc arthroplasty and fusion in everyday clinical practice: surgical and methodological aspects. Eur Spine J. 2010 Feb;19(2):297-306. doi: 10.1007/s00586-009-1194-3. PMID: 19882177.
111. Nayak R, Razzouk J, Ramos O, et al. Reoperation and perioperative complications after surgical treatment of cervical radiculopathy: a comparison between three procedures. Spine (Phila Pa 1976). 2023 Feb 15;48(4):261-9. doi: 10.1097/BRS.0000000000004506. PMID: 36255369.
112. Ng MK, Kobryn A, Baidya J, et al. Multi-level posterior cervical foraminotomy associated with increased post-operative infection rates and overall re-operation relative to anterior cervical discectomy with fusion or cervical disc arthroplasty. Global spine j. 2022 Sep 2:21925682221124530. doi: 10.1177/21925682221124530. PMID: 36052872.
113. Nunley PD, Kerr EJ, 3rd, Cavanaugh DA, et al. Adjacent segment pathology after treatment with cervical disc arthroplasty or anterior cervical discectomy and fusion, part 2: clinical results at 7-year follow-up. Int J Spine Surg. 2020 Jun;14(3):278-85. doi: 10.14444/7037. PMID: 32699748.
114. U.S. Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED). Mobi-C® Cervical Disc Prosthesis (One-level Indication). PMA No.: P110002. August 7, 2013 https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpma/pma.cfm?id=P110002.
115. U.S. Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED). BRYAN® Cervical Disc Prosthesis. PMA No.: P060023. May 12, 2009 https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpma/pma.cfm?id=P060023.
116. U.S. Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED). NuVasive PCM® Cervical Disc System. PMA No.: P100012. October 26, 2012. https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpma/pma.cfm?id=P100012.
117. U.S. Food and Drug Administration. Summary of Safety and Effectiveness Data

(SSED). PRESTIGE® Cervical Disc System. PMA No.: P060018. July 16, 2007. https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpma/pma.cfm?id=P060018.
118. U.S. Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED). ProDisc™-C Total Disc Replacement. PMA No.: P070001. December 17, 2007. https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpma/pma.cfm?id=P070001.
119. U.S. Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED). SECURE®-C Artificial Cervical Disc. PMA No.: P100003. September 29, 2012. https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpma/pma.cfm?id=P100003.
120. U.S. Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED). M6-C™ Artificial Cervical Disc. PMA No.: P170036. February 6, 2019. https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpma/pma.cfm?id=P170036.
121. U.S. Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED). Mobi-C® Cervical Disc Prosthesis (Two-level Indication). PMA No.: P110009. August,23, 2013 https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpma/pma.cfm?id=P110009.
122. U.S. Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED). PRESTIGE LP™ Cervical Disc. PMA No.: P090029. July 7, 2016. https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpma/pma.cfm?id=P090029.
123. U.S. Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED). Simplify® Cervical Artificial Disc. PMA No.: P200022. September 18, 2020. https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpma/pma.cfm?id=P200022.
124. Zhou J, Li J, Lin H, et al. Could self-locking stand-alone cage reduce adjacent-level ossification development after aneterior cervical discectomy and fusion? J Clin Neurosci. 2020 Aug;78:60-6. doi: 10.1016/j.jocn.2020.06.014. PMID: 32624365.
125. Scholz M, Onal B, Schleicher P, et al. Two-level ACDF with a zero-profile stand-alone spacer compared to conventional plating: a prospective randomized single-center study. Eur Spine J. 2020 11;29(11):2814-22. doi: 10.1007/s00586-020-06454-z. PMID: 32430769.
126. Panchal RR, Kim KD, Eastlack R, et al. A clinical comparison of anterior cervical plates versus stand-alone intervertebral fusion devices for single-level anterior cervical discectomy and fusion procedures. World Neurosurg. 2017 Mar;99:630-7. doi: 10.1016/j.wneu.2016.12.060. PMID: 28017756.
127. Chen Y, Chen H, Wu X, et al. Comparative analysis of clinical outcomes between zero-profile implant and cages with plate fixation in treating multilevel cervical spondilotic myelopathy: A three-year follow-up. Clin Neurol Neurosurg. 2016 May;144:72-6. doi: 10.1016/j.clineuro.2016.03.010. PMID: 26999528.
128. Li Y, Hao D, He B, et al. The efficiency of zero-profile implant in anterior cervical discectomy fusion: a prospective controlled long-term follow-up study. J Spinal Disord Tech. 2015 Dec;28(10):398-403. doi: 10.1097/BSD.0000000000000032. PMID: 24136051.
129. He S, Feng H, Lan Z, et al. A randomized trial comparing clinical outcomes between zero-profile and traditional multilevel anterior cervical discectomy and fusion surgery for cervical myelopathy. Spine. 2018 03 01;43(5):E259-E66. doi: 10.1097/BRS.0000000000002323. PMID: 29432408.
130. Nemoto O, Kitada A, Naitou S, et al. Stand-alone anchored cage versus cage with plating for single-level anterior cervical discectomy and fusion: a prospective, randomized, controlled study with a 2-year follow-up. Eur. 2015 Jul;25 Suppl 1:S127-34. doi: 10.1007/s00590-014-1547-4. PMID: 25283362.
131. Zhang B, Jiang YZ, Song QP, et al. Outcomes of cervical degenerative disc disease treated by anterior cervical discectomy and fusion with self-locking fusion cage. World j. 2022;10(15):4776-84. doi: 10.12998/wjcc.v10.i15.4776. PMID: 35801046.
132. Zavras AG, Nolte MT, Sayari AJ, et al. Stand-alone cage versus anterior plating for 1-level and 2-level anterior cervical discectomy and fusion: a randomized controlled trial. Clin Spine Surg. 2022 05 01;35(4):155-65. doi: 10.1097/BSD.0000000000001332. PMID: 35394961.

133. Chen Y, Wang X, Lu X, et al. Comparison of titanium and polyetheretherketone (PEEK) cages in the surgical treatment of multilevel cervical spondylotic myelopathy: a prospective, randomized, control study with over 7-year follow-up. Eur Spine J. 2013 Jul;22(7):1539-46. doi: 10.1007/s00586-013-2772-y. PMID: 23568254.
134. Niu CC, Liao JC, Chen WJ, et al. Outcomes of interbody fusion cages used in 1 and 2-levels anterior cervical discectomy and fusion: titanium cages versus polyetheretherketone (PEEK) cages. J Spinal Disord Tech. 2010 Jul;23(5):310-6. doi: 10.1097/BSD.0b013e3181af3a84. PMID: 20124907.
135. Godlewski B, Bebenek A, Dominiak M, et al. PEEK versus titanium-coated PEEK cervical cages: fusion rate. Acta Neurochir (Wien). 2022 06;164(6):1501-7. doi: 10.1007/s00701-022-05217-7. PMID: 35471708.
136. Kanna RM, Perambuduri AS, Shetty AP, et al. A randomized control trial comparing local autografts and allografts in single level anterior cervical discectomy and fusion using a stand-alone cage. Asian spine j. 2021 Dec;15(6):817-24. doi: 10.31616/asj.2020.0182. PMID: 33189111.
137. Arnold PM, Sasso RC, Janssen ME, et al. i-Factor TM bone graft vs autograft in anterior cervical discectomy and fusion: 2-year follow-up of the randomized single-blinded food and drug administration investigational device exemption study. Neurosurgery; 2018. p. 377-84.
138. Xie Y, Li H, Yuan J, et al. A prospective randomized comparison of PEEK cage containing calcium sulphate or demineralized bone matrix with autograft in anterior cervical interbody fusion. Int Orthop. 2015 Jun;39(6):1129-36. doi: 10.1007/s00264-014-2610-9. PMID: 25432324.
139. Cho DY, Lee WY, Sheu PC, et al. Cage containing a biphasic calcium phosphate ceramic (Triosite) for the treatment of cervical spondylosis. Surg Neurol. 2005 Jun;63(6):497-503; discussion -4. doi: 10.1016/j.surneu.2004.10.016. PMID: 15936361.
140. Baskin DS, Ryan P, Sonntag V, et al. A prospective, randomized, controlled cervical fusion study using recombinant human bone morphogenetic protein-2 with the CORNERSTONE-SR allograft ring and the ATLANTIS anterior cervical plate. Spine. 2003 Jun 15;28(12):1219-24; discussion 25. doi: 10.1097/01.BRS.0000065486.22141.CA. PMID: 12811263.
141. Yi J, Lee GW, Nam WD, et al. A prospective randomized clinical trial comparing bone union rate following anterior cervical discectomy and fusion using a polyetheretherketone cage: hydroxyapatite/b-tricalcium phosphate mixture versus hydroxyapatite/demineralized bone matrix mixture. Asian spine j. 2015 Feb;9(1):30-8. doi: 10.4184/asj.2015.9.1.30. PMID: 25705332.
142. Arnold PM, Anderson KK, Selim A, et al. Heterotopic ossification following single-level anterior cervical discectomy and fusion: results from the prospective, multicenter, historically controlled trial comparing allograft to an optimized dose of rhBMP-2. J Neurosurg Spine. 2016 Sep;25(3):292-302. doi: 10.3171/2016.1.SPINE15798. PMID: 27129045.
143. Smucker JD, Rhee JM, Singh K, et al. Increased swelling complications associated with off-label usage of rhBMP-2 in the anterior cervical spine. Spine (Phila Pa 1976). 2006 Nov 15;31(24):2813-9. doi: 10.1097/01.brs.0000245863.52371.c2. PMID: 17108835.
144. Vedantam A, Rajshekhar V. Does the type of T2-weighted hyperintensity influence surgical outcome in patients with cervical spondylotic myelopathy? A review. Eur Spine J. 2013 Jan;22(1):96-106. doi: 10.1007/s00586-012-2483-9. PMID: 22926434.
145. Aggarwal RA, Srivastava SK, Bhosale SK, et al. Prediction of surgical outcome in compressive cervical myelopathy: a novel clinicoradiological prognostic score. J Craniovertebr Junction Spine. 2016 Apr-Jun;7(2):82-6. doi: 10.4103/0974-8237.181828. PMID: 27217653.
146. Baker JD, Harada GK, Tao Y, et al. The impact of modic changes on preoperative symptoms and clinical outcomes in anterior cervical discectomy and fusion patients. Neurospine. 2020 Mar;17(1):190-203. doi: 10.14245/ns.2040062.031. PMID: 32252168.

147. Harada GK, Alter K, Nguyen AQ, et al. Cervical spine endplate abnormalities and association with pain, disability, and adjacent segment degeneration after anterior cervical discectomy and fusion. Spine. 2020 Aug 01;45(15):E917-E26. doi: 10.1097/BRS.0000000000003460. PMID: 32675603.
148. Kim TH, Ha Y, Shin JJ, et al. Signal intensity ratio on magnetic resonance imaging as a prognostic factor in patients with cervical compressive myelopathy. Medicine (Baltimore). 2016 Sep;95(39):e4649. doi: 10.1097/MD.0000000000004649. PMID: 27684796.
149. Li XY, Lu SB, Sun XY, et al. Clinical and magnetic resonance imaging predictors of the surgical outcomes of patients with cervical spondylotic myelopathy. Clin Neurol Neurosurg. 2018 11;174:137-43. doi: 10.1016/j.clineuro.2018.09.003. PMID: 30241007.
150. Nouri A, Martin AR, Kato S, et al. The relationship between MRI signal intensity changes, clinical presentation, and surgical outcome in degenerative cervical myelopathy: Analysis of a global cohort. Spine. 2017 Dec 15;42(24):1851-8. doi: 10.1097/BRS.0000000000002234. PMID: 28498290.
151. Sarkar S, Turel MK, Jacob KS, et al. The evolution of T2-weighted intramedullary signal changes following ventral decompressive surgery for cervical spondylotic myelopathy: clinical article. J Neurosurg Spine. 2014 Oct;21(4):538-46. doi: 10.3171/2014.6.SPINE13727. PMID: 25014501.
152. Sharma R, Borkar S, Katiyar V, et al. Interplay of dynamic extension reserve and T1 slope in determining the loss of cervical lordosis following laminoplasty: a novel classification system. World Neurosurg. 2020 Apr;136:e33-e40. doi: 10.1016/j.wneu.2019.08.212. PMID: 31493608.
153. Uchida K, Nakajima H, Takeura N, et al. Prognostic value of changes in spinal cord signal intensity on magnetic resonance imaging in patients with cervical compressive myelopathy. Spine J. 2014 Aug 01;14(8):1601-10. doi: 10.1016/j.spinee.2013.09.038. PMID: 24411833.
154. Yin LQ, Zhang J, Wu YG, et al. Increased signal intensity of spinal cord on T2W magnetic resonance imaging for cervical spondylotic myelopathy patients: risk factors and prognosis (a STROBE-compliant article). Medicine (Baltimore). 2020 Dec 04;99(49):e23098. doi: 10.1097/MD.0000000000023098. PMID: 33285685.
155. Zhang JT, Meng FT, Wang S, et al. Predictors of surgical outcome in cervical spondylotic myelopathy: focusing on the quantitative signal intensity. Eur Spine J. 2015 Dec;24(12):2941-5. doi: 10.1007/s00586-015-4109-5. PMID: 26155898.
156. Zhang P, Shen Y, Zhang YZ, et al. Significance of increased signal intensity on MRI in prognosis after surgical intervention for cervical spondylotic myelopathy. J Clin Neurosci. 2011 Aug;18(8):1080-3. doi: 10.1016/j.jocn.2010.12.023. PMID: 21696960.
157. Morio Y, Teshima R, Nagashima H, et al. Correlation between operative outcomes of cervical compression myelopathy and MRI of the spinal cord. Spine. 2001 Jun 01;26(11):1238-45. PMID: 11389390.
158. Wang K, Chen Z, Zhang F, et al. Evaluation of DTI parameter ratios and diffusion tensor tractography grading in the diagnosis and prognosis prediction of cervical spondylotic myelopathy. Spine (Phila Pa 1976). 2017 Feb 15;42(4):E202-e10. doi: 10.1097/brs.0000000000001784. PMID: 28207659.
159. Suri A, Chabbra RP, Mehta VS, et al. Effect of intramedullary signal changes on the surgical outcome of patients with cervical spondylotic myelopathy. Spine J. 2003 Jan-Feb;3(1):33-45. doi: 10.1016/s1529-9430(02)00448-5. PMID: 14589243.
160. Fukushima T, Ikata T, Taoka Y, et al. Magnetic resonance imaging study on spinal cord plasticity in patients with cervical compression myelopathy. Spine (Phila Pa 1976). 1991 Oct;16(10 Suppl):S534-8. doi: 10.1097/00007632-199110001-00016. PMID: 1801267.
161. Zhang JK, Jayasekera D, Javeed S, et al. Diffusion basis spectrum imaging predicts long-term clinical outcomes following surgery in cervical spondylotic myelopathy. Spine J. 2022 Apr;23(4):504-12. doi: 10.1016/j.spinee.2022.12.003. PMID: 36509379.

162. Zhang JK, Sun P, Jayasekera D, et al. Utility of diffusion basis spectrum imaging in quantifying baseline disease severity and prognosis of cervical spondylotic myelopathy. Spine (Phila Pa 1976). 2022 Dec 15;47(24):1687-93. doi: 10.1097/BRS.0000000000004456. PMID: 35969006.
163. Zhang MZ, Ou-Yang HQ, Liu JF, et al. Predicting postoperative recovery in cervical spondylotic myelopathy: construction and interpretation of T2*-weighted radiomic-based extra trees models. Eur Radiol. 2022 May;32(5):3565-75. doi: 10.1007/s00330-021-08383-x. PMID: 35024949.
164. Lambrechts MJ, D'Antonio ND, Karamian BA, et al. What is the role of dynamic cervical spine radiographs in predicting pseudarthrosis revision following anterior cervical discectomy and fusion? Spine J. 2022 May 12;12(10):12. doi: 10.1016/j.spinee.2022.04.020. PMID: 35568109.
165. Song KS, Piyaskulkaew C, Chuntarapas T, et al. Dynamic radiographic criteria for detecting pseudarthrosis following anterior cervical arthrodesis. J Bone Joint Surg Am. 2014 Apr 02;96(7):557-63. doi: 10.2106/JBJS.M.00167. PMID: 24695922.
166. Balouch E, Burapachaisri A, Woo D, et al. Assessing postoperative pseudarthrosis in Anterior Cervical Discectomy and Fusion (ACDF) on dynamic radiographs using novel angular measurements. Spine (Phila Pa 1976). 2022 Aug 15;47(16):1151-6. doi: 10.1097/BRS.0000000000004375. PMID: 35853174.
167. Badhiwala JH, Nassiri F, Witiw CD, et al. Investigating the utility of intraoperative neurophysiological monitoring for anterior cervical discectomy and fusion: analysis of over 140,000 cases from the National (Nationwide) Inpatient Sample data set. J Neurosurg Spine. 2019 03 29;31(1):76-86. doi: 10.3171/2019.1.SPINE181110. PMID: 30925481.
168. Ajiboye RM, D'Oro A, Ashana AO, et al. Routine use of intraoperative neuromonitoring during ACDFs for the treatment of spondylotic myelopathy and radiculopathy is questionable: a review of 15,395 cases. Spine. 2017 Jan 01;42(1):14-9. doi: 10.1097/BRS.0000000000001662. PMID: 27120059.
169. Smith SS, Stewart ME, Davies BM, et al. The prevalence of asymptomatic and symptomatic spinal cord compression on magnetic resonance imaging: a systematic review and meta-analysis. Global spine j. 2021;11(4):597-607. doi: 10.1177/2192568220934496. PMID: 32677521.
170. Nakashima H, Yukawa Y, Suda K, et al. Narrow cervical canal in 1211 asymptomatic healthy subjects: the relationship with spinal cord compression on MRI. Eur Spine J. 2016 Jul;25(7):2149-54. doi: 10.1007/s00586-016-4608-z.
171. Kovalova I, Kerkovsky M, Kadanka Z, et al. Prevalence and imaging characteristics of nonmyelopathic and myelopathic spondylotic cervical cord compression. Spine (Phila Pa 1976). 2016 Dec 15;41(24):1908-16. doi: 10.1097/brs.0000000000001842.
172. Nouri A, Tessitore E, Molliqaj G, et al. Degenerative Cervical Myelopathy: Development and Natural History [AO Spine RECODE-DCM Research Priority Number 2]. Global spine j. 2022;12(1):39S-54S. doi: 10.1177/21925682211036071.
173. Martin AR, De Leener B, Cohen-Adad J, et al. Can microstructural MRI detect subclinical tissue injury in subjects with asymptomatic cervical spinal cord compression? A prospective cohort study. BMJ Open. 2018 Apr 13;8(4):e019809. doi: 10.1136/bmjopen-2017-019809. PMID: 29654015.
174. Bednarik J, Kadanka Z, Dusek L, et al. Presymptomatic spondylotic cervical myelopathy: an updated predictive model. Eur Spine J. 2008 Mar;17(3):421-31. doi: 10.1007/s00586-008-0585-1. PMID: 18193301.
175. Kadanka Z, Jr., Adamova B, Kerkovsky M, et al. Predictors of symptomatic myelopathy in degenerative cervical spinal cord compression. Brain Behav. 2017 Sep;7(9):e00797. doi: 10.1002/brb3.797. PMID: 28948090.
176. Nurick S. The pathogenesis of the spinal cord disorder associated with cervical spondylosis. Brain. 1972;95(1):87-100. doi: 10.1093/brain/95.1.87. PMID: 5023093.
177. Beattie MS, Manley GT. Tight squeeze, slow burn: inflammation and the aetiology of cervical myelopathy. Brain. 2011 May;134(Pt 5):1259-61. doi: 10.1093/brain/awr088. PMID: 21596766.
178. Karadimas SK, Moon ES, Yu WR, et al. A novel experimental model of cervical

spondylotic myelopathy (CSM) to facilitate translational research. Neurobiol Dis. 2013 Jun;54:43-58. doi: 10.1016/j.nbd.2013.02.013. PMID: 23466695.
179. Yu WR, Baptiste DC, Liu T, et al. Molecular mechanisms of spinal cord dysfunction and cell death in the spinal hyperostotic mouse: implications for the pathophysiology of human cervical spondylotic myelopathy. Neurobiol Dis. 2009 Feb;33(2):149-63. doi: 10.1016/j.nbd.2008.09.024. PMID: 19006686.
180. Yu WR, Liu T, Kiehl TR, et al. Human neuropathological and animal model evidence supporting a role for Fas-mediated apoptosis and inflammation in cervical spondylotic myelopathy. Brain. 2011 May;134(Pt 5):1277-92. doi: 10.1093/brain/awr054. PMID: 21490053.
181. Karadimas SK, Erwin WM, Ely CG, et al. Pathophysiology and natural history of cervical spondylotic myelopathy. Spine (Phila Pa 1976). 2013 Oct 15;38(22 Suppl 1):S21-36. doi: 10.1097/BRS.0b013e3182a7f2c3. PMID: 23963004.
182. Martin AR, Jentzsch T, Wilson JRF, et al. Inter-rater reliability of the Modified Japanese Orthopedic Association Score in degenerative cervical myelopathy: a cross-sectional study. Spine. 2021 Aug 15;46(16):1063-9. doi: 10.1097/BRS.0000000000003956. PMID: 33492085.
183. Yonenobu K, Abumi K, Nagata K, et al. Interobserver and intraobserver reliability of the japanese orthopaedic association scoring system for evaluation of cervical compression myelopathy. Spine (Phila Pa 1976). 2001 Sep 1;26(17):1890-4; discussion 5. doi: 10.1097/00007632-200109010-00014. PMID: 11568701.
184. Fehlings MG, Tetreault LA, Riew KD, et al. A clinical practice guideline for the management of patients with degenerative cervical myelopathy: recommendations for patients with mild, moderate, and severe disease and nonmyelopathic patients with evidence of cord compression. Global spine j. 2017 Sep;7(3 Suppl):70S-83S. doi: 10.1177/2192568217701914. PMID: 29164035.
185. Fehlings MG, Wilson JR, Kopjar B, et al. Efficacy and safety of surgical decompression in patients with cervical spondylotic myelopathy: results of the AOSpine North America prospective multi-center study. J Bone Joint Surg Am. 2013 Sep 18;95(18):1651-8. doi: 10.2106/JBJS.L.00589. PMID: 24048552.
186. Shimomura T, Sumi M, Nishida K, et al. Prognostic factors for deterioration of patients with cervical spondylotic myelopathy after nonsurgical treatment. Spine (Phila Pa 1976). 2007 Oct 15;32(22):2474-9. doi: 10.1097/BRS.0b013e3181573aee. PMID: 18090088.
187. Vonck C, Tanenbaum J, Bomberger T, et al. Short-term outcomes following posterior cervical fusion among octogenarians with cervical spondylotic myelopathy: a NSQIP database analysis. Spine J. 2018 Sep;18(9):1603-11. doi: 10.1016/j.spinee.2018.02.012. PMID: 29454135.

Abbreviations and Acronyms

ACCF	anterior cervical corpectomy and fusion
ACDF	anterior cervical discectomy and fusion
ACD	anterior cervical decompression without fusion
ACF	anterior cervical foraminotomy
ADL	activities of daily living
AE	adverse event
AHRQ	Agency for Healthcare and Research Quality
ASD	adjacent segment disease
AUC	area under the curve
BMP-2	bone morphogenetic protein 2
CCI	Charlson Comorbidity Index
CDD	cervical degenerative disease
CI	confidence interval
CNS	Congress of Neurological Surgeons
COMI-neck	Core Outcome Measures Index-neck
CSM	cervical spondylotic myelopathy
CT	computed tomography
DRI	Disability Rating Index
DVT	deep vein thrombosis
EQ-5Dm	EuroQol-5 dimension instrument
EMS	electromagnetic stimulation
FDA	US Food and Drug Administration
HO	heterotopic ossification
HTE	Heterogeneity of treatment effect
IDE	Investigational Device Exemption
IONM	intraoperative neuromonitoring
ISI	increased signal intensity
JOA	Japanese Orthopaedic Association Scale
KQ	Key Question
MCS	mental component summary score
MD	mean difference
MDI	myelopathy disability index
mJOA	Modified Japanese Orthopaedic Association Scale
MRI	magnetic resonance imaging
NA	not applicable
NASS	North American Spine Society

NDI	Neck Disability Index
NIS	National Inpatient Sample
NMSCC	nonmyelopathic spinal cord compression
NR	not reported
N(P)RS	numeric (pain) rating scale
NRSI	nonrandomized studies of interventions
OPLL	ossification of the posterior longitudinal ligament
OR	odds ratio
PCDF	posterior cervical decompression and fusion
PCF	posterior cervical foraminotomy
PCS	physical component summary score
PEEK	polyetheretherketone
PEG	percutaneous endoscopic gastrostomy
PEMF	pulsed electro-magnetic field
PICOTS	Population, Intervention, Comparator, Outcome, Time, Setting
PL	profile likelihood
PROMIS-29	patient-reported outcome measurement information system
QOL	quality of life
RCT	randomized controlled trial
RR	risk ratio
SAE	serious adverse event
SF-12	12-Item Short Form Health Survey
SF-36	36-Item Short Form Health Survey
SIR	signal intensity ratio
SOE	strength of evidence
SSED	Summary of Safety and Effectiveness Data (FDA)
T2	T2 weighted image
VAS	visual analogue scale
WHO Grade	World Health Organization Grade scale

Appendix A. Methods

A1.1 Search Strategy

The searches were conducted by Key Question, with the exception of EMBASE.

Database: Ovid MEDLINE(R) ALL <1946 to February 15, 2023>
Search Strategy for KQ1-2:

---

1 Spinal Cord Compression/
2 "spinal cord compression".ti,ab.
3 exp Cervical Vertebrae/
4 3 and degenerat*.ti,ab.
5 (cervical and degenerat*).ti,ab.
6 (1 or 2) and (4 or 5)
7 su.fs.
8 (surgery or surgical).ti,ab.
9 6 and (7 or 8)
10 limit 9 to (comparative study or controlled clinical trial or meta analysis or randomized controlled trial or "systematic review")
11 (random* or control* or NRSI or observational or prospective or retrospective or review or systematic or "meta analysis" or "metaanalysis").ti,ab,pt.
12 9 and 11
13 10 or 12
14 (Animals/ or Models, Animal/ or Disease Models, Animal/) not Humans/
15 ((animal or animals or avian or bird or birds or bovine or canine or cow* or dog or dogs or cat or cats or feline or hamster* or horse* or lamb or lamb* or mouse or mice or monkey or monkeys or murine or pig or piglet* or pigs or porcine or primate* or rabbit* or rat or rats or rodent* or songbird* or veterinar*) not (human* or patient*)).ti,kf,jw.
16 or/14-15
17 13 not 16
18 limit 17 to yr="1980 -Current"

Database: Ovid MEDLINE(R) ALL <1946 to February 15, 2023>
Search Strategy for KQ3-4:

---

1 exp Cervical Vertebrae/su [Surgery]
2 1 and degenerat*.ti,ab.
3 (cervical and degenerat*).ti,ab.
4 su.fs.
5 (surgery or surgical).ti,ab.
6 3 and (4 or 5)
7 2 or 6
8 limit 7 to (comparative study or controlled clinical trial or meta analysis or randomized controlled trial or "systematic review")
9 (random* or control* or NRSI or observational or prospective or retrospective or review or systematic or "meta analysis" or "metaanalysis").ti,ab,pt.

10 7 and 9
11 8 or 10
12 (Animals/ or Models, Animal/ or Disease Models, Animal/) not Humans/
13 ((animal or animals or avian or bird or birds or bovine or canine or cow* or dog or dogs or cat or cats or feline or hamster* or horse* or lamb or lamb* or mouse or mice or monkey or monkeys or murine or pig or piglet* or pigs or porcine or primate* or rabbit* or rat or rats or rodent* or songbird* or veterinar*) not (human* or patient*)).ti,kf,jw.
14 or/12-13
15 11 not 14
16 limit 15 to yr="1980 -Current"

Database: Ovid MEDLINE(R) ALL <1946 to February 15, 2023>
Search Strategy for KQ5:
---
1 Radiculopathy/su [Surgery]
2 radiculopathy.ti,ab.
3 su.fs.
4 (surgery or surgical).ti,ab.
5 2 and (3 or 4)
6 1 or 5
7 (anterior and posterior).ti,ab.
8 6 and 7
9 limit 8 to (comparative study or controlled clinical trial or meta analysis or randomized controlled trial or "systematic review")
10 (random* or control* or NRSI or observational or prospective or retrospective or review or systematic or "meta analysis" or "metaanalysis").ti,ab,pt.
11 8 and 10
12 9 or 11
13 (Animals/ or Models, Animal/ or Disease Models, Animal/) not Humans/
14 ((animal or animals or avian or bird or birds or bovine or canine or cow* or dog or dogs or cat or cats or feline or hamster* or horse* or lamb or lamb* or mouse or mice or monkey or monkeys or murine or pig or piglet* or pigs or porcine or primate* or rabbit* or rat or rats or rodent* or songbird* or veterinar*) not (human* or patient*)).ti,kf,jw.
15 or/13-14
16 12 not 15
17 limit 16 to yr="2006 -Current"

Database: Ovid MEDLINE(R) ALL <1946 to February 15, 2023>
Search Strategy for KQ6:
---
1 exp Cervical Vertebrae/su [Surgery]
2 1 and degenerat*.ti,ab.
3 (cervical and degenerat*).ti,ab.
4 su.fs.
5 (surgery or surgical).ti,ab.
6 3 and (4 or 5)

7 2 or 6
8 (anterior and posterior).ti,ab.
9 7 and 8
10 limit 9 to (comparative study or controlled clinical trial or meta analysis or randomized controlled trial or "systematic review")
11 (random* or control* or NRSI or observational or prospective or retrospective or review or systematic or "meta analysis" or "metaanalysis").ti,ab,pt.
12 9 and 11
13 10 or 12
14 (Animals/ or Models, Animal/ or Disease Models, Animal/) not Humans/
15 ((animal or animals or avian or bird or birds or bovine or canine or cow* or dog or dogs or cat or cats or feline or hamster* or horse* or lamb or lamb* or mouse or mice or monkey or monkeys or murine or pig or piglet* or pigs or porcine or primate* or rabbit* or rat or rats or rodent* or songbird* or veterinar*) not (human* or patient*)).ti,kf,jw.
16 or/14-15
17 13 not 16
18 limit 17 to yr="2006 -Current"

Database: Ovid MEDLINE(R) ALL <1946 to February 15, 2023>
Search Strategy for KQ7:
---
1 Spinal Cord Diseases/
2 (spondylo* or cervical or myelopathy).ti.
3 1 and 2
4 ((spondylo* or cervical) and myelopathy).ti,ab.
5 3 or 4
6 Laminectomy/ or Laminoplasty/
7 (laminectomy or laminoplasty).ti,ab.
8 6 or 7
9 5 and 8
10 limit 9 to (comparative study or controlled clinical trial or meta analysis or randomized controlled trial or "systematic review")
11 (random* or control* or NRSI or observational or prospective or retrospective or review or systematic or "meta analysis" or "metaanalysis").ti,ab,pt.
12 9 and 11
13 10 or 12
14 (Animals/ or Models, Animal/ or Disease Models, Animal/) not Humans/
15 ((animal or animals or avian or bird or birds or bovine or canine or cow* or dog or dogs or cat or cats or feline or hamster* or horse* or lamb or lamb* or mouse or mice or monkey or monkeys or murine or pig or piglet* or pigs or porcine or primate* or rabbit* or rat or rats or rodent* or songbird* or veterinar*) not (human* or patient*)).ti,kf,jw.
16 or/14-15
17 13 not 16
18 limit 17 to yr="2006 -Current"

Database: Ovid MEDLINE(R) ALL <1946 to February 15, 2023>

Search Strategy for KQ8:
---
1 Spinal Cord Diseases/
2 1 and myelopathy.ti.
3 Radiculopathy/
4 (spondylo* or cervical).ti.
5 (2 or 3) and 4
6 ((spondylo* or cervical) and (radiculopathy or myelopathy)).ti,ab.
7 5 or 6
8 Arthroplasty/ and Diskectomy/
9 (arthroplasty and (discectomy or diskectomy)).ti,ab.
10 8 or 9
11 7 and 10
12 limit 11 to (comparative study or controlled clinical trial or meta analysis or randomized controlled trial or "systematic review")
13 (random* or control* or NRSI or observational or prospective or retrospective or review or systematic or "meta analysis" or "metaanalysis").ti,ab,pt.
14 11 and 13
15 12 or 14
16 (Animals/ or Models, Animal/ or Disease Models, Animal/) not Humans/
17 ((animal or animals or avian or bird or birds or bovine or canine or cow* or dog or dogs or cat or cats or feline or hamster* or horse* or lamb or lamb* or mouse or mice or monkey or monkeys or murine or pig or piglet* or pigs or porcine or primate* or rabbit* or rat or rats or rodent* or songbird* or veterinar*) not (human* or patient*)).ti,kf,jw.
18 or/16-17
19 15 not 18
20 limit 19 to yr="2006 -Current"

Database: Ovid MEDLINE(R) ALL <1946 to February 15, 2023>
Search Strategy for KQ9:
---
1 Diskectomy/
2 (discectomy or diskectomy).ti,ab.
3 (1 or 2) and cervical.ti,ab.
4 3 and anterior.ti,ab.
5 (interbody or graft* or type or device* or "standalone" or "stand alone" or traditional or plat* or cage*).ti,ab.
6 4 and 5
7 limit 6 to (comparative study or controlled clinical trial or meta analysis or randomized controlled trial or "systematic review")
8 (random* or control* or NRSI or observational or prospective or retrospective or review or systematic or "meta analysis" or "metaanalysis").ti,ab,pt.
9 6 and 8
10 7 or 9
11 (Animals/ or Models, Animal/ or Disease Models, Animal/) not Humans/

12 ((animal or animals or avian or bird or birds or bovine or canine or cow* or dog or dogs or cat or cats or feline or hamster* or horse* or lamb or lamb* or mouse or mice or monkey or monkeys or murine or pig or piglet* or pigs or porcine or primate* or rabbit* or rat or rats or rodent* or songbird* or veterinar*) not (human* or patient*)).ti,kf,jw.
13 or/11-12
14 10 not 13
15 limit 14 to yr="2006 -Current"

Database: Ovid MEDLINE(R) ALL <1946 to February 15, 2023>
Search Strategy for KQ10:
---
1 Pseudarthrosis/
2 pseudarthrosis.ti,ab.
3 1 or 2
4 cervical.ti,ab.
5 3 and 4
6 Arthrodesis/
7 arthrodesis.ti,ab.
8 6 or 7
9 (anterior or posterior).ti,ab.
10 5 and (8 or 9)
11 limit 10 to (comparative study or controlled clinical trial or meta analysis or randomized controlled trial or "systematic review")
12 (random* or control* or NRSI or observational or prospective or retrospective or review or systematic or "meta analysis" or "metaanalysis").ti,ab,pt.
13 10 and 12
14 11 or 13
15 (Animals/ or Models, Animal/ or Disease Models, Animal/) not Humans/
16 ((animal or animals or avian or bird or birds or bovine or canine or cow* or dog or dogs or cat or cats or feline or hamster* or horse* or lamb or lamb* or mouse or mice or monkey or monkeys or murine or pig or piglet* or pigs or porcine or primate* or rabbit* or rat or rats or rodent* or songbird* or veterinar*) not (human* or patient*)).ti,kf,jw.
17 15 or 16
18 14 not 17
19 limit 18 to yr="2006 -Current"

Database: Ovid MEDLINE(R) ALL <1946 to February 15, 2023>
Search Strategy for KQ11:
---
1 Spinal Cord Diseases/dg [Diagnostic Imaging]
2 1 and myelopathy.ti,ab.
3 ((cervical or spondylo*) and myelopathy).ti,ab.
4 2 or 3
5 Magnetic Resonance Imaging/
6 ("magnetic resonance imag*" or "mri").ti,ab.
7 ("pre operative" or "preoperative").ti,ab.

8 (5 or 6) and 7
9 limit 8 to "prognosis (maximizes sensitivity)"
10 4 and 9
11 limit 10 to yr="1980 -Current"

Database: Ovid MEDLINE(R) ALL <1946 to February 15, 2023>
Search Strategy for KQ12:
---
1 Pseudarthrosis/dg [Diagnostic Imaging]
2 pseudarthrosis.ti,ab.
3 Diagnostic Imaging/
4 dg.fs.
5 (image or imaging).ti,ab.
6 2 and (or/3-5)
7 1 or 6
8 exp "Sensitivity and Specificity"/
9 (sensitivity or specificity or accuracy or predict* or "reference standard" or "gold standard").ti,ab.
10 "reproducibility of results"/
11 8 or 9 or 10
12 7 and 11
13 limit 12 to yr="1980 -Current"

Database: Ovid MEDLINE(R) ALL <1946 to February 15, 2023>
Search Strategy for KQ13:
---
1 Spinal Cord Diseases/
2 1 and myelopathy.ti,ab.
3 ((cervical or spondylo*) and myelopathy).ti,ab.
4 2 or 3
5 exp Monitoring, Intraoperative/
6 (intraoperat* and monitor*).ti,ab.
7 (neuromonitor* or somatosensory or "motor evoked potential").ti,ab.
8 7 and intraoperat*.ti,ab.
9 5 or 6 or 8
10 4 and 9
11 limit 10 to yr="2006 -Current"

Database: EMBASE
Search Strategy:

('cervical degenerative disc disease'/exp OR 'cervical degenerative disease'/exp OR 'cervical degenerative':ab,ti OR (('cervicobrachial neuralgia'/exp OR 'cervicobrachial neuralgia') AND degenerative) OR (myelopathy AND degenerative) OR (pseudarthrosis AND cervical AND fusion AND (anterior OR posterior))) AND ('diagnostic imaging' OR 'nuclear magnetic resonance imaging' OR 'neuromonitoring') AND ('prognosis' OR 'predictive value' OR 'predictive

validity' OR 'sensitivity and specificity') AND [embase]/lim NOT ([embase]/lim AND [medline]/lim)

Database: EBM Reviews - Cochrane Database of Systematic Reviews <2005 to February 2023>
Search Strategy:
---
1 (spine or spinal or radiculopathy or myelopathy).ti.
2 (cervical and degenerat*).ti,ab.
3 1 or 2
4 limit 3 to full systematic reviews

Database: EBM Reviews - Cochrane Central Register of Controlled Trials <February 2023>
Search Strategy for KQ1-2:
---
1 Spinal Cord Compression/
2 "spinal cord compression".ti,ab.
3 exp Cervical Vertebrae/
4 3 and degenerat*.ti,ab.
5 (cervical and degenerat*).ti,ab.
6 (1 or 2) and (4 or 5)
7 su.fs.
8 (surgery or surgical).ti,ab.
9 6 and (7 or 8)
10 limit 9 to yr="1980 -Current"

Database: EBM Reviews - Cochrane Central Register of Controlled Trials <February 2023>
Search Strategy for KQ3-4:
---
1 Cervical Vertebrae/ (1027)
2 1 and degenerat*.ti,ab.
3 (cervical and degenerat*).ti,ab.
4 su.fs.
5 (surgery or surgical).ti,ab.
6 (2 or 3) and (4 or 5)
7 limit 6 to yr="1980 -Current"

Database: EBM Reviews - Cochrane Central Register of Controlled Trials <February 2023>
Search Strategy for KQ5:
---
1 Radiculopathy/
2 radiculopathy.ti,ab.
3 su.fs.
4 (surgery or surgical).ti,ab.
5 (1 or 2) and (3 or 4)
6 (anterior and posterior).ti,ab.
7 5 and 6

8 limit 7 to yr="2006 -Current"

Database: EBM Reviews - Cochrane Central Register of Controlled Trials <February 2023>
Search Strategy for KQ6:
---
1 Cervical Vertebrae/
2 1 and degenerat*.ti,ab.
3 (cervical and degenerat*).ti,ab.
4 su.fs.
5 (surgery or surgical).ti,ab.
6 (2 or 3) and (4 or 5)
7 (anterior and posterior).ti,ab.
8 6 and 7
9 limit 8 to yr="2006 -Current"

Database: EBM Reviews - Cochrane Central Register of Controlled Trials <February 2023>
Search Strategy for KQ7:
---
1 Spinal Cord Diseases/
2 (spondylo* or cervical or myelopathy).ti.
3 1 and 2
4 ((spondylo* or cervical) and myelopathy).ti,ab.
5 3 or 4
6 Laminectomy/ or Laminoplasty/
7 (laminectomy or laminoplasty).ti,ab.
8 5 and (6 or 7)
9 limit 8 to yr="2006 -Current"

Database: EBM Reviews - Cochrane Central Register of Controlled Trials <February 2023>
Search Strategy for KQ8:
---
1 Spinal Cord Diseases/
2 1 and myelopathy.ti.
3 Radiculopathy/
4 (spondylo* or cervical).ti.
5 (2 or 3) and 4
6 ((spondylo* or cervical) and (radiculopathy or myelopathy)).ti,ab.
7 5 or 6
8 Arthroplasty/ and Diskectomy/
9 (arthroplasty and (discectomy or diskectomy)).ti,ab.
10 8 or 9
11 7 and 10
12 limit 11 to yr="2006 -Current"

Database: EBM Reviews - Cochrane Central Register of Controlled Trials <February 2023>
Search Strategy for KQ9:

---
1 Diskectomy/
2 (discectomy or diskectomy).ti,ab.
3 (1 or 2) and cervical.ti,ab.
4 3 and anterior.ti,ab.
5 (interbody or graft* or type or device* or "standalone" or "stand alone" or traditional or plat* or cage*).ti,ab.
6 4 and 5
7 limit 6 to yr="2006 -Current"

Database: EBM Reviews - Cochrane Central Register of Controlled Trials <February 2023>
Search Strategy for KQ10:
---
1 Pseudarthrosis/
2 pseudarthrosis.ti,ab.
3 1 or 2
4 cervical.ti,ab.
5 3 and 4
6 Arthrodesis/
7 arthrodesis.ti,ab.
8 6 or 7
9 (anterior or posterior).ti,ab.
10 5 and (8 or 9)
11 limit 10 to yr="2006 -Current"

Database: EBM Reviews - Cochrane Central Register of Controlled Trials <February 2023>
Search Strategy for KQ11:
---
1 Spinal Cord Diseases/
2 1 and myelopathy.ti,ab.
3 ((cervical or spondylo*) and myelopathy).ti,ab.
4 2 or 3
5 Magnetic Resonance Imaging/
6 ("magnetic resonance imag*" or "mri").ti,ab.
7 ("pre operative" or "preoperative").ti,ab.
8 (5 or 6) and 7
9 4 and 8
10 limit 9 to yr="1980 -Current"

Database: EBM Reviews - Cochrane Central Register of Controlled Trials <February 2023>
Search Strategy for KQ12:
---
1 Pseudarthrosis/
2 pseudarthrosis.ti,ab.
3 Diagnostic Imaging/
4 dg.fs.

5 (image or imaging).ti,ab.
6 (1 or 2) and (or/3-5)
7 exp "Sensitivity and Specificity"/
8 (sensitivity or specificity or accuracy or predict* or "reference standard" or "gold standard").ti,ab.
9 "reproducibility of results"/
10 7 or 8 or 9
11 6 and 10

Database: EBM Reviews - Cochrane Central Register of Controlled Trials <February 2023>
Search Strategy for KQ13:
---
1 Spinal Cord Diseases/
2 1 and myelopathy.ti,ab.
3 ((cervical or spondylo*) and myelopathy).ti,ab.
4 2 or 3
5 exp Monitoring, Intraoperative/
6 (intraoperat* and monitor*).ti,ab.
7 (neuromonitor* or somatosensory or "motor evoked potential").ti,ab.
8 7 and intraoperat*.ti,ab.
9 5 or 6 or 8
10 4 and 9

A2.1 Expanded Methods

2.1.1 Literature Search Strategy

We conducted electronic searches in Ovid MEDLINE®, EMBASE, and Cochrane CENTRAL from 1980 to February 15, 2023 (see **Appendix A1.1** for full strategies). For Key Questions that compare operative approaches, we searched databases for studies published after 2006 (studies published in 2007 or earlier were included in the 2009 guidelines).[1] Additionally, we reviewed all studies included in the 2009 guidelines for inclusion in this review.[1] For Key Questions not covered by the 2009 guidelines (e.g., operative versus nonoperative studies, neuromonitoring studies) we searched the databases from 1980 to the present in order to identify relevant, earlier studies based on when technologies such as neuromonitoring and advanced imaging were first used in research trials. Reference lists of included systematic reviews were screened for additional studies and relevant references were carried forward. A Federal Register notification for a Supplemental Evidence and Data for Systematic review (SEADS) portal was posted from August 12th to September 12th, 2022, for submission of unpublished studies.

2.1.1.1 PICOTS

Criteria were established *a priori* to determine eligibility for inclusion and exclusion of abstracts in accordance with the Agency for Healthcare Research and Quality (AHRQ) *Methods Guide for Effectiveness and Comparative Effectiveness Reviews* (hereafter the "AHRQ Methods Guide").[2] Study eligibility criteria for this CER were based on the population, intervention, comparisons, outcomes, timing, settings, and study designs of interest (PICOTS) framework and the Key Questions. The population of interest was adults (aged ≥18 years) with symptomatic

cervical degenerative disease (e.g., pain, radiculopathy, myelopathy) for all Key Questions except for Key Question 1, which included asymptomatic patients. We also captured effectiveness and harms of surgery based on patient characteristics, disease characteristics and radiographic characteristics, where available. Details regarding the PICOTS are summarized in **Table A-1.** Specific outcomes for each management approach considered are described in detail in **Table A-1.**

For this review, management included cervical spine surgery, non-surgical treatments, intraoperative monitoring, imaging to identify symptomatic pseudarthrosis (vertebrae do not fuse successfully) after cervical fusion surgery, and preoperative MRI to predict neurological recovery in myelopathy. Comparisons included any eligible intervention, placebo, waitlist, or active control.

Study designs considered for inclusion were comparative studies of any design including trials of any size and observational studies (N≥50). For Key Questions 11-12 and studies focused on harms as the primary outcome, we considered large intervention series (N≥50) eligible, including those with single arms where everyone received the same intervention. We reviewed existing systematic reviews and included their results if appropriate. References lists of systematic reviews were also used to identify relevant studies. Descriptive studies with no outcome data or studies that included only data from one point in time (cross-sectional) were not included. For Key Questions 1-10, pre-post single-arm studies and systematic reviews published prior to 2007 were excluded, as these studies would have been captured in the guidelines. Also excluded were commentaries, letters, and narrative reviews, as were studies published only as conference abstracts. Inclusion was restricted to English-language articles, and studies of nonhuman subjects were excluded (**Appendix B**).

To ensure accuracy, all excluded abstracts were dual reviewed by two investigators. Each full-text article was independently reviewed for eligibility by two team members. All disagreements were resolved through a consensus process between investigators.

Contextual Questions were addressed without presepecified inclusion criteria; we used studies identified in our main searches to answer the Contextual Questions.

Table A-1. PICOTS – inclusion and exclusion criteria

PICOT	Include	Exclude
Population	• Age 18 and above with symptomatic cervical degenerative disease (e.g., pain, radiculopathy, myelopathy) for all KQs except for KQ1, which includes asymptomatic patients • Effectiveness and harms of surgery based on patient characteristics, disease characteristics and radiographic characteristics (e.g., age, gender, comorbidities [e.g., comorbid lumbar disease, autoimmune disease, neurological disease, mental illness, Down's syndrome], severity of cervical degenerative disease, Frailty Index, sagittal vertical aspect, degree of kyphosis, prior treatment [e.g., bracing, traction, medications, massage, acupuncture, injections, chiropractic care, spinal manipulation], duration of pain, skill of surgeon)	• Younger than 18 years • Patients without cervical degenerative disease • Nonhumans

PICOT	Include	Exclude
Interventions	• Cervical spine surgery (e.g., discectomy, disc replacement, fusion up to T2, arthroplasty, laminectomy, laminoplasty, corpectomy, cervical hybrid surgery, foraminotomy, ACDF cage vs. ACDF cage + plate) • Non-surgical treatments (e.g., heat, exercise, acupuncture, drugs, radiofrequency ablation, steroid injections, Botox® for neck pain, psychological strategies [e.g., cognitive behavioral therapy], occupational therapy, multidisciplinary rehabilitation) • Intraoperative neuromonitoring • Imaging to identify symptomatic pseudarthrosis after cervical fusion surgery • Preoperative MRI to predict neurologic recovery in myelopathy	• Preoperative imaging using CT or plain films • KQ4: intraoperative therapy • KQ7: laminectomy without fusion
Comparators	• Any included intervention • Placebo, waitlist, active control • No comparator (KQs 11 and 12)	• Nonoperative intervention versus nonoperative intervention without surgical comparator
Outcomes	• Pain, sensory function, motor function, gait, quality of life (e.g., VAS, NRS, NDI, SF-36, SF-12, EQ-5Dm, mJOA score, Nurick score, MDI, PROMIS-29), dysphagia scales, return to work • Fusion rate, reoperation rate • Harms (e.g., withdrawals due to adverse events, serious adverse events, new symptomatic adjacent segment disease, postoperative infection, device failure, ossification of the posterior ligament, development of kyphotic deformity) • Sensitivity and specificity of imaging after cervical fusion surgery	• Nonvalidated instruments
Timing	• All time periods	None
Setting	• Inpatient, outpatient, ambulatory surgical centers	None
Study types and designs	• RCTs, prospective trials and retrospective observational studies with a control group (study N≥50), current systematic reviews • KQs 11-13 and studies focused on harms as a primary outcome: large intervention series (N≥50; can be single arm, but everyone received the same intervention)	• KQ1-10: pre-post single-arm studies, case series (everyone selected based on outcome), case reports, systematic reviews published prior to 2007 • KQ11-13: pre-post non-intervention studies, case series, case reports, systematic reviews published prior to 2007
Language	• English language	• Non-English

Abbreviations: ACDF = anterior cervical discectomy and fusion; CT = computed tomography; EQ-5D = EuroQol-5 dimension instrument; KQ = Key Question; MDI = myelopathy disability index; MRI = magnetic resonance imaging; mJOA = modified Japanese orthopedic association scale; NDI = neck disability index; NRS = numerical pain rating scale; PROMIS-29 = patient reported outcome measurement information system; RCT = randomized controlled trial; QOL = quality of life; SF = short form health survey (12 or 36 items); VAS = visual analogue scale

2.1.2 Data Abstraction and Data Management

Dual review of abstracts was conducted using prespecified inclusion criteria and DistillerSR software version 2.35 (https://www.distillersr.com/). Discrepancies were resolved by discussion and consensus. Investigators tracked results in EndNote version 20.1 (Thomson Reuters, New York, NY). For studies meeting inclusion criteria, evidence tables were constructed with the following data: study design, author, year, setting, country, sample size, patient characteristics (e.g., age, gender, obesity, number of vertebral levels involved, severity of radiculopathy and/or myelopathy), effectiveness-related outcomes (e.g., validated pain, function and quality of life measures), as well as treatment-related adverse effects/harms) and results relevant to each Key Question as outlined in the previous PICOTS section (**Appendix C**).

2.1.3 Risk of Bias Assessment of Individual Studies

Predefined criteria were used to assess the risk of bias (also referred to as quality or internal validity) for each individual included study, using criteria appropriate for the study design (**Table A-2** and **Appendix D1.1**). Controlled trials and observational studies were assessed using a priori established criteria consistent with the AHRQ-Evidence-based Practice Center (EPC) approach recommended in the chapter, "Assessing the Risk of Bias of Individual Studies," described in the AHRQ Methods Guide.[2] RCTs were evaluated using criteria and methods developed by the Cochrane Back and Neck Group,[3] nonrandomized studies of interventions (NRSI) and other observational studies of interventions were evaluated using criteria developed by the U.S. Preventive Services Task Force,[4] and followed the approach recommended in the AHRQ Methods Guide chapter "Assessing the Risk of Bias of Individual Studies When Comparing Medical Interventions."[2] For randomized controlled trials (RCTs), we focused on randomization, allocation concealment, analysis according to randomized groups (intent-to-treat analysis), and attrition. NRSIs that controlled for potential prognostic variables were included to fill gaps in evidence when RCTs did not sufficient address the Key Questions.

Each study was independently reviewed for risk of bias by two team members. Any disagreements were resolved through consensus. Based on the risk of bias assessment, included studies were rated as having "low," "moderate," or "high" risk of bias (**Appendix D2.1**). Studies rated high risk of bias were not excluded a priori, but were considered to be less reliable than low or moderate risk of bias studies when synthesizing the evidence.

Table A-2. Criteria for grading the risk of bias of individual studies

Rating	Description and Criteria
Low	Least risk of bias, results generally considered valid Employ valid methods for selection, inclusion, and allocation of patients to treatment; report similar baseline characteristics in different treatment groups; clearly describe attrition and have low attrition; use appropriate means for preventing bias (e.g., blinding of patients, care providers, and outcomes assessors); and use appropriate analytic methods (e.g., intention-to-treat analysis)
Moderate	Susceptible to some bias but not enough to necessarily invalidate results May not meet all criteria for low risk of bias, but no flaw is likely to cause major bias; the study may be missing information making it difficult to assess limitations and potential problems Category is broad; studies with this rating will vary in strengths and weaknesses; some studies rated moderate risk of bias are likely to be valid, while others may be only possibly valid

Rating	Description and Criteria
High	Significant flaws that imply biases of various kinds that may invalidate results; "fatal flaws" in design, analysis or reporting; large amounts of missing information; discrepancies in reporting; or serious problems with intervention delivery Studies are at least as likely to reflect flaws in the study design or execution as the true difference between the compared interventions Considered to be less reliable than studies rated moderate or low risk of bias when synthesizing the evidence, particularly if discrepancies between studies are present

Table A-2 is taken from the Cervical Degenerative Disease Protocol, published online at https://effectivehealthcare.ahrq.gov/sites/default/files/product/pdf/cervical-degenerative-protocol.pdf

Because most studies were rated moderate risk of bias, we called out in the text studies rated high risk of bias as extra caution should be exercised when drawing conclusions from such studies.

2.1.4 Data Analysis and Synthesis

Evidence tables identify study characteristics, results of interest, and risk of bias ratings for all included studies and summary tables highlight the main findings. Studies were reviewed and highlighted using a hierarchy-of-evidence approach, where the best evidence is the focus of the synthesis for each Key Question. Since the Key Questions varied in nature and scope, the approach to synthesis also varied. We analyzed the evidence according to Key Question, using both qualitative (narrative) and where possible quantitative (meta-analysis) methods. RCTs were prioritized and studies with lower risk of bias ratings were given more weight in our synthesis for each clinical indication and outcome.

Meta-analyses were conducted to obtain more precise effect estimates for comparative effectiveness of various interventions for cervical spine. To determine the appropriateness of meta-analysis, we considered clinical and methodological diversity and assessed statistical heterogeneity. We conducted meta-analyses of randomized and nonrandomized evidence separately. For binary outcomes (e.g., overall success, neurological success, re-operation, fusion), risk ratio (RR) was used as the effect measure. For continuous outcomes (e.g. NDI, neck or arm pain, Japanese Orthopaedic Association Scale [JOA] scores, quality of life), mean difference (MD) was used as the effect measure as the studies reported outcomes using the same scale, or the outcomes could be converted to the same scale (e.g. pain, converted to 0-100 scale) (**Table A-3**). Adjusted mean differences between interventions were used if reported; otherwise, MD was calculated using the follow-up score if reported and then the change score from the baseline. When the reported measure of dispersion for each intervention group was not specified as standard deviation (SD) or standard error (SE), judgement was made based on the reported p-values for comparing the intervention groups and the magnitude of dispersion measures of similar studies. When SD was not reported, or could not be calculated from the reported data, it was imputed using the average coefficient of variation from the other included studies reporting the same outcome.

Table A-3. Definition of effect sizes

Effect Size	Definition
Small effect	MD 0.5 to 1.0 points on a 0 to 10-point scale, 5 to 10 points on a 0 to 100-point scale SMD 0.2 to 0.5 RR/OR 1.2 to 1.4
Moderate effect	MD >1 to 2 points on a 0 to10-point scale, >10 to 20 points on a 0 to 100-point scale SMD >0.5 to 0.8 RR/OR 1.5 to 1.9
Large effect	MD >2 points on a 0 to10-point scale, >20 points on a 0 to 100-point scale SMD >0.8 RR/OR ≥2.0

MD = mean difference; OR = odds ratio; RR = relative risk; SMD = standardized mean difference
Table A-3 taken from the Cervical Degenerative Disease Protocol, published online at https://effectivehealthcare.ahrq.gov/sites/default/files/product/pdf/cervical-degenerative-protocol.pdf

A random effects model based on the profile likelihood method[5] was used to obtain pooled RR and MD. When applicable, the primary analyses were stratified by the length of follow up: short term (≤ 6 months), intermediate term (6 to 60 months), long term (> 60 months), or using the actual follow up time. For arm pain success and arm pain score, when studies reported data from each arm separately, we conducted an optimistic analysis by using data from the arm with larger effect size, and a conservative analysis by data from the arm with smaller effect size. For arm pain score, we also conducted a sensitivity analysis using the average pain score of both arms. Additional sensitivity analyses were conducted by excluding studies rated high risk of bias.

Statistical heterogeneity among the studies was assessed using Cochran's χ^2 test and the I^2 statistic.[6] For analyses with at least 10 trials, we constructed funnel plots and performed the Egger test to detect small sample effects (a marker for potential publication bias).[7] All meta-analyses were conducted using Stata/SE 16.1 (StataCorp, College Station, TX).

To help determine the degree of effect, we examined the magnitude of relative risks and mean differences according to **Table A-3**. There were instances where a statistically significant difference between treatments was of such a small magnitude as to not be clinically meaningful. Conversely, there were instances where a small, moderate, or large effect was found but was not statistically significant.

2.1.5 Grading the Strength of the Body of Evidence

The EPC strength of evidence (SOE) rating for each body of evidence was assessed as high, moderate, low, or insufficient, using the approach described in the AHRQ Methods Guide,[2] based on study limitations, consistency, directness, precision, and reporting bias. These criteria were applied regardless of whether evidence was synthesized quantitatively or qualitatively. The I^2 statistic was used to help assess consistency in pooled analyses; The confidence intervals surrounding effect estimates were reviewed for clear benefit, no effect, and clear harms to aid in assessing precision. We considered evidence from both randomized trials and nonrandomized studies in determining strength of evidence with greater weight given to randomized studies. Strength of evidence ratings reflected our confidence or certainty in the findings (**Appendix G1.1**). Strength of evidence was considered insufficient when evidence was sparse, of poor quality or too conflicting such that we were unable to draw conclusions. SOE was initially assessed by one researcher and confirmed by a second. Descriptions of criteria and overall grades are described in **Table A-4** and **Appendix G**.

Table A-4. Strength of evidence grades and definitions

Grade	Definition
High	**We are very confident that the estimate of effect lies close to the true effect for this outcome.** The body of evidence has few or no deficiencies. We believe that the findings are stable, i.e., another study would not change the conclusions.
Moderate	**We are moderately confident that the estimate of effect lies close to the true effect for this outcome.** The body of evidence has some deficiencies. We believe that the findings are likely to be stable, but some doubt remains.
Low	**We have limited confidence that the estimate of effect lies close to the true effect for this outcome.** The body of evidence has major or numerous deficiencies (or both). We believe that additional evidence is needed before concluding either that the findings are stable or that the estimate of effect is close to the true effect.
Insufficient	**We have no evidence, we are unable to estimate an effect, or we have no confidence in the estimate of effect for this outcome.** No evidence is available or the body of evidence has unacceptable deficiencies, precluding reaching a conclusion.

Table A-4 taken from page 18 of the AHRQ Methods Guide.[2]

2.1.6 Peer Review and Public Commentary

An associate editor from a different EPC reviewed the draft report. Experts were invited to provide external peer review of this systematic review; AHRQ also provided comments. In addition, the draft report was posted on the AHRQ website June 9 to July 7, 2023, for public comment. All comments were reviewed and used to inform revisions to the draft report.

Appendix B. Included Studies

1. Abbott A, Halvorsen M, Dedering A. Is there a need for cervical collar usage post anterior cervical decompression and fusion using interbody cages? A randomized controlled pilot trial. Physiotherapy Theory & Practice. 2013;29(4):290-300. doi: 10.3109/09593985.2012.731627. PMID: 23074995

2. Aggarwal RA, Srivastava SK, Bhosale SK, et al. Prediction of surgical outcome in compressive cervical myelopathy: a novel clinicoradiological prognostic score. Journal of Craniovertebral Junction & Spine. 2016;7(2):82-6. doi: 10.4103/0974-8237.181828. PMID: 27217653.

3. Ajiboye RM, D'Oro A, Ashana AO, et al. Routine use of intraoperative neuromonitoring during ACDFs for the treatment of spondylotic myelopathy and radiculopathy is questionable: a review of 15,395 cases. Spine. 2017;42(1):14-9. doi: 10.1097/BRS.0000000000001662. PMID: 27120059.

4. Alvin MD, Lubelski D, Abdullah KG, et al. Cost-utility analysis of anterior cervical discectomy and fusion with plating (ACDFP) versus posterior cervical foraminotomy (PCF) for patients with single-level cervical radiculopathy at 1-year follow-up. Clinical Spine Surgery : A Spine Publication. 2016;29(2):E67-72. doi: 10.1097/BSD.0000000000000099. PMID: 26889994.

5. Alvin MD, Lubelski D, Abdullah KG, et al. Cost-utility analysis of anterior cervical discectomy and fusion with plating (ACDFP) versus posterior cervical foraminotomy (PCF) for patients with single-level cervical radiculopathy at 1-year follow-up. Clinical Spine Surgery : A Spine Publication. 2016;29(2):E67-72. doi: 10.1097/BSD.0000000000000099. PMID: 26889994.

6. Anderson PA, Sasso RC, Riew KD. Comparison of adverse events between the Bryan artificial cervical disc and anterior cervical arthrodesis. Spine. 2008;33(12):1305-12. doi: 10.1097/BRS.0b013e31817329a1. PMID: 18496341.

7. Arnold PM, Anderson KK, Selim A, et al. Heterotopic ossification following single-level anterior cervical discectomy and fusion: results from the prospective, multicenter, historically controlled trial comparing allograft to an optimized dose of rhBMP-2. Journal of Neurosurgery Spine. 2016;25(3):292-302. doi: 10.3171/2016.1.SPINE15798. PMID: 27129045.

8. Arnold PM, Anderson KK, Selim A, et al. Heterotopic ossification following single-level anterior cervical discectomy and fusion: results from the prospective, multicenter, historically controlled trial comparing allograft to an optimized dose of rhBMP-2. Journal of Neurosurgery Spine. 2016;25(3):292-302. doi: 10.3171/2016.1.SPINE15798. PMID: 27129045.

9. Arnold PM, Sasso RC, Janssen ME, et al. i-Factor TM bone graft vs autograft in anterior cervical discectomy and fusion: 2-year follow-up of the randomized single-blinded food and drug administration investigational device exemption study. Neurosurgery; 2018. p. 377-84.

10. Arnold PM, Sasso RC, Janssen ME, et al. Efficacy of i-Factor bone graft versus autograft in anterior cervical discectomy and fusion: results of the prospective, randomized, single-blinded food and drug administration investigational device exemption study. Spine. 2016;41(13):1075-83. doi: 10.1097/BRS.0000000000001466. PMID: 26825787.

11. Arnold PM, Vaccaro AR, Sasso RC, et al. Six-year follow-up of a randomized controlled trial of i-FACTOR peptide-enhanced bone graft versus local autograft in single-level anterior cervical discectomy and fusion. Neurosurgery. 2022 Apr 1;92(4):725-33. doi: 10.1227/neu.0000000000002290. PMID: 36700705.

12. Asher AL, Devin CJ, Kerezoudis P, et al. Comparison of outcomes following anterior vs posterior fusion surgery for patients with degenerative cervical myelopathy: an analysis from quality outcomes database. Neurosurgery. 2019;84(4):919-26. doi: 10.1093/neuros/nyy144. PMID: 29741718.

13. Badhiwala JH, Ellenbogen Y, Khan O, et al. Comparison of the inpatient complications and health care costs of anterior versus posterior cervical decompression and fusion in patients with multilevel degenerative cervical myelopathy: a retrospective propensity score-matched analysis. World Neurosurgery. 2020;134:e112-e9. doi: 10.1016/j.wneu.2019.09.132. PMID: 31574327.

14. Badhiwala JH, Nassiri F, Witiw CD, et al. Investigating the utility of intraoperative neurophysiological monitoring for anterior cervical discectomy and fusion: analysis of over 140,000 cases from the National (Nationwide) Inpatient Sample data set. Journal of Neurosurgery Spine. 2019;31(1):76-86. doi: 10.3171/2019.1.SPINE181110. PMID: 30925481.

15. Baker JD, Harada GK, Tao Y, et al. The impact of modic changes on preoperative symptoms and clinical outcomes in anterior cervical discectomy and fusion patients. Neurospine. 2020;17(1):190-203. doi: 10.14245/ns.2040062.031. PMID: 32252168.

16. Balouch E, Burapachaisri A, Woo D, et al. Assessing postoperative pseudarthrosis in Anterior Cervical Discectomy and Fusion (ACDF) on dynamic radiographs using novel angular measurements. Spine (Phila Pa 1976). 2022 Aug 15;47(16):1151-6. doi: 10.1097/BRS.0000000000004375. PMID: 35853174.

17. Baskin DS, Ryan P, Sonntag V, et al. A prospective, randomized, controlled cervical fusion study using recombinant human bone morphogenetic protein-2 with the CORNERSTONE-SR allograft ring and the ATLANTIS anterior cervical plate. Spine. 2003;28(12):1219-24; discussion 25. doi: 10.1097/01.BRS.0000065486.22141.CA. PMID: 12811263.

18. Bhashyam N, De la Garza Ramos R, Nakhla J, et al. Thirty-day readmission and reoperation rates after single-level anterior cervical discectomy and fusion versus those after cervical disc replacement. Neurosurg Focus. 2017;42(2):E6. doi: 10.3171/2016.11.Focus16407. PMID: 28142261.

19. Blizzard DJ, Caputo AM, Sheets CZ, et al. Laminoplasty versus laminectomy with fusion for the treatment of spondylotic cervical myelopathy: short-term follow-up. European Spine Journal. 2017;26(1):85-93. doi: 10.1007/s00586-016-4746-3. PMID: 27554354.

20. Broekema AEH, Simoes de Souza NF, Soer R, et al. Noninferiority of posterior cervical foraminotomy vs anterior cervical discectomy with fusion for procedural success and reduction in arm pain among patients with cervical radiculopathy at 1 year: the FACET randomized clinical trial. JAMA Neurol. 2023 Jan 1;80(1):40-8. doi: 10.1001/jamaneurol.2022.4208. PMID: 36409485.

21. Burkus JK, Haid RW, Traynelis VC, et al. Long-term clinical and radiographic outcomes of cervical disc replacement with the Prestige disc: results from a prospective randomized controlled clinical trial. Journal of Neurosurgery Spine. 2010;13(3):308-18. doi: 10.3171/2010.3.SPINE09513. PMID: 20809722.

22. Burkus JK, Traynelis VC, Haid RW, Jr., et al. Clinical and radiographic analysis of an artificial cervical disc: 7-year follow-up from the Prestige prospective randomized controlled clinical trial: Clinical article. Journal of Neurosurgery Spine. 2014;21(4):516-28. doi: 10.3171/2014.6.SPINE13996. PMID: 25036218.

23. Chen X, Shi L, Yu X, et al. Comparative study of artificial cervical disc replacement and anterior cervical discectomy/fusion in the treatment of cervical spondylotic myelopathy. International journal of clinical and experimental medicine. 2019;12(8):10597-604p.

24. Chen Y, Chen H, Wu X, et al. Comparative analysis of clinical outcomes between zero-profile implant and cages with plate fixation in treating multilevel cervical spondilotic myelopathy: A three-year follow-up. Clinical Neurology & Neurosurgery. 2016;144:72-6. doi: 10.1016/j.clineuro.2016.03.010. PMID: 26999528.

25. Chen Y, Wang X, Lu X, et al. Comparison of titanium and polyetheretherketone (PEEK) cages in the surgical treatment of multilevel cervical spondylotic myelopathy: a prospective, randomized, control study with over 7-year follow-up. European Spine Journal. 2013;22(7):1539-46. doi: 10.1007/s00586-013-2772-y. PMID: 23568254.

26. Cheng L, Nie L, Li M, et al. Superiority of the Bryan(R) disc prosthesis for cervical myelopathy: a randomized study with 3-year followup. Clinical Orthopaedics & Related Research. 2011;469(12):3408-14. doi: 10.1007/s11999-011-2039-z. PMID: 21997779.

27. Cheng L, Nie L, Zhang L, et al. Fusion versus Bryan Cervical Disc in two-level cervical disc disease: a prospective, randomised study. Int Orthop. 2009;33(5):1347-51. doi: 10.1007/s00264-008-0655-3. PMID: 18956190.

28. Cheung JPY, Cheung PWH, Law K, et al. Postoperative rigid cervical collar leads to less axial neck pain in the early stage after open-door laminoplasty-a single-blinded randomized controlled trial. Neurosurgery. 2019;85(3):325-34p. doi: 10.1093/neuros/nyy359.

29. Cho DY, Lee WY, Sheu PC, et al. Cage containing a biphasic calcium phosphate ceramic (Triosite) for the treatment of cervical spondylosis. Surg Neurol. 2005;63(6):497-503; discussion -4. doi: 10.1016/j.surneu.2004.10.016. PMID: 15936361.

30. Cincu R, Lorente Fde A, Gomez J, et al. Long term preservation of motion with artificial cervical disc implants: a comparison between cervical disc replacement and rigid fusion with cage. Asian Journal of Neurosurgery. 2014;9(4):213-7. doi: 10.4103/1793-5482.146608. PMID: 25685218.

31. Colamaria A, Ciappetta P, Fochi NP, et al. Anterior cervical corpectomy for treatment of spondylotic myelopathy. Results of a prospective double-armed study with a three-year follow-up. Journal of Neurosurgical Sciences. 2022;13:13. doi: 10.23736/S0390-5616.22.05608-9. PMID: 35416453.

32. Cole T, Veeravagu A, Zhang M, et al. Anterior versus posterior approach for multilevel degenerative cervical disease: a retrospective propensity score-matched study of the marketscan database. Spine. 2015;40(13):1033-8. doi: 10.1097/BRS.0000000000000872. PMID: 25768690.

33. Coric D, Guyer RD, Bae H, et al. Prospective, multicenter study of 2-level cervical arthroplasty with a PEEK-on-ceramic artificial disc. Journal of Neurosurgery Spine. 2022;37(3):1-11. doi: 10.3171/2022.1.SPINE211264. PMID: 35364570.

34. Davis RJ, Kim KD, Hisey MS, et al. Cervical total disc replacement with the Mobi-C cervical artificial disc compared with anterior discectomy and fusion for treatment of 2-level symptomatic degenerative disc disease: a prospective, randomized, controlled multicenter clinical trial: clinical article. Journal of Neurosurgery Spine. 2013;19(5):532-45. doi: 10.3171/2013.6.SPINE12527. PMID: 24010901.

35. Davis RJ, Nunley PD, Kim KD, et al. Two-level total disc replacement with Mobi-C cervical artificial disc versus anterior discectomy and fusion: a prospective, randomized, controlled multicenter clinical trial with 4-year follow-up results. Journal of Neurosurgery Spine. 2015;22(1):15-25. doi: 10.3171/2014.7.SPINE13953. PMID: 25380538.

36. Delamarter RB, Murrey D, Janssen ME, et al. Results at 24 months from the prospective, randomized, multicenter Investigational Device Exemption trial of ProDisc-C versus anterior cervical discectomy and fusion with 4-year follow-up and continued access patients. SAS journal [Electronic Resource]. 2010;4(4):122-8. doi: 10.1016/j.esas.2010.09.001. PMID: 25802660.

37. Delamarter RB, Zigler J. Five-year reoperation rates, cervical total disc replacement versus fusion, results of a prospective randomized clinical trial. Spine. 2013;38(9):711-7. doi: 10.1097/BRS.0b013e3182797592. PMID: 23124255.

38. Donk RD, Verbeek ALM, Verhagen WIM, et al. What's the best surgical treatment for patients with cervical radiculopathy due to single-level degenerative disease? A randomized controlled trial. PLoS ONE [Electronic Resource]. 2017;12(8):e0183603. doi: 10.1371/journal.pone.0183603. PMID: 28850600.

39. Ebrahim KS, El-Shehaby A, Darwish A, et al. Anterior or posterior foraminotomy for unilateral cervical radiculopathy. Pan arab journal of neurosurgery. 2011;15(2):34-46p.

40. Elmallawany M, Kandel H, Soliman MAR, et al. The safety and efficacy of cervical laminectomy and fusion versus cervical laminoplasty surgery in degenerative cervical myelopathy: a prospective randomized trial. Open access macedonian journal of medical sciences. 2020;8:807-14. doi: 10.3889/oamjms.2020.4841.

41. Fehlings MG, Barry S, Kopjar B, et al. Anterior versus posterior surgical approaches to treat cervical spondylotic myelopathy: outcomes of the prospective multicenter aospine north america csm study in 264 patients. Spine. 2013;38(26):2247-52. doi: 10.1097/BRS.0000000000000047. PMID: 24108289.

42. Fehlings MG, Santaguida C, Tetreault L, et al. Laminectomy and fusion versus laminoplasty for the treatment of degenerative cervical myelopathy: results from the AOSpine North America and International prospective multicenter studies. Spine Journal: Official Journal of the North American Spine Society. 2017;17(1):102-8. doi: 10.1016/j.spinee.2016.08.019. PMID: 27597512.

43. Foley KT, Mroz TE, Arnold PM, et al. Randomized, prospective, and controlled clinical trial of pulsed electromagnetic field stimulation for cervical fusion. Spine Journal: Official Journal of the North American Spine Society. 2008;8(3):436-42. doi: 10.1016/j.spinee.2007.06.006. PMID: 17983841.

44. Foster MT, Carleton-Bland NP, Lee MK, et al. Comparison of clinical outcomes in anterior cervical discectomy versus foraminotomy for brachialgia. British Journal of Neurosurgery. 2019;33(1):3-7. doi: 10.1080/02688697.2018.1527013. PMID: 30450995.

45. Fukushima T, Ikata T, Taoka Y, et al. Magnetic resonance imaging study on spinal cord plasticity in patients with cervical compression myelopathy. Spine (Phila Pa 1976). 1991;16(10 Suppl):S534-8. doi: 10.1097/00007632-199110001-00016. PMID: 1801267.

46. Ghobrial GM, Lavelle WF, Florman JE, et al. Symptomatic adjacent level disease requiring surgery: Analysis of 10-year results from a prospective, randomized, clinical trial comparing cervical disc arthroplasty to anterior cervical fusion. Neurosurgery. 2018;84(2):347-54. doi: 10.1093/neuros/nyy118. PMID: 29635520.

47. Godlewski B, Bebenek A, Dominiak M, et al. PEEK versus titanium-coated PEEK cervical cages: fusion rate. Acta Neurochirurgica. 2022;164(6):1501-7. doi: 10.1007/s00701-022-05217-7. PMID: 35471708.

48. Gornet M, McConnell J, Riew K, et al. Treatment of cervical myelopathy: long-term outcomes of arthroplasty for myelopathy versus radiculopathy, And arthroplasty versus arthrodesis for myelopathy. Clin Spine Surg. 2018;31(10):420-7. doi: 10.1097/BSD.0000000000000744. PMID: 30371602.

49. Gornet MF, Lanman TH, Burkus JK, et al. Two-level cervical disc arthroplasty versus anterior cervical discectomy and fusion: 10-year outcomes of a prospective, randomized investigational device exemption clinical trial. Journal of Neurosurgery Spine. 2019;31(4):1-11. doi: 10.3171/2019.4.SPINE19157. PMID: 31226684.

50. Gornet MF, Lanman TH, Burkus JK, et al. Cervical disc arthroplasty with the Prestige LP disc versus anterior cervical discectomy and fusion, at 2 levels: results of a prospective, multicenter randomized controlled clinical trial at 24 months. Journal of Neurosurgery Spine. 2017;26(6):653-67. doi: 10.3171/2016.10.SPINE16264. PMID: 28304237.

51. Grob D, Porchet F, Kleinstuck FS, et al. A comparison of outcomes of cervical disc arthroplasty and fusion in everyday clinical practice: surgical and methodological aspects. European Spine Journal. 2010;19(2):297-306. doi: 10.1007/s00586-009-1194-3. PMID: 19882177.

52. Gupta VK, Basantani N, Carvalho AS, et al. Long-term clinicoradiological outcomes of cervical fusion with polyether ether ketone versus cervical disc arthroplasty in a double-blinded randomized control trial. Asian Journal of Neurosurgery. 2021;16(4):725-31. doi: 10.4103/ajns.AJNS_345_20. PMID: 35071069.

53. Harada GK, Alter K, Nguyen AQ, et al. Cervical spine endplate abnormalities and association with pain, disability, and adjacent segment degeneration after anterior cervical discectomy and fusion. Spine. 2020;45(15):E917-E26. doi: 10.1097/BRS.0000000000003460. PMID: 32675603.

54. He S, Feng H, Lan Z, et al. A randomized trial comparing clinical outcomes between zero-profile and traditional multilevel anterior cervical discectomy and fusion surgery for cervical myelopathy. Spine. 2018;43(5):E259-E66. doi: 10.1097/BRS.0000000000002323. PMID: 29432408.

55. He X, Zhang JN, Liu TJ, et al. Is laminectomy and fusion the better choice than laminoplasty for multilevel cervical myelopathy with signal changes on magnetic resonance imaging? A comparison of two posterior surgeries. BMC Musculoskeletal Disorders. 2020;21(1):423. doi: 10.1186/s12891-020-03435-7. PMID: 32615953.

56. Heller JG, Sasso RC, Papadopoulos SM, et al. Comparison of BRYAN cervical disc arthroplasty with anterior cervical decompression and fusion: clinical and radiographic results of a randomized, controlled, clinical trial. Spine. 2009;34(2):101-7. doi: 10.1097/BRS.0b013e31818ee263. PMID: 19112337.

57. Hida T, Sakai Y, Ito K, et al. Collar fixation is not mandatory after cervical laminoplasty: a randomized controlled trial. Spine. 2017;42(5):E253-E9. doi: 10.1097/BRS.0000000000001994. PMID: 27879567.

58. Hisey MS, Bae HW, Davis R, et al. Multi-center, prospective, randomized, controlled investigational device exemption clinical trial comparing Mobi-C Cervical Artificial Disc to anterior discectomy and fusion in the treatment of symptomatic degenerative disc disease in the cervical spine. International Journal of Spine Surgery. 2014;8:7. doi: 10.14444/1007. PMID: 25694918.

59. Hisey MS, Bae HW, Davis RJ, et al. Prospective, randomized comparison of cervical total disk replacement versus anterior cervical fusion: results at 48 months follow-up. Journal of Spinal Disorders & Techniques. 2015;28(4):E237-43. doi: 10.1097/BSD.0000000000000185. PMID: 25310394.

60. Hisey MS, Zigler JE, Jackson R, et al. Prospective, randomized comparison of one-level mobi-c cervical total disc replacement vs. anterior cervical discectomy and fusion: Results at 5-year follow-up. International Journal of Spine Surgery. 2016;10:10. doi: 10.14444/3010. PMID: 27162712.

61. Hou Y, Nie L, Pan X, et al. Effectiveness and safety of Mobi-C for treatment of single-level cervical disc spondylosis: a randomised control trial with a minimum of five years of follow-up. Bone Joint J. 2016;98-B(6):829-33. doi: 10.1302/0301-620X.98B6.36381. PMID: 27235528.

62. Jackson RJ, Davis RJ, Hoffman GA, et al. Subsequent surgery rates after cervical total disc replacement using a Mobi-C Cervical Disc Prosthesis versus anterior cervical discectomy and fusion: a prospective randomized clinical trial with 5-year follow-up. Journal of Neurosurgery Spine. 2016;24(5):734-45. doi: 10.3171/2015.8.SPINE15219. PMID: 26799118.

63. Janssen ME, Zigler JE, Spivak JM, et al. ProDisc-C total disc replacement versus anterior cervical discectomy and fusion for single-level symptomatic cervical disc disease: seven-year follow-up of the prospective randomized u.S. Food and drug administration investigational device exemption study. Journal of Bone & Joint Surgery - American Volume. 2015;97(21):1738-47. doi: 10.2106/JBJS.N.01186. PMID: 26537161.

64. Jiang YQ, Li XL, Zhou XG, et al. A prospective randomized trial comparing anterior cervical discectomy and fusion versus plate-only open-door laminoplasty for the treatment of spinal stenosis in degenerative diseases. European Spine Journal. 2017;26(4):1162-72. doi: 10.1007/s00586-016-4878-5. PMID: 27885472.

65. Joo PY, Jayaram RH, McLaughlin WM, et al. Four-level anterior versus posterior cervical fusions: perioperative outcomes and five-year reoperation rates: outcomes after four-level anterior versus posterior cervical procedures. North American Spine Society Journal. 2022;10:100115. doi: 10.1016/j.xnsj.2022.100115. PMID: 35392022.

66. Kadanka Z, Bednařík J, Novotný O, et al. Cervical spondylotic myelopathy: conservative versus surgical treatment after 10 years. Eur Spine J. 2011;20(9):1533-8. doi: 10.1007/s00586-011-1811-9. PMID: 21519928.

67. Kadanka Z, Mares M, Bednaník J, et al. Approaches to spondylotic cervical myelopathy: conservative versus surgical results in a 3-year follow-up study. Spine (Phila Pa 1976). 2002;27(20):2205-10; discussion 10-1. doi: 10.1097/01.Brs.0000029255.77224.Bb. PMID: 12394893.

68. Kadanka Z, Mares M, Bednarík J, et al. Predictive factors for mild forms of spondylotic cervical myelopathy treated conservatively or surgically. Eur J Neurol. 2005;12(1):16-24. doi: 10.1111/j.1468-1331.2004.00947.x. PMID: 15613142.

69. Kanna RM, Perambuduri AS, Shetty AP, et al. A randomized control trial comparing local autografts and allografts in single level anterior cervical discectomy and fusion using a stand-alone cage. Asian Spine Journal. 2021;15(6):817-24. doi: 10.31616/asj.2020.0182. PMID: 33189111.

70. Karabag H, Cakmak E, Celik B, et al. Arthroplasty versus fusion for single-level cervical disc disease. JPMA - Journal of the Pakistan Medical Association. 2014;64(12):1348-51. PMID: 25842575.

71. Kelly MP, Eliasberg CD, Riley MS, et al. Reoperation and complications after anterior cervical discectomy and fusion and cervical disc arthroplasty: a study of 52,395 cases. European Spine Journal. 2018;27(6):1432-9. doi: 10.1007/s00586-018-5570-8. PMID: 29605899.

72. Kim TH, Ha Y, Shin JJ, et al. Signal intensity ratio on magnetic resonance imaging as a prognostic factor in patients with cervical compressive myelopathy. Medicine. 2016;95(39):e4649. doi: 10.1097/MD.0000000000004649. PMID: 27684796.

73. Lambrechts MJ, D'Antonio ND, Karamian BA, et al. What is the role of dynamic cervical spine radiographs in predicting pseudarthrosis revision following anterior cervical discectomy and fusion? Spine Journal: Official Journal of the North American Spine Society. 2022;12(10):12. doi: 10.1016/j.spinee.2022.04.020. PMID: 35568109.

74. Lanman TH, Burkus JK, Dryer RG, et al. Long-term clinical and radiographic outcomes of the Prestige LP artificial cervical disc replacement at 2 levels: results from a prospective randomized controlled clinical trial. Journal of Neurosurgery Spine. 2017;27(1):7-19. doi: 10.3171/2016.11.SPINE16746. PMID: 28387616.

75. Lavelle WF, Riew KD, Levi AD, et al. Ten-year outcomes of cervical disc replacement with the bryan cervical disc: results from a prospective, randomized, controlled clinical trial. Spine. 2019;44(9):601-8. doi: 10.1097/BRS.0000000000002907. PMID: 30325888.

76. Lee NJ, Boddapati V, Mathew J, et al. What is the impact of surgical approach in the treatment of degenerative cervical myelopathy in patients with OPLL? a propensity-score matched, multi-center analysis on inpatient and post-discharge 90-day outcomes. Global Spine Journal. 2021:2192568221994797. doi: 10.1177/2192568221994797. PMID: 33601898.

77. Lee NJ, Kim JS, Park P, et al. A comparison of various surgical treatments for degenerative cervical myelopathy: a propensity score matched analysis. Global Spine Journal. 2022;12(6):1109-18. doi: 10.1177/2192568220976092. PMID: 33375849.

78. Li XY, Lu SB, Sun XY, et al. Clinical and magnetic resonance imaging predictors of the surgical outcomes of patients with cervical spondylotic myelopathy. Clinical Neurology & Neurosurgery. 2018;174:137-43. doi: 10.1016/j.clineuro.2018.09.003. PMID: 30241007.

79. Li Y, Hao D, He B, et al. The efficiency of zero-profile implant in anterior cervical discectomy fusion: a prospective controlled long-term follow-up study. Journal of Spinal Disorders & Techniques. 2015;28(10):398-403. doi: 10.1097/BSD.0000000000000032. PMID: 24136051.

80. Loidolt T, Kurra S, Riew KD, et al. Comparison of adverse events between cervical disc arthroplasty and anterior cervical discectomy and fusion: a 10-year follow-up. Spine Journal: Official Journal of the North American Spine Society. 2021;21(2):253-64. doi: 10.1016/j.spinee.2020.10.013. PMID: 33080376.

81. Lubelski D, Healy AT, Silverstein MP, et al. Reoperation rates after anterior cervical discectomy and fusion versus posterior cervical foraminotomy: a propensity-matched analysis. Spine Journal: Official Journal of the North American Spine Society. 2015;15(6):1277-83. doi: 10.1016/j.spinee.2015.02.026. PMID: 25720729.

82. Manzano GR, Casella G, Wang MY, et al. A prospective, randomized trial comparing expansile cervical laminoplasty and cervical laminectomy and fusion for multilevel cervical myelopathy. Neurosurgery. 2012;70(2):264-77. doi: 10.1227/NEU.0b013e3182305669. PMID: 22251974.

83. McDonald CL, Hershman SH, Hogan W, et al. Cervical laminoplasty versus posterior laminectomy and fusion: trends in utilization and evaluation of complication and revision surgery rates. Journal of the American Academy of Orthopaedic Surgeons. 2022;30(17):30. doi: 10.5435/JAAOS-D-22-00106. PMID: 35640093.

84. Mesregah MK, Formanek B, Liu JC, et al. Perioperative complications of surgery for degenerative cervical myelopathy: a comparison between 3 procedures. Global Spine Journal. 2021:2192568221998306. doi: 10.1177/2192568221998306. PMID: 33709809.

85. Morio Y, Teshima R, Nagashima H, et al. Correlation between operative outcomes of cervical compression myelopathy and MRI of the spinal cord. Spine. 2001;26(11):1238-45. PMID: 11389390.

86. Mummaneni PV, Burkus JK, Haid RW, et al. Clinical and radiographic analysis of cervical disc arthroplasty compared with allograft fusion: a randomized controlled clinical trial. Journal of Neurosurgery Spine. 2007;6(3):198-209. doi: 10.3171/spi.2007.6.3.198. PMID: 17355018.

87. Murrey D, Janssen M, Delamarter R, et al. Results of the prospective, randomized, controlled multicenter Food and Drug Administration investigational device exemption study of the ProDisc-C total disc replacement versus anterior discectomy and fusion for the treatment of 1-level symptomatic cervical disc disease. Spine Journal: Official Journal of the North American Spine Society. 2009;9(4):275-86. doi: 10.1016/j.spinee.2008.05.006. PMID: 18774751.

88. Nabhan A, Ahlhelm F, Shariat K, et al. The ProDisc-C prosthesis: clinical and radiological experience 1 year after surgery. Spine. 2007;32(18):1935-41. doi: 10.1097/BRS.0b013e31813162d8. PMID: 17700437.

89. Nabhan A, Ishak B, Steudel WI, et al. Assessment of adjacent-segment mobility after cervical disc replacement versus fusion: RCT with 1 year's results. European Spine Journal. 2011;20(6):934-41. doi: 10.1007/s00586-010-1588-2. PMID: 21221666.

90. Nabhan A, Steudel WI, Nabhan A, et al. Segmental kinematics and adjacent level degeneration following disc replacement versus fusion: RCT with three years of follow-up. Journal of Long-Term Effects of Medical Implants. 2007;17(3):229-36. doi: 10.1615/jlongtermeffmedimplants.v17.i3.60. PMID: 19023947.

91. Nandyala SV, Marquez-Lara A, Fineberg SJ, et al. Comparison between cervical total disc replacement and anterior cervical discectomy and fusion of 1 to 2 levels from 2002 to 2009. Spine. 2014;39(1):53-7. doi: 10.1097/BRS.0000000000000044. PMID: 24108292.

92. Nayak R, Razzouk J, Ramos O, et al. Reoperation and perioperative complications after surgical treatment of cervical radiculopathy: a comparison between three procedures. Spine (Phila Pa 1976). 2023 Feb 15;48(4):261-9. doi: 10.1097/BRS.0000000000004506. PMID: 36255369.

93. Nemoto O, Kitada A, Naitou S, et al. Stand-alone anchored cage versus cage with plating for single-level anterior cervical discectomy and fusion: a prospective, randomized, controlled study with a 2-year follow-up. European journal of orthopaedic surgery & traumatologie. 2015;25 Suppl 1:S127-34. doi: 10.1007/s00590-014-1547-4. PMID: 25283362.

94. Ng MK, Kobryn A, Baidya J, et al. Multi-level posterior cervical foraminotomy associated with increased post-operative infection rates and overall re-operation relative to anterior cervical discectomy with fusion or cervical disc arthroplasty. Global spine j. 2022 Sep 2:21925682221124530. doi: 10.1177/21925682221124530. PMID: 36052872.

95. Niu CC, Liao JC, Chen WJ, et al. Outcomes of interbody fusion cages used in 1 and 2-levels anterior cervical discectomy and fusion: titanium cages versus polyetheretherketone (PEEK) cages. Journal of Spinal Disorders & Techniques. 2010;23(5):310-6. doi: 10.1097/BSD.0b013e3181af3a84. PMID: 20124907.

96. Nouri A, Martin AR, Kato S, et al. The relationship between MRI signal intensity changes, clinical presentation, and surgical outcome in degenerative cervical myelopathy: Analysis of a global cohort. Spine. 2017;42(24):1851-8. doi: 10.1097/BRS.0000000000002234. PMID: 28498290.

97. Nunley PD, Kerr EJ, 3rd, Cavanaugh DA, et al. Adjacent segment pathology after treatment with cervical disc arthroplasty or anterior cervical discectomy and fusion, part 2: clinical results at 7-year follow-up. International Journal of Spine Surgery. 2020;14(3):278-85. doi: 10.14444/7037. PMID: 32699748.

98. Nunna RS, Khalid S, Chiu RG, et al. Anterior vs posterior approach in multilevel cervical spondylotic myelopathy: a nationwide propensity-matched analysis of complications, outcomes, and narcotic use. International Journal of Spine Surgery. 2022;16(1):88-94. doi: 10.14444/8198. PMID: 35314510.

99. Ostrov PB, Reddy AK, Ryoo JS, et al. Anterior cervical discectomy and fusion versus cervical disc arthroplasty: a comparison of national trends and outcomes. World Neurosurgery. 2022;160:e96-e110. doi: 10.1016/j.wneu.2021.12.099. PMID: 34973439.

100. Panchal RR, Kim KD, Eastlack R, et al. A clinical comparison of anterior cervical plates versus stand-alone intervertebral fusion devices for single-level anterior cervical discectomy and fusion procedures. World Neurosurgery. 2017;99:630-7. doi: 10.1016/j.wneu.2016.12.060. PMID: 28017756.

101. Peng-Fei S, Yu-Hua J. Cervical disc prosthesis replacement and interbody fusion: a comparative study. Int Orthop. 2008;32(1):103-6. doi: 10.1007/s00264-006-0287-4. PMID: 17180356.

102. Persson LC, Lilja A. Pain, coping, emotional state and physical function in patients with chronic radicular neck pain. A comparison between patients treated with surgery, physiotherapy or neck collar--a blinded, prospective randomized study. Disabil Rehabil. 2001;23(8):325-35. doi: 10.1080/09638280010005567. PMID: 11374522.

103. Persson LC, Moritz U, Brandt L, et al. Cervical radiculopathy: pain, muscle weakness and sensory loss in patients with cervical radiculopathy treated with surgery, physiotherapy or cervical collar. A prospective, controlled study. Eur Spine J. 1997;6(4):256-66. doi: 10.1007/bf01322448. PMID: 9294750.

104. Phillips FM, Coric D, Sasso R, et al. Prospective, multicenter clinical trial comparing M6-C compressible six degrees of freedom cervical disc with anterior cervical discectomy and fusion for the treatment of single-level degenerative cervical radiculopathy: 2-year results of an FDA investigational device exemption study. Spine Journal: Official Journal of the North American Spine Society. 2020;21(2):239-52. doi: 10.1016/j.spinee.2020.10.014. PMID: 33096243.

105. Phillips FM, Geisler FH, Gilder KM, et al. Long-term outcomes of the US FDA IDE prospective, randomized controlled clinical trial comparing PCM cervical disc arthroplasty with anterior cervical discectomy and fusion. Spine. 2015;40(10):674-83. doi: 10.1097/BRS.0000000000000869. PMID: 25955086.

106. Phillips FM, Lee JY, Geisler FH, et al. A prospective, randomized, controlled clinical investigation comparing PCM cervical disc arthroplasty with anterior cervical discectomy and fusion. 2-year results from the US FDA IDE clinical trial. Spine. 2013;38(15):E907-18. doi: 10.1097/BRS.0b013e318296232f. PMID: 23591659.

107. Qi M, Xu C, Liu Y, et al. Comparison of clinical outcomes between cervical disc arthroplasty and anterior cervical discectomy and fusion for the treatment of single-level cervical spondylosis: a 10-year follow-up study. Spine J. 2023 Mar;23(3):361-8. doi: 10.1016/j.spinee.2022.11.013. PMID: 36481680.

108. Radcliff K, Coric D, Albert T. Five-year clinical results of cervical total disc replacement compared with anterior discectomy and fusion for treatment of 2-level symptomatic degenerative disc disease: a prospective, randomized, controlled, multicenter investigational device exemption clinical trial. Journal of Neurosurgery Spine. 2016;25(2):213-24. doi: 10.3171/2015.12.SPINE15824. PMID: 27015130.

109. Radcliff K, Davis RJ, Hisey MS, et al. Long-term evaluation of cervical disc arthroplasty with the Mobi-C cervical disc: a randomized, prospective, multicenter clinical trial with seven-year follow-up. International journal of spine surgery. 2017;11(4):244-62. doi: 10.14444/4031.

110. Ruetten S, Komp M, Merk H, et al. Full-endoscopic cervical posterior foraminotomy for the operation of lateral disc herniations using 5.9-mm endoscopes: a prospective, randomized, controlled study. Spine (Phila Pa 1976). 2008;33(9):940-8. doi: 10.1097/BRS.0b013e31816c8b67. PMID: 18427313.

111. Sarkar S, Turel MK, Jacob KS, et al. The evolution of T2-weighted intramedullary signal changes following ventral decompressive surgery for cervical spondylotic myelopathy: Clinical article. Journal of Neurosurgery Spine. 2014;21(4):538-46. doi: 10.3171/2014.6.SPINE13727. PMID: 25014501.

112. Sasso RC, Anderson PA, Riew KD, et al. Results of cervical arthroplasty compared with anterior discectomy and fusion: four-year clinical outcomes in a prospective, randomized controlled trial. Journal of Bone & Joint Surgery - American Volume. 2011;93(18):1684-92. doi: 10.2106/JBJS.J.00476. PMID: 21938372.

113. Scholz M, Onal B, Schleicher P, et al. Two-level ACDF with a zero-profile stand-alone spacer compared to conventional plating: a prospective randomized single-center study. European Spine Journal. 2020;29(11):2814-22. doi: 10.1007/s00586-020-06454-z. PMID: 32430769.

114. Sharma R, Borkar S, Katiyar V, et al. Interplay of dynamic extension reserve and T1 slope in determining the loss of cervical lordosis following laminoplasty: a novel classification system. World Neurosurgery. 2020;136:e33-e40. doi: 10.1016/j.wneu.2019.08.212. PMID: 31493608.

115. Smucker JD, Rhee JM, Singh K, et al. Increased swelling complications associated with off-label usage of rhBMP-2 in the anterior cervical spine. Spine (Phila Pa 1976). 2006;31(24):2813-9. doi: 10.1097/01.brs.0000245863.52371.c2. PMID: 17108835.

116. Song KS, Piyaskulkaew C, Chuntarapas T, et al. Dynamic radiographic criteria for detecting pseudarthrosis following anterior cervical arthrodesis. Journal of Bone & Joint Surgery - American Volume. 2014;96(7):557-63. doi: 10.2106/JBJS.M.00167. PMID: 24695922.

117. Suri A, Chabbra RP, Mehta VS, et al. Effect of intramedullary signal changes on the surgical outcome of patients with cervical spondylotic myelopathy. Spine Journal: Official Journal of the North American Spine Society. 2003;3(1):33-45. doi: 10.1016/s1529-9430(02)00448-5. PMID: 14589243.

118. Uchida K, Nakajima H, Takeura N, et al. Prognostic value of changes in spinal cord signal intensity on magnetic resonance imaging in patients with cervical compressive myelopathy. Spine Journal: Official Journal of the North American Spine Society. 2014;14(8):1601-10. doi: 10.1016/j.spinee.2013.09.038. PMID: 24411833.

119. Uehara T, Tsushima E, Yamada S, et al. A randomized controlled trial for the intervention effect of early exercise therapy on axial pain after cervical laminoplasty. Spine surgery and related research. 2022;6(2):123-32. doi: 10.22603/SSRR.2021-0110.

120. Vaccaro A, Beutler W, Peppelman W, et al. Long-term clinical experience with selectively constrained SECURE-C cervical artificial disc for 1-level cervical disc disease: results from seven-year follow-up of a prospective, randomized, controlled investigational device exemption clinical trial. International Journal of Spine Surgery. 2018;12(3):377-87. doi: 10.14444/5044. PMID: 30276095.

121. Vaccaro A, Beutler W, Peppelman W, et al. Clinical outcomes with selectively constrained SECURE-C cervical disc arthroplasty: two-year results from a prospective, randomized, controlled, multicenter investigational device exemption study. Spine. 2013;38(26):2227-39. doi: 10.1097/BRS.0000000000000031. PMID: 24335629.

122. Vedantam A, Rajshekhar V. Does the type of T2-weighted hyperintensity influence surgical outcome in patients with cervical spondylotic myelopathy? A review. European Spine Journal. 2013;22(1):96-106. doi: 10.1007/s00586-012-2483-9. PMID: 22926434.

123. Wadhwa H, Sharma J, Varshneya K, et al. Anterior cervical discectomy and fusion versus laminoplasty for multilevel cervical spondylotic myelopathy: A national administrative database analysis. World Neurosurgery. 2021;152:e738-e44. doi: 10.1016/j.wneu.2021.06.064. PMID: 34153482.

124. Wang K, Chen Z, Zhang F, et al. Evaluation of DTI parameter ratios and diffusion tensor tractography grading in the diagnosis and prognosis prediction of cervical spondylotic myelopathy. Spine (Phila Pa 1976). 2017;42(4):E202-e10. doi: 10.1097/brs.0000000000001784. PMID: 28207659.

125. Wirth FP, Dowd GC, Sanders HF, et al. Cervical discectomy. A prospective analysis of three operative techniques. Surg Neurol. 2000;53(4):340-6; discussion 6-8. doi: 10.1016/s0090-3019(00)00201-9. PMID: 10825519.

126. Witiw CD, Smieliauskas F, O'Toole JE, et al. Comparison of anterior cervical discectomy and fusion to posterior cervical foraminotomy for cervical radiculopathy: utilization, costs, and adverse events 2003 to 2014. Neurosurgery. 2019;84(2):413-20. doi: 10.1093/neuros/nyy051. PMID: 29548034.

127. Woods BI, Hohl J, Lee J, et al. Laminoplasty versus laminectomy and fusion for multilevel cervical spondylotic myelopathy. Clinical Orthopaedics & Related Research. 2011;469(3):688-95. doi: 10.1007/s11999-010-1653-5. PMID: 21089002.

128. Xie Y, Li H, Yuan J, et al. A prospective randomized comparison of PEEK cage containing calcium sulphate or demineralized bone matrix with autograft in anterior cervical interbody fusion. International Orthopaedics. 2015;39(6):1129-36. doi: 10.1007/s00264-014-2610-9. PMID: 25432324.

129. Yang W, Si M, Hou Y, et al. Superiority of 2-level total disk replacement using a cervical disk prosthesis versus anterior cervical diskectomy and fusion. Orthopedics. 2018;41(6):344-50. doi: 10.3928/01477447-20180815-01. PMID: 30125034.

130. Yi J, Lee GW, Nam WD, et al. A prospective randomized clinical trial comparing bone union rate following anterior cervical discectomy and fusion using a polyetheretherketone cage: hydroxyapatite/b-tricalcium phosphate mixture versus hydroxyapatite/demineralized bone matrix mixture. Asian Spine Journal. 2015;9(1):30-8. doi: 10.4184/asj.2015.9.1.30. PMID: 25705332.

131. Yin LQ, Zhang J, Wu YG, et al. Increased signal intensity of spinal cord on T2W magnetic resonance imaging for cervical spondylotic myelopathy patients: Risk factors and prognosis (a STROBE-compliant article). Medicine. 2020;99(49):e23098. doi: 10.1097/MD.0000000000023098. PMID: 33285685.

132. Zavras AG, Nolte MT, Sayari AJ, et al. Stand-alone cage versus anterior plating for 1-level and 2-level anterior cervical discectomy and fusion: a randomized controlled trial. Clinical Spine Surgery : A Spine Publication. 2022;35(4):155-65. doi: 10.1097/BSD.0000000000001332. PMID: 35394961.

133. Zhang B, Jiang YZ, Song QP, et al. Outcomes of cervical degenerative disc disease treated by anterior cervical discectomy and fusion with self-locking fusion cage. World Journal of Clinical Cases. 2022;10(15):4776-84. doi: 10.12998/wjcc.v10.i15.4776. PMID: 35801046.

134. Zhang HX, Shao YD, Chen Y, et al. A prospective, randomised, controlled multicentre study comparing cervical disc replacement with anterior cervical decompression and fusion. Int Orthop. 2014;38(12):2533-41. doi: 10.1007/s00264-014-2497-5. PMID: 25209344.

135. Zhang JK, Jayasekera D, Javeed S, et al. Diffusion basis spectrum imaging predicts long-term clinical outcomes following surgery in cervical spondylotic myelopathy. Spine J. 2022 Apr;23(4):504-12. doi: 10.1016/j.spinee.2022.12.003. PMID: 36509379.

136. Zhang JK, Sun P, Jayasekera D, et al. Utility of diffusion basis spectrum imaging in quantifying baseline disease severity and prognosis of cervical spondylotic myelopathy. Spine (Phila Pa 1976). 2022 Dec 15;47(24):1687-93. doi: 10.1097/BRS.0000000000004456. PMID: 35969006.

137. Zhang JT, Meng FT, Wang S, et al. Predictors of surgical outcome in cervical spondylotic myelopathy: focusing on the quantitative signal intensity. European Spine Journal. 2015;24(12):2941-5. doi: 10.1007/s00586-015-4109-5. PMID: 26155898.

138. Zhang MZ, Ou-Yang HQ, Liu JF, et al. Predicting postoperative recovery in cervical spondylotic myelopathy: construction and interpretation of T2*-weighted radiomic-based extra trees models. Eur Radiol. 2022 May;32(5):3565-75. doi: 10.1007/s00330-021-08383-x. PMID: 35024949.

139. Zhang P, Shen Y, Zhang YZ, et al. Significance of increased signal intensity on MRI in prognosis after surgical intervention for cervical spondylotic myelopathy. Journal of Clinical Neuroscience. 2011;18(8):1080-3. doi: 10.1016/j.jocn.2010.12.023. PMID: 21696960.

140. Zhang X, Zhang X, Chen C, et al. Randomized, controlled, multicenter, clinical trial comparing BRYAN cervical disc arthroplasty with anterior cervical decompression and fusion in China. Spine (Phila Pa 1976). 2012;37(6):433-8. doi: 10.1097/BRS.0b013e31822699fa. PMID: 21673620.

141. Zhou J, Li J, Lin H, et al. Could self-locking stand-alone cage reduce adjacent-level ossification development after aneterior cervical discectomy and fusion? Journal of Clinical Neuroscience. 2020;78:60-6. doi: 10.1016/j.jocn.2020.06.014. PMID: 32624365.

142. Zigler JE, Delamarter R, Murrey D, et al. ProDisc-C and anterior cervical discectomy and fusion as surgical treatment for single-level cervical symptomatic degenerative disc disease: five-year results of a Food and Drug Administration study. Spine. 2013;38(3):203-9. doi: 10.1097/BRS.0b013e318278eb38. PMID: 23080427.

Appendix C. Evidence Tables

Please see the Excel file, located at https://effectivehealthcare.ahrq.gov/products/cervical-degenerative-disease/research.

Appendix D. Risk of Bias Assessment

D1.1 Risk of Bias Assessment Methods

Based on the risk of bias assessment, included studies were rated as having "low," "moderate," or "high" risk of bias. Studies rated high risk of bias were not excluded a priori, but were considered to be less reliable than low or moderate risk of bias studies when synthesizing the evidence.

Table D-1. Criteria for grading the risk of bias of individual studies

Rating	Description and Criteria
Low	Least risk of bias, results generally considered valid Employ valid methods for selection, inclusion, and allocation of patients to treatment; report similar baseline characteristics in different treatment groups; clearly describe attrition and have low attrition; use appropriate means for preventing bias (e.g., blinding of patients, care providers, and outcomes assessors); and use appropriate analytic methods (e.g., intention-to-treat analysis)
Moderate	Susceptible to some bias but not enough to necessarily invalidate results May not meet all criteria for low risk of bias, but no flaw is likely to cause major bias; the study may be missing information making it difficult to assess limitations and potential problems Category is broad; studies with this rating will vary in strengths and weaknesses; some studies rated moderate risk of bias are likely to be valid, while others may be only possibly valid
High	Significant flaws that imply biases of various kinds that may invalidate results; "fatal flaws" in design, analysis or reporting; large amounts of missing information; discrepancies in reporting; or serious problems with intervention delivery Studies are at least as likely to reflect flaws in the study design or execution as the true difference between the compared interventions Considered to be less reliable than studies rated moderate or low risk of bias when synthesizing the evidence, particularly if discrepancies between studies are present

Table 2 is taken from the Cervical Degenerative Disease Protocol, published online at https://effectivehealthcare.ahrq.gov/sites/default/files/product/pdf/cervical-degenerative-protocol.pdf

D2.1 Risk of Bias Tables

Please see the Excel file for Risk of Bias assessments, located at https://effectivehealthcare.ahrq.gov/products/cervical-degenerative-disease/research.

Appendix E. List of Excluded Studies

Exclusion codes: E1 = Ineligible population; E2 = Ineligible or no intervention; E3 = Ineligible or no comparison; E4 = Ineligible or no outcome; E5 = Ineligible study design; E6 = Ineligible publication type; E7 = Ineligible sample size; E8 = Systematic review, secondary analysis, or meta-analysis used as a source document only to identify individual studies; E9 = Article or systematic review covered by a more recent systematic review; E10 = Foreign Language; E11 = Cohort study, no confounding adjustment; E12 = Key Question with sufficient RCT evidence, observational study not needed

1. Aarabi B, Koltz M, Ibrahimi D. Hyperextension cervical spine injuries and traumatic central cord syndrome. Neurosurg. 2008;25(5):E9. doi: 10.3171/FOC.2008.25.11.E9. PMID: 18980483. Exclusion: E1.
2. Abbas S, Spurgas M, Szewczyk B, et al. A comparison of minimally invasive posterior cervical decompression and open anterior cervical decompression and instrumented fusion in the surgical management of degenerative cervical myelopathy. Neurosurg Focus. 2016 Jun;40(6):E7. doi: 10.3171/2016.3.FOCUS1650. PMID: 27246490. Exclusion: E11.
3. Abd-Alrahman N, Dokmak AS, Abou-Madawi A. Anterior cervical discectomy (ACD) versus anterior cervical fusion (ACF), clinical and radiological outcome study. Acta Neurochir (Wien). 1999;141(10):1089-92. doi: 10.1007/s007010050487. PMID: 10550654. Exclusion: E3.
4. Abudouaini H, Wu T, Liu H, et al. Comparison of the postoperative motion stabilization between anterior cervical decompression and fusion with a zero-profile implant system and a plate-cage construct. World Neurosurg. 2022 Oct;166:e484-e94. doi: 10.1016/j.wneu.2022.07.033. PMID: 35843577. Exclusion: E11.
5. Adamson TE. Microendoscopic posterior cervical laminoforaminotomy for unilateral radiculopathy: results of a new technique in 100 cases. J Neurosurg. 2001 Jul;95(1 Suppl):51-7. doi: 10.3171/spi.2001.95.1.0051. PMID: 11453432. Exclusion: E5.
6. Ahmed AF, Al Dosari MAA, Al Kuwari A, et al. The outcomes of stand alone polyetheretherketone cages in anterior cervical discectomy and fusion. Int Orthop. 2021 01;45(1):173-80. doi: 10.1007/s00264-020-04760-1. PMID: 32803359. Exclusion: E6.
7. Ahmed OEF, Galal A. Single level anterior cervical discectomy and fusion versus dynamic cervical implant: clinical and radiological outcome. Egyptian Journal of Neurology, Psychiatry and Neurosurgery. 2020;56(1) doi: 10.1186/s41983-020-0153-0. Exclusion: E7.
8. Ahn JS, Lee JK, Kim JH. Comparative study of clinical outcomes of anterior cervical discectomy and fusion using autobone graft or cage with bone substitute. Asian spine j. 2011 Sep;5(3):169-75. doi: 10.4184/asj.2011.5.3.169. PMID: 21892389. Exclusion: E11.
9. Ahn PG, Kim KN, Moon SW, et al. Changes in cervical range of motion and sagittal alignment in early and late phases after total disc replacement: radiographic follow-up exceeding 2 years. J Neurosurg Spine. 2009 Dec;11(6):688-95. doi: 10.3171/2009.7.SPINE0946. PMID: 19951021. Exclusion: E7.
10. Ahn SS, Paik HK, Chin DK, et al. The fate of adjacent segments after anterior cervical discectomy and fusion: The influence of an anterior plate system. World Neurosurg. 2016 May;89:42-50. doi: 10.1016/j.wneu.2016.01.013. PMID: 26828457. Exclusion: E11.

11. Ahn SS, So WS, Ku MG, et al. Radiologic findings and risk factors of adjacent segment degeneration after anterior cervical discectomy and fusion : a retrospective matched cohort study with 3-year follow-up using MRI. J. 2016 Mar;59(2):129-36. doi: 10.3340/jkns.2016.59.2.129. PMID: 26962418. Exclusion: E3.

12. Ahn Y. The current state of cervical endoscopic spine surgery: an updated literature review and technical considerations. Expert Rev Med Devices. 2020 Dec;17(12):1285-92. doi: 10.1080/17434440.2020.1853523. PMID: 33210554. Exclusion: E8.

13. Ahsan MK, Awwal MA, Khan SI, et al. Open-door laminoplasty for multilevel cervical spondylotic myelopathy and ossification of the posterior longitudinal ligament (OPLL) using titanium reconstruction miniplate and screws. Mymensingh Med J. 2017 07;26(3):558-68. PMID: 28919610. Exclusion: E7.

14. Ajiboye RM, Zoller SD, Ashana AA, et al. Regression of disc-osteophyte complexes following laminoplasty versus laminectomy with fusion for cervical spondylotic myelopathy. Int J Spine Surg. 2017 ISASS (E-mail: info@ISASS;11(3):129-37p. doi: 10.14444/4017. Exclusion: E4.

15. Akbari KK, Badikillaya V, Venkatesan M, et al. Do intraoperative neurophysiological changes during decompressive surgery for cervical myeloradiculopathy affect functional outcome? A prospective study. Global spine j. 2022 Apr;12(3):366-72. doi: 10.1177/2192568220951779. PMID: 32959684. Exclusion: E7.

16. Al Barbarawi MM, Audat ZA, Obeidat MM, et al. Decompressive cervical laminectomy and lateral mass screw-rod arthrodesis. Surgical analysis and outcome. Scoliosis. 2011 May 19;6:10. doi: 10.1186/1748-7161-6-10. PMID: 21595968. Exclusion: E3.

17. Al Eissa S, Konbaz F, Aldeghaither S, et al. Anterior cervical discectomy and fusion complications and thirty-day mortality and morbidity. Cureus. 2020 Apr 12;12(4):e7643. doi: 10.7759/cureus.7643. PMID: 32411545. Exclusion: E5.

18. Alafifi T, Kern R, Fehlings M. Clinical and MRI predictors of outcome after surgical intervention for cervical spondylotic myelopathy. J Neuroimaging. 2007 Oct;17(4):315-22. doi: 10.1111/j.1552-6569.2007.00119.x. PMID: 17894620. Exclusion: E11.

19. Albert TJ. CORR Insights(R): reoperation after cervical disc arthroplasty versus anterior cervical discectomy and fusion: a meta-analysis. Clin Orthop. 2016 May;474(5):1317-8. doi: 10.1007/s11999-016-4753-z. PMID: 26906011. Exclusion: E6.

20. Albert TJ, Coric D, Kim HJ, et al. Clinical obesity in total disc replacement and anterior cervical discectomy and fusion patients through five years follow-up. Spine. 2015:146-9. Exclusion: E1.

21. Albert TJ, Pinto M, Smith MD, et al. Accuracy of SPECT scanning in diagnosing pseudoarthrosis: a prospective study. J Spinal Disord. 1998 Jun;11(3):197-9. PMID: 9657542. Exclusion: E7.

22. Alhashash M, Boehm H, Shousha M. Management of symptomatic cervical spine pseudarthrosis: a suggested algorithm for surgical planning. Int J Spine Surg. 2021 Dec;15(6):1167-73. doi: 10.14444/8148. PMID: 35086874. Exclusion: E11.

23. Alimi M, Njoku I, Hofstetter CP, et al. Anterior Cervical Discectomy and Fusion (ACDF): comparison between zero profile implants and anterior cervical plate and spacer. Cureus. 2016 Apr 17;8(4):e573. doi: 10.7759/cureus.573. PMID: 27200226. Exclusion: E5.

24. Alluri RK, Vaishnav AS, Fourman MS, et al. Anterior cervical discectomy and fusion versus cervical disc replacement in patients with significant cervical spondylosis. Clin Spine Surg. 2022 03 01;35(2):E327-E32. doi: 10.1097/BSD.0000000000001250. PMID: 35213422. Exclusion: E12.

25. Almeida ND, Lee R, Wei C, et al. Coagulation profile as a significant risk factor for short-term complications and mortality after anterior cervical discectomy and fusion. World Neurosurg. 2021 04;148:e74-e86. doi: 10.1016/j.wneu.2020.12.007. PMID: 33307267. Exclusion: E5.

26. Alomar SA, Maghrabi Y, Baeesa SS, et al. Outcome of anterior and posterior endoscopic procedures for cervical radiculopathy due to degenerative disk disease: a systematic review and meta-analysis. Global spine j. 2021;12(7):1546-60. doi: 10.1177/21925682211037270. PMID: 34402323. Exclusion: E5.

27. Alomari S, Liu A, Westbroek E, et al. Effect of patient's sex on early perioperative outcomes following anterior cervical discectomy and fusion. J Clin Neurosci. 2021 Nov;93:247-52. doi: 10.1016/j.jocn.2021.09.015. PMID: 34656256. Exclusion: E3.

28. Alonso F, Rustagi T, Schmidt C, et al. Failure patterns in standalone anterior cervical discectomy and fusion implants. World Neurosurg. 2017 Dec;108:676-82. doi: 10.1016/j.wneu.2017.09.071. PMID: 28942019. Exclusion: E5.

29. Alosh H, Riley LH, 3rd, Skolasky RL. Insurance status, geography, race, and ethnicity as predictors of anterior cervical spine surgery rates and in-hospital mortality: an examination of United States trends from 1992 to 2005. Spine. 2009 Aug 15;34(18):1956-62. doi: 10.1097/BRS.0b013e3181ab930e. PMID: 19652634. Exclusion: E6.

30. Ament JD, Karnati T, Kulubya E, et al. Treatment of cervical radiculopathy: a review of the evolution and economics. Surg Neurol Int. 2018;9:35. doi: 10.4103/sni.sni_441_17. PMID: 29527393. Exclusion: E8.

31. Ament JD, Yang Z, Chen Y, et al. A novel quality-of-life utility index in patients with multilevel cervical degenerative disc disease: comparison of anterior cervical discectomy and fusion with total disc replacement. Spine. 2015 Jul 15;40(14):1072-8. doi: 10.1097/BRS.0000000000000898. PMID: 25811263. Exclusion: E4.

32. Ament JD, Yang Z, Nunley PD, et al. Cost utility analysis of the cervical artificial disc vs. fusion for the treatment of two-level symptomatic degenerative disc disease: five-year follow-up. Spine. 2015:110-2. Exclusion: E6.

33. An HS, Al-Shihabi L, Kurd M. Surgical treatment for ossification of the posterior longitudinal ligament in the cervical spine. J Am Acad Orthop Surg. 2014 Jul;22(7):420-9. doi: 10.5435/JAAOS-22-07-420. PMID: 24966248. Exclusion: E6.

34. An HS, Simpson JM, Glover JM, et al. Comparison between allograft plus demineralized bone matrix versus autograft in anterior cervical fusion. A prospective multicenter study. Spine (Phila Pa 1976). 1995 Oct 15;20(20):2211-6. PMID: 8545714. Exclusion: E7.

35. Anakwenze OA, Auerbach JD, Milby AH, et al. Sagittal cervical alignment after cervical disc arthroplasty and anterior cervical discectomy and fusion: results of a prospective, randomized, controlled trial. Spine. 2009 Sep 01;34(19):2001-7. doi: 10.1097/BRS.0b013e3181b03fe6. PMID: 19730207. Exclusion: E4.

36. Anderson PA, Matz PG, Groff MW, et al. Laminectomy and fusion for the treatment of cervical degenerative myelopathy. J Neurosurg Spine. 2009 Aug;11(2):150-6. doi: 10.3171/2009.2.SPINE08727. PMID: 19769494. Exclusion: E6 - background.

37. Anderson PA, Nassr A, Currier BL, et al. Evaluation of adverse events in total disc replacement: a meta-analysis of FDA summary of safety and effectiveness data. Global spine j. 2017 Apr;7(1 Suppl):76S-83S. doi: 10.1177/2192568216688195. PMID: 28451497. Exclusion: E8.

38. Anderson PA, Puschak TJ, Sasso RC. Comparison of short-term SF-36 results between total joint arthroplasty and cervical spine decompression and fusion or arthroplasty. Spine. 2009 Jan 15;34(2):176-83. doi: 10.1097/BRS.0b013e3181913cba. PMID: 19139668. Exclusion: E3.

39. Anderson PA, Sasso RC, Rouleau JP, et al. The Bryan Cervical Disc: wear properties and early clinical results. Spine J. 2004 Nov-Dec;4(6 Suppl):303S-9S. doi: 10.1016/j.spinee.2004.07.026. PMID: 15541681. Exclusion: E3.

40. Anderson-Smits C, Sing D, Dmitriev A, et al. A comparative analysis of secondary surgeries of six total cervical disc arthroplasty devices to cervical arthrodesis at 5-years. Pharmacoepidemiology and drug safety. 2016;25(64):2016-08. doi: 10.1002/pds.4070. Exclusion: E6.

41. Ando M, Tamaki T, Matsumoto T, et al. Can postoperative deltoid weakness after cervical laminoplasty be prevented by using intraoperative neurophysiological monitoring? J Clin Monit Comput. 2019 Feb;33(1):123-32. doi: 10.1007/s10877-018-0141-4. PMID: 29667095. Exclusion: E2.

42. Angevine PD. Comment: a prospective, randomized trial comparing expansile cervical laminoplasty and cervical laminectomy and fusion for multilevel cervical myelopathy. Clin Neurosurg. 2012 United States Oxford University Press (E-mail: agents@lww;70(2):277p. doi: 10.1227/NEU.0b013e3182305669. Exclusion: E6.

43. Anonymous. Corrigendum to: "Surgery for Degenerative Cervical Myelopathy: a Nationwide Registry-Based Observational Study With Patient-Reported Outcomes" by Sasha Gulati, MD, PhD, Vetle Vangen-Lonne, MS, Oystein P Nygaard, MD, PhD, Agnete M Gulati, MD, PhD, Tommy A Hammer, MD, Tonje O Johansen, MD, Wilco C Peul, MD, PhD, Oyvind O Salvesen, MSc, PhD, Tore K Solberg, MD, PhD. Neurosurgery, nyab259, https://doi.org/10.1093/neuros/nyab259. Neurosurgery. 2021 Oct 13;89(5):943. doi: 10.1093/neuros/nyab334. PMID: 34432876. Exclusion: E5.

44. Aragones M, Hevia E, Barrios C. Polyurethane on titanium unconstrained disc arthroplasty versus anterior discectomy and fusion for the treatment of cervical disc disease: a review of level I-II randomized clinical trials including clinical outcomes. Eur Spine J. 2015 Dec;24(12):2735-45. doi: 10.1007/s00586-015-4228-z. PMID: 26363559. Exclusion: E8.

45. Arnasson O, Carlsson CA, Pellettieri L. Surgical and conservative treatment of cervical spondylotic radiculopathy and myelopathy. Acta Neurochir (Wien). 1987;84(1-2):48-53. doi: 10.1007/bf01456351. PMID: 3030063. Exclusion: E11.

46. Arnold PM, Anderson KK, Foley KT. Heterotopic ossification following single-level anterior cervical discectomy and fusion: results from a prospective, multicenter, historically-controlled trial comparing allograft to an optimized dose of rhBMP-2. Spine journal. 2015 Netherlands Elsevier Inc;Conference: 30th annual meeting of the north american spine society, NASS. Vol.15(10 Supplement 1):180Sp. doi: 10.1016/j.spinee.2015.07.224. Exclusion: E6.

47. Arnold PM, Kopjar B, Tetreault L, et al. Tobacco smoking and outcomes of surgical decompression in patients with symptomatic degenerative cervical spondylotic myelopathy. Clinical neurosurgery. Conference. 2016;63(165) doi: 10.1227/01.neu.0000489731.76982.a4. Exclusion: E6.

48. Arnold PM, Sasso R, Janssen M, et al. Efficacy of i-FactorTM bone graft versus autograft in ACDF: prospective randomized FDA IDE study results. J Neurosurg. 2016 to 2016-05-04;124(4):A1209-p. doi: 10.3171/2016.4.JNS.AANS2016abstracts. Exclusion: E6 - conference abstract.

49. Arnold PM, Sasso RC, Janssen ME, et al. I-factor™ bone graft versus autograft in anterior cervical discectomy and fusion: two-year follow-up of the randomized single-blinded food and drug administration investigational device exemption study. Spine journal. 2016 to 2016-10-29;16(10):S153-S4p. doi: 10.1016/j.spinee.2016.07.051. Exclusion: E6.

50. Arnold PM, Sasso RC, Janssen ME, et al. I-Factor™ bone graft vs. autograft in anterior cervical discectomy and fusion: two-year follow-up of the randomized single-blinded food and drug administration investigational device exemption study. Spine. 2016(366):2016-12. Exclusion: E6.

51. Arts MP, Wolfs JF, Corbin TP. The CASCADE trial: effectiveness of ceramic versus PEEK cages for anterior cervical discectomy with interbody fusion; protocol of a blinded randomized controlled trial. BMC Musculoskelet Disord. 2013 Aug 16;14:244. doi: 10.1186/1471-2474-14-244. PMID: 23947902. Exclusion: E6.

52. Arts MP, Wolfs JFC, Corbin TP. Porous silicon nitride spacers versus PEEK cages for anterior cervical discectomy and fusion: clinical and radiological results of a single-blinded randomized controlled trial. Eur Spine J. 2017 Sep;26(9):2372-9. doi: 10.1007/s00586-017-5079-6. PMID: 28382392. Exclusion: E3.

53. Arvin B, Kalsi-Ryan S, Karpova A, et al. Postoperative magnetic resonance imaging can predict neurological recovery after surgery for cervical spondylotic myelopathy: a prospective study with blinded assessments. Neurosurgery. 2011 Aug;69(2):362-8. doi: 10.1227/NEU.0b013e31821a418c. PMID: 21471834. Exclusion: E2.

54. Arvin B, Kalsi-Ryan S, Mercier D, et al. Preoperative magnetic resonance imaging is associated with baseline neurological status and can predict postoperative recovery in patients with cervical spondylotic myelopathy. Spine. 2013 Jun 15;38(14):1170-6. doi: 10.1097/BRS.0b013e31828e23a8. PMID: 23462574. Exclusion: E11.

55. Asgari S, Bassiouni H, Massoud N, et al. Decompressive laminoplasty in multisegmental cervical spondylotic myelopathy: bilateral cutting versus open-door technique. Acta Neurochir (Wien). 2009;151(7):739-49p. doi: 10.1007/s00701-009-0343-0. PMID: 19436951. Exclusion: E7.

56. Ashana AO, Ajiboye RM, Sheppard WL, et al. Cervical paraspinal muscle atrophy rates following laminoplasty and laminectomy with fusion for cervical spondylotic myelopathy. World Neurosurg. 2017 Nov;107:445-50. doi: 10.1016/j.wneu.2017.07.173. PMID: 28790004. Exclusion: E4.

57. Astur N, Martins DE, Kanas M, et al. Quality assessment of systematic reviews of surgical treatment of cervical spine degenerative diseases: an overview. Einstein. 2022;20:eAO6567. doi: 10.31744/einstein_journal/2022AO6567. PMID: 35476082. Exclusion: E5.

58. Auerbach JD, Anakwenze OA, Milby AH, et al. Segmental contribution toward total cervical range of motion: a comparison of cervical disc arthroplasty and fusion. Spine. 2011 Dec 01;36(25):E1593-9. doi: 10.1097/BRS.0b013e31821cfd47. PMID: 21508886. Exclusion: E4.

59. Ayan S, Cho W, Shein D, et al. Adjacent segment level ossific disease after ACDF: comparative study between stand-alone anterior cervical interbody fusion (SAACIF) device and conventional plating. Spine journal. 2015 to 2015-10-17;15(10):237S-8Sp. doi: 10.1016/j.spinee.2015.07.352. Exclusion: E6.

60. Aydin Y, Cavusoglu H, Yuce I, et al. A prospective study of interbody fat graft application with the anterior contralateral cervical microdiscectomy to preserve segmental mobility. Neurosurgery. 2017 Oct 01;81(4):627-37. doi: 10.1093/neuros/nyx056. PMID: 28368476. Exclusion: E11.

61. Aydin Y, Kaya RA, Can SM, et al. Minimally invasive anterior contralateral approach for the treatment of cervical disc herniation. Surg Neurol. 2005 Mar;63(3):210-8; discussion 8-9. doi: 10.1016/j.surneu.2004.07.001. PMID: 15734502. Exclusion: E5.

62. Ayoub C, Zreik T, Sawaya R, et al. Significance and cost-effectiveness of somatosensory evoked potential monitoring in cervical spine surgery. Neurol India. 2010 May-Jun;58(3):424-8. doi: 10.4103/0028-3886.66454. PMID: 20644272. Exclusion: E5.

63. Badhiwala J, Khan O, Wegner A, et al. A partial least squares analysis of functional status, disability, and quality of life after surgical decompression for degenerative cervical myelopathy. Sci Rep. 2020 Sep 30;10(1):16132. doi: 10.1038/s41598-020-72595-2. PMID: 32999299. Exclusion: E5.

64. Badhiwala JH, Ahuja CS, Akbar MA, et al. Degenerative cervical myelopathy - update and future directions. Nat Rev Neurol. 2020 02;16(2):108-24. doi: 10.1038/s41582-019-0303-0. PMID: 31974455. Exclusion: E4.

65. Badhiwala JH, Leung SN, Ellenbogen Y, et al. A comparison of the perioperative outcomes of anterior surgical techniques for the treatment of multilevel degenerative cervical myelopathy. J Neurosurg Spine. 2020 Jun 12;33(4):1-8. doi: 10.3171/2020.4.SPINE191094. PMID: 32534484. Exclusion: E4.

66. Badhiwala JH, Platt A, Witiw CD, et al. Cervical disc arthroplasty versus anterior cervical discectomy and fusion: a meta-analysis of rates of adjacent-level surgery to 7-year follow-up. J. 2020 Mar;6(1):217-32. doi: 10.21037/jss.2019.12.09. PMID: 32309660. Exclusion: E8.

67. Badhiwala JH, Witiw CD, Nassiri F, et al. Efficacy and safety of surgery for mild degenerative cervical myelopathy: Results of the aospine north america and international prospective multicenter studies. Neurosurgery. 2019 04 01;84(4):890-7. doi: 10.1093/neuros/nyy133. PMID: 29684181. Exclusion: E3.

68. Badiee RK, Mayer R, Pennicooke B, et al. Complications following posterior cervical decompression and fusion: a review of incidence, risk factors, and prevention strategies. J. 2020 Mar;6(1):323-33. doi: 10.21037/jss.2019.11.01. PMID: 32309669. Exclusion: E8.

69. Badran A, Davies BM, Bailey HM, et al. Is there a role for postoperative physiotherapy in degenerative cervical myelopathy? A systematic review. Clin Rehabil. 2018 Sep;32(9):1169-74. doi: 10.1177/0269215518766229. PMID: 29663830. Exclusion: E8.

70. Badve SA, Kurra S, Nunley PD, et al. The Mobi-C R cervical disc and other devices for two-level disc replacement: overview of its safety and efficacy. Expert Rev Med Devices. 2019 04;16(4):307-15. doi: 10.1080/17434440.2019.1593137. PMID: 30907183. Exclusion: E3.

71. Badve SA, Nunley PD, Kurra S, et al. Review of long-term outcomes of disc arthroplasty for symptomatic single level cervical degenerative disc disease. Expert Rev Med Devices. 2018 03;15(3):205-17. doi: 10.1080/17434440.2018.1433533. PMID: 29378457. Exclusion: E8.

72. Bae HW, Davis RJ, Hisey MS, et al. Cervical total disc replacement and anterior cervical discectomy and fusion: a comparison of one-and two-level treatment. Spine journal. 2014 START: 2014 Nov 12 CONFERENCE END: 2014 Nov 15 29th Annual Meeting of the North American Spine Society, NASS 2014 San Francisco, CA United States;14(11 SUPPL. 1):S41p. doi: 10.1016/j.spinee.2014.08.109. Exclusion: E6.

73. Bae HW, Davis RJ, Hisey MS, et al. Comparing one-level versus two-level cervical TDR and one-level versus two-level ACDF at seven-year follow-up. Spine journal. 2016 to 2016-10-29;16(10):S203-S4p. doi: 10.1016/j.spinee.2016.07.112. Exclusion: E6.

74. Bae HW, Kim KD, Nunley PD, et al. Comparison of Clinical Outcomes of 1- and 2-Level Total Disc Replacement: Four-Year Results From a Prospective, Randomized, Controlled, Multicenter IDE Clinical Trial. Spine. 2015 Jun 01;40(11):759-66. doi: 10.1097/BRS.0000000000000887. PMID: 25785955. Exclusion: E3.

75. Bae HW, Lotuaco R, Kanim LEA, et al. Mobi-C cervical disc replacement for the treatment of one and two-level cervical degenerative disc disease: One-site analysis participating in the US FDA trial. Spine journal. 2010;Vol.Conference: 25th Annual Meeting of the North American Spine Society, NASS Miami, FL United States. Conference Start: 20101005 Conference End: 20101009. Conference Publication:(10 :(9 SUPPL. 1)):145Sp. doi: 10.1016/j.spinee.2010.07.373. Exclusion: E6.

76. Bai YB, Wang Y, Zhang YG. [Is allograft a procedure with high-risk in anterior cervical fusion]. Chung Hua Liu Hsing Ping Hsueh Tsa Chih. 2004 Jul;25(7):620-2. PMID: 15308046. Exclusion: E10.

77. Baird EO, Egorova NN, McAnany SJ, et al. National trends in outpatient surgical treatment of degenerative cervical spine disease. Global spine j. 2014 Aug;4(3):143-50. doi: 10.1055/s-0034-1376917. PMID: 25083354. Exclusion: E5.

78. Bajamal AH, Kim SH, Arifianto MR, et al. Posterior surgical techniques for cervical spondylotic myelopathy: WFNS Spine Committee recommendations. Neurospine. 2019 09;16(3):421-34. doi: 10.14245/ns.1938274.137. PMID: 31607074. Exclusion: E6.

79. Bakare AA, Kolcun JPG, Piracha AZ, et al. Cervical alignment analysis comparing two-level cervical disc arthroplasty to anterior cervical discectomy and fusion with anterior plate fixation. World Neurosurg. 2022 Jun 26;26:26. doi: 10.1016/j.wneu.2022.06.109. PMID: 35768058. Exclusion: E11.

80. Baker JD, Sayari AJ, Harada GK, et al. The Modic-endplate-complex phenotype in cervical spine patients: association with symptoms and outcomes. J Orthop Res. 2022 Feb;40(2):449-59. doi: 10.1002/jor.25042. PMID: 33749924. Exclusion: E9.

81. Baker JD, Sayari AJ, Tao Y, et al. Endplate abnormalities, Modic changes and their relationship to alignment parameters and surgical outcomes in the cervical spine. J Orthop Res. 2022 Apr 10;41(1):206-14. doi: 10.1002/jor.25333. PMID: 35398932. Exclusion: E4.

82. Baker JF, Gomez J, Shenoy K, et al. A radiographic follow-up study of stand-alone-cage and graft-plate constructs for single-level anterior cervical discectomy and fusion. J. 2017 Dec;3(4):596-600. doi: 10.21037/jss.2017.11.06. PMID: 29354737. Exclusion: E11.

83. Balakumar B, Raju S, Marconi SD, et al. A pragmatic single centre retrospective comparative review of complication profile between PEEK cages and Zero-P cage screw constructs. Br J Neurosurg. 2021 Dec 01:1-7. doi: 10.1080/02688697.2021.2005772. PMID: 34850648. Exclusion: E12.

84. Barber SM, Radaideh M, Parrish R. Efficacy of autogenous bone marrow aspirate as a fusion-promoting adjunct to anterior cervical discectomy and fusion: a single center retrospective cohort study. Cureus. 2018 May 16;10(5):e2636. doi: 10.7759/cureus.2636. PMID: 30034958. Exclusion: E11.

85. Barkley AS, Eaton J, Carroll K, et al. The rare occurrence of reoperation after cervical laminoplasty: a 14-year retrospective review of reoperative rates at a single institution. Clin Spine Surg. 2021 07 01;34(6):E342-E8. doi: 10.1097/BSD.0000000000001142. PMID: 33591023. Exclusion: E3.

86. Bärlocher CB, Barth A, Krauss JK, et al. Comparative evaluation of microdiscectomy only, autograft fusion, polymethylmethacrylate interposition, and threaded titanium cage fusion for treatment of single-level cervical disc disease: a prospective randomized study in 125 patients. Neurosurg Focus. 2002 Jan 15;12(1):E4. doi: 10.3171/foc.2002.12.1.5. PMID: 16212331. Exclusion: E3.

87. Barnes B, Haid R, Rodts G, et al. Early results using the Atlantis anterior cervical plate system. Neurosurg Focus. 2002 Jan 15;12(1):E13. doi: 10.3171/foc.2002.12.1.14. PMID: 16212326. Exclusion: E5.

88. Bartels RH, Groenewoud H, Peul WC, et al. Lamifuse: results of a randomized controlled trial comparing laminectomy with and without fusion for cervical spondylotic myelopathy. J Neurosurg Sci. 2017 Italy Edizioni Minerva Medica (E-mail: subscriptions;61(2):134-9p. doi: 10.23736/S0390-5616.16.03315-4. Exclusion: E2.

89. Bartels RH, van Tulder MW, Moojen WA, et al. Laminoplasty and laminectomy for cervical sponydylotic myelopathy: a systematic review. Eur Spine J. 2015 Apr;24 Suppl 2(Suppl 2):160-7. doi: 10.1007/s00586-013-2771-z. PMID: 23575659. Exclusion: E2.

90. Basaran R, Kaner T. C5 nerve root palsy following decompression of cervical spine with anterior versus posterior types of procedures in patients with cervical myelopathy. Eur Spine J. 2016 07;25(7):2050-9. doi: 10.1007/s00586-016-4567-4. PMID: 27095700. Exclusion: E1.

91. Bashir K, Cai CY, Moore TA, 2nd, et al. Surgery for cervical spinal cord compression in patients with multiple sclerosis. Neurosurgery. 2000 Sep;47(3):637-42; discussion 42-3. doi: 10.1097/00006123-200009000-00022. PMID: 10981751. Exclusion: E7.

92. Basques BA, Ahn J, Markowitz J, et al. Does the duration of cervical radicular symptoms impact outcomes after anterior cervical discectomy and fusion? Clin Spine Surg. 2019 11;32(9):387-91. doi: 10.1097/BSD.0000000000000893. PMID: 31569176. Exclusion: E3.

93. Basques BA, Louie PK, Mormol J, et al. Multi- versus single-level anterior cervical discectomy and fusion: comparing sagittal alignment, early adjacent segment degeneration, and clinical outcomes. Eur Spine J. 2018 11;27(11):2745-53. doi: 10.1007/s00586-018-5677-y. PMID: 29946938. Exclusion: E3.

94. Basu S, Rathinavelu S. A prospective study of clinical and radiological outcomes of zero-profile cage screw implants for single-level anterior cervical discectomy and fusion: is segmental lordosis maintained at 2 years? Asian spine j. 2017 Apr;11(2):264-71. doi: 10.4184/asj.2017.11.2.264. PMID: 28443171. Exclusion: E7.

95. Baucher G, Taskovic J, Troude L, et al. Risk factors for the development of degenerative cervical myelopathy: a review of the literature. Neurosurg Rev. 2022 Apr;45(2):1675-89. doi: 10.1007/s10143-021-01698-9. PMID: 34845577. Exclusion: E5.

96. Beaurain J, Bernard P, Dufour T, et al. Intermediate clinical and radiological results of cervical TDR (Mobi-C) with up to 2 years of follow-up. Eur Spine J. 2009 Jun;18(6):841-50. doi: 10.1007/s00586-009-1017-6. PMID: 19434431. Exclusion: E5.

97. Beaurain J, Dufour T, Radcliff K, et al. Reemergence of symptoms after successful treatment with cervical disc arthroplasty or anterior cervical discectomy and fusion between 2 to 5 years follow up. Eur Spine J. 2016;25:2016-10. doi: 10.1007/s00586-016-4722-y. Exclusion: E6.

98. Beaurain J, Nunley P. Prevalence, progression, and clinical implications of heterotopic ossification after cervical disc arthroplasty at 7 years. Eur Spine J. 2017 to 2017-10-13;26(2):S278-p. doi: 10.1007/s00586-017-5224-2. Exclusion: E6.

99. Bednarík J, Kadanka Z, Vohánka S, et al. The value of somatosensory- and motor-evoked potentials in predicting and monitoring the effect of therapy in spondylotic cervical myelopathy. Prospective randomized study. Spine (Phila Pa 1976). 1999 Aug 1;24(15):1593-8. doi: 10.1097/00007632-199908010-00014. PMID: 10457580. Exclusion: E2.

100. Benek B, Akcay E, Yilmaz H, et al. A comparison of the surgical outcomes of laminoplasty and laminectomy with fusion in the treatment of multilevel cervical spondylotic myelopathy: a retrospective cohort study. Turk. 2021;31(4):530-7. doi: 10.5137/1019-5149.JTN.31386-20.2. PMID: 33759164. Exclusion: E11.

101. Benzel EC, Lancon J, Kesterson L, et al. Cervical laminectomy and dentate ligament section for cervical spondylotic myelopathy. J Spinal Disord. 1991 Sep;4(3):286-95. doi: 10.1097/00002517-199109000-00005. PMID: 1802159. Exclusion: E11.

102. Bergin SM, Wang TY, Park C, et al. Pseudarthrosis rate following anterior cervical discectomy with fusion using an allograft cellular bone matrix: a multi-institutional analysis. Neurosurg. 2021 06;50(6):E6. doi: 10.3171/2021.3.FOCUS2166. PMID: 34062497. Exclusion: E5.

103. Bertagnoli R, Duggal N, Pickett GE, et al. Cervical total disc replacement, part two: clinical results. Orthop Clin North Am. 2005 Jul;36(3):355-62. doi: 10.1016/j.ocl.2005.02.009. PMID: 15950695. Exclusion: E5.

104. Beutler W, Myer J, Baker K. Cervical arthroplasty with the Secure-C cervical artificial disc: a superior option. Spine journal. 2012 START: 2012 Oct 24 CONFERENCE END: 2012 Oct 27 27th Annual Meeting of the North American Spine Society, NASS 2012 Dallas, TX United States;12(9 SUPPL. 1):82S-3Sp. doi: 10.1016/j.spinee.2012.08.233. Exclusion: E6.

105. Beutler W, Volcan IJ, Asdourian PL, et al. Superiority of cervical arthroplasty versus ACDF: seven-year outcomes from the evaluation of the SECURE -c cervical artificial disc. Spine journal. 2016 to 2016-10-29;16(10):S261-p. doi: 10.1016/j.spinee.2016.07.177. Exclusion: E6.

106. Bhadra AK, Raman AS, Casey AT, et al. Single-level cervical radiculopathy: clinical outcome and cost-effectiveness of four techniques of anterior cervical discectomy and fusion and disc arthroplasty. Eur Spine J. 2009 Feb;18(2):232-7. doi: 10.1007/s00586-008-0866-8. PMID: 19132413. Exclusion: E11.

107. Bhaganagare AS, Nagesh SA, Shrihari BG, et al. Management of cervical monoradiculopathy due to prolapsed intervertebral disc, an institutional experience. J Craniovertebr Junction Spine. 2017 Apr-Jun;8(2):132-5. doi: 10.4103/jcvjs.JCVJS_2_17. PMID: 28694597. Exclusion: E1.

108. Bhagavatula I, Bhat D, Sasidharan G, et al. Subclinical respiratory dysfunction in chronic cervical cord compression: a pulmonary function test correlation. Neurosurg Focus. 2016 Jun;40(6):E3. doi: 10.3171/2016.3.FOCUS1647. PMID: 27246486. Exclusion: E2.

109. Bhosale S, Ingale P, Srivastava S, et al. Diffusion tensor imaging as an additional postoperative prognostic predictor factor in cervical myelopathy patients: an observational study. J Craniovertebr Junction Spine. 2019 Jan-Mar;10(1):10-3. doi: 10.4103/jcvjs.JCVJS_77_18. PMID: 31000973. Exclusion: E7.

110. Bishara SN. The posterior operation in treatment of cervical spondylosis with myelopathy: a long-term follow-up study. J Neurol Neurosurg Psychiatry. 1971 Aug;34(4):393-8. doi: 10.1136/jnnp.34.4.393. PMID: 5096553. Exclusion: E5.

111. Bishop RC, Moore KA, Hadley MN. Anterior cervical interbody fusion using autogeneic and allogeneic bone graft substrate: a prospective comparative analysis. J Neurosurg. 1996 Aug;85(2):206-10. doi: 10.3171/jns.1996.85.2.0206. PMID: 8755747. Exclusion: E11.

112. Bivona LJ, Camacho JE, Usmani F, et al. The prevalence of bacterial infection in patients undergoing elective acdf for degenerative cervical spine conditions: a prospective cohort study with contaminant control. Global spine j. 2021 Jan;11(1):13-20. doi: 10.1177/2192568219888179. PMID: 32875844. Exclusion: E4.

113. Blumenthal SL, Hisey MS, Bae HW, et al. Comparison of one-and two-level treatment with cervical disc arthroplasty or anterior cervical discectomy and fusion through five-year follow-up. Spine. 2015:116-7. Exclusion: E6.

114. Blumenthal SL, Ohnmeiss DD, Guyer RD, et al. Reoperations in cervical total disc replacement compared with anterior cervical fusion: results compiled from multiple prospective food and drug administration investigational device exemption trials conducted at a single site. Spine. 2013 Jun 15;38(14):1177-82. doi: 10.1097/BRS.0b013e31828ce774. PMID: 23429685. Exclusion: E9.

115. Boddapati V, Lee NJ, Mathew J, et al. Hybrid anterior cervical discectomy and fusion and cervical disc arthroplasty: an analysis of short-term complications, reoperations, and readmissions. Global spine j. 2021 Oct;11(8):1183-9. doi: 10.1177/2192568220941453. PMID: 32705903. Exclusion: E5.

116. Boer LFR, Zorzetto E, Yeh F, et al. Degenerative cervical disorder-stand-alone cage versus cage and cervical plate: a systematic review. Global spine j. 2021 Mar;11(2):249-55. doi: 10.1177/2192568220906173. PMID: 32875874. Exclusion: E8.

117. Boerger T, Alsouhibani A, Mowforth O, et al. Moving beyond the neck and arm: the pain experience of people with degenerative cervical myelopathy who have pain. Global spine j. 2021 Feb 25;12(7):1434-42. doi: 10.1177/2192568220986143. PMID: 33626937. Exclusion: E5.

118. Bohl DD, Ahn J, Collins M, et al. Functional capacity evaluation following spinal fusion surgery. Spine. 2016 Jul 01;41(13):1104-10. doi: 10.1097/BRS.0000000000001457. PMID: 26780614. Exclusion: E3.

119. Bohl MA, Reece EM, Farrokhi F, et al. Vascularized Bone Grafts for Spinal Fusion-Part 3: The Occiput. Oper Neurosurg (Hagerstown). 2021 Apr 15;20(5):502-7. doi: 10.1093/ons/opab036. PMID: 33609121. Exclusion: E7.

120. Bohlman HH, Emery SE, Goodfellow DB, et al. Robinson anterior cervical discectomy and arthrodesis for cervical radiculopathy. Long-term follow-up of one hundred and twenty-two patients. J Bone Joint Surg Am. 1993 Sep;75(9):1298-307. doi: 10.2106/00004623-199309000-00005. PMID: 8408151. Exclusion: E5.

121. Boselie TF, Willems PC, van Mameren H, et al. Arthroplasty versus fusion in single-level cervical degenerative disc disease. Cochrane Database Syst Rev. 2012 Sep 12(9):CD009173. doi: 10.1002/14651858.CD009173.pub2. PMID: 22972137. Exclusion: E8.

122. Boselie TF, Willems PC, van Mameren H, et al. Arthroplasty versus fusion in single-level cervical degenerative disc disease: a Cochrane review. Spine. 2013 Aug 01;38(17):E1096-107. doi: 10.1097/BRS.0b013e3182994a32. PMID: 23656959. Exclusion: E8.

123. Botelho RV, Moraes OJ, Fernandes GA, et al. A systematic review of randomized trials on the effect of cervical disc arthroplasty on reducing adjacent-level degeneration. Neurosurg. 2010 Jun;28(6):E5. doi: 10.3171/2010.3.FOCUS1032. PMID: 20568920. Exclusion: E9.

124. Bourgonjon B, Duerinck J, Moens M, et al. Comparison of the effect of anterior and posterior neurosurgical treatment for cervical spondylotic myelopathy: a clinical outcome. Acta Neurol Belg. 2019 Dec;119(4):585-93. doi: 10.1007/s13760-019-01184-6. PMID: 31309455. Exclusion: E11.

125. Broekema AEH, Cosijn MCFJ, Koopmans J, et al. Long-term clinical outcome after anterior cervical discectomy with polymethylmethacrylate (PMMA) as intervertebral spacer: a propensity score matched analysis. Interdisciplinary Neurosurgery: advanced Techniques and Case Management. 2022;28 doi: 10.1016/j.inat.2021.101474. Exclusion: E3.

126. Broekema AEH, Groen RJM, Simoes de Souza NF, et al. Surgical interventions for cervical radiculopathy without myelopathy: a systematic review and meta-analysis. J Bone Joint Surg Am. 2020 Dec 16;102(24):2182-96. doi: 10.2106/JBJS.20.00324. PMID: 32842045. Exclusion: E8.

127. Broida SE, Murakami K, Abedi A, et al. Clinical risk factors associated with the development of adjacent segment disease in patients undergoing ACDF: a systematic review. Spine J. 2023 Jan;23(1):146-56. doi: 10.1016/j.spinee.2022.08.011. PMID: 36031098. Exclusion: E4.

128. Brotzki C, Petridis AK, Steiger HJ, et al. Comparison of different hybrid techniques for the treatment of multilevel cervical degenerative disc disease-analysis of prospectively collected clinical, radiologic, and psychological parameters. World Neurosurg. 2020 08;140:e112-e20. doi: 10.1016/j.wneu.2020.04.182. PMID: 32371075. Exclusion: E11.

129. Brown MD, Malinin TI, Davis PB. A roentgenographic evaluation of frozen allografts versus autografts in anterior cervical spine fusions. Clin Orthop Relat Res. 1976 Sep;119(119):231-6. PMID: 782759. Exclusion: E11.

130. Brown NJ, Lien BV, Shahrestani S, et al. Getting down to the bare bones: does laminoplasty or laminectomy with fusion provide better outcomes for patients with multilevel cervical spondylotic myelopathy? Neurospine. 2021 Mar;18(1):45-54. doi: 10.14245/ns.2040520.260. PMID: 33819935. Exclusion: E8.

131. Brusko GD, Perez-Roman RJ, Tapamo H, et al. Preoperative SPECT imaging as a tool for surgical planning in patients with axial neck and back pain. Neurosurg. 2019 12 01;47(6):E19. doi: 10.3171/2019.9.FOCUS19648. PMID: 31786563. Exclusion: E2.

132. Bryman J, Combs K, Kay R, et al. 224. The utility of neuromonitoring in cervical myelopathy patients. Spine Journal. 2020;20(9):S111. doi: 10.1016/j.spinee.2020.05.635. Exclusion: E6.

133. Bucciero A, Vizioli L, Tedeschi G. Cord diameters and their significance in prognostication and decisions about management of cervical spondylotic myelopathy. J Neurosurg Sci. 1993 Dec;37(4):223-8. PMID: 7931646. Exclusion: E7.

134. Buckland AJ, Baker JF, Roach RP, et al. Cervical disc replacement - emerging equivalency to anterior cervical discectomy and fusion. Int Orthop. 2016 Jun;40(6):1329-34. doi: 10.1007/s00264-016-3181-8. PMID: 27055447. Exclusion: E5.

135. Burkhardt BW, Kerolus MG, Witiw CD, et al. Comparison of radiographic parameters after anterior cervical discectomy and fusion with semiconstrained translational versus rotational plate systems. Clin Neurol Neurosurg. 2019 Aug;183:105379. doi: 10.1016/j.clineuro.2019.105379. PMID: 31176235. Exclusion: E3.

136. Burkhardt BW, Kerolus MG, Witiw CD, et al. Anterior cervical discectomy and fusion with a dynamic translational plating versus a rigid carbon fiber reinforced PEEK plating system - a comparison study of radiographic parameters. Br J Neurosurg. 2021 Sep 15:1-5. doi: 10.1080/02688697.2021.1976394. PMID: 34524041. Exclusion: E12.

137. Burkhardt BW, Simgen A, Dehnen M, et al. Is there an impact of cervical plating on the development of adjacent segment degeneration following Smith-Robinson procedure? A magnetic resonance imaging study of 84 patients with a 24-year follow-up. Spine J. 2019 04;19(4):587-96. doi: 10.1016/j.spinee.2018.09.001. PMID: 30195935. Exclusion: E3.

138. Burkhardt JK, Mannion AF, Marbacher S, et al. The influence of cervical plate fixation with either autologous bone or cage insertion on radiographic and patient-rated outcomes after two-level anterior cervical discectomy and fusion. Eur Spine J. 2015 Jan;24(1):113-9. doi: 10.1007/s00586-014-3456-y. PMID: 25011582. Exclusion: E12.

139. Burkus JK, Dryer RF, Arnold PM, et al. Clinical and radiographic outcomes in patients undergoing single-level anterior cervical arthrodesis: a prospective trial comparing allograft to a reduced dose of rhBMP-2. Clin Spine Surg. 2017 Nov;30(9):E1321-E32. doi: 10.1097/BSD.0000000000000409. PMID: 27352370. Exclusion: E3.

140. Burneikiene S, Babuska JM, Ashton A, et al. Prospective randomized double blinded clinical study evaluating the correlation of clinical outcomes and cervical sagittal alignment. Eur Spine J. 2010 START: 2010 May 26 CONFERENCE END: 2010 May 29 CSRS-ES Congress 2010 Kurfu Greece;19(6):1051-2p. doi: 10.1007/s00586-010-1436-4. Exclusion: E6 - conference abstract.

141. Buser Z, Brodke DS, Youssef JA, et al. Synthetic bone graft versus autograft or allograft for spinal fusion: a systematic review. J Neurosurg Spine. 2016 Oct;25(4):509-16. doi: 10.3171/2016.1.SPINE151005. PMID: 27231812. Exclusion: E3.

142. Buttermann GR. Prospective nonrandomized comparison of an allograft with bone morphogenic protein versus an iliac-crest autograft in anterior cervical discectomy and fusion. Spine J. 2008 May-Jun;8(3):426-35. doi: 10.1016/j.spinee.2006.12.006. PMID: 17977799. Exclusion: E11.

143. Buttermann GR. Anterior cervical discectomy and fusion outcomes over 10 years: a prospective study. Spine. 2018 02 01;43(3):207-14. doi: 10.1097/BRS.0000000000002273. PMID: 28604488. Exclusion: E3.

144. Buyuk AF, Onyekwelu I, Gaffney CJ, et al. Symptomatic pseudarthrosis requiring revision surgery after 1- or 2-level ACDF with plating: peek versus allograft. J. 2020 Dec;6(4):670-80. doi: 10.21037/jss-19-419. PMID: 33447669. Exclusion: E11.

145. Bydon M, Macki M, Kaloostian P, et al. Incidence and prognostic factors of c5 palsy: a clinical study of 1001 cases and review of the literature. Neurosurgery. 2014 Jun;74(6):595-604; discussion -5. doi: 10.1227/NEU.0000000000000322. PMID: 24561867. Exclusion: E11.

146. Bydon M, Mathios D, Macki M, et al. Long-term patient outcomes after posterior cervical foraminotomy: an analysis of 151 cases. J Neurosurg Spine. 2014 Nov;21(5):727-31. doi: 10.3171/2014.7.SPINE131110. PMID: 25127430. Exclusion: E3.

147. Bydon M, Xu R, De la Garza-Ramos R, et al. Adjacent segment disease after anterior cervical discectomy and fusion: Incidence and clinical outcomes of patients requiring anterior versus posterior repeat cervical fusion. Surg Neurol Int. 2014;5(Suppl 3):S74-8. doi: 10.4103/2152-7806.130676. PMID: 24843815. Exclusion: E2.

148. Byval'tsev VA, Stepanov IA, Aliev MA, et al. [Comparison of the long-term outcomes of total arthroplasty and anterior spinal fusion in the treatment of cervical degenerative disc disease: a metaanalysis]. Zh Vopr Neirokhir Im N N Burdenko. 2019;83(6):100-10. doi: 10.17116/neiro201983061100. PMID: 32031173. Exclusion: E8.

149. Byvaltsev VA, Stepanov IA, Riew DK. Mid-term to long-term outcomes after total cervical disk arthroplasty compared with anterior diskectomy and fusion: a systematic review and meta-analysis of randomized controlled trials. Clin Spine Surg. 2020 06;33(5):192-200. doi: 10.1097/BSD.0000000000000929. PMID: 32271175. Exclusion: E8.

150. Cabraja M, Oezdemir S, Koeppen D, et al. Anterior cervical discectomy and fusion: comparison of titanium and polyetheretherketone cages. BMC Musculoskelet Disord. 2012 Sep 14;13:172. doi: 10.1186/1471-2474-13-172. PMID: 22978810. Exclusion: E11.

151. Callanan G, Radcliff KE. Cervical Total Disc Replacement: Long-Term Outcomes. Neurosurg Clin N Am. 2021 Oct;32(4):461-72. doi: 10.1016/j.nec.2021.05.007. PMID: 34538472. Exclusion: E6.

152. Cancienne JM, Werner BC, Loeb AE, et al. The effect of local intraoperative steroid administration on the rate of postoperative dysphagia following ACDF: a study of 245,754 patients. Spine. 2016 Jul 01;41(13):1084-8. doi: 10.1097/BRS.0000000000001407. PMID: 26679890. Exclusion: E11.

153. Cannada LK, Scherping SC, Yoo JU, et al. Pseudoarthrosis of the cervical spine: a comparison of radiographic diagnostic measures. Spine. 2003 Jan 01;28(1):46-51. doi: 10.1097/00007632-200301010-00012. PMID: 12544955. Exclusion: E7.

154. Cao J, Shen Y, Yang D, et al. Contrastive analysis of neck axial symptoms after Bryan cervical disc arthroplasty or traditional anterior cervical discectomy and fusion. Zhongguo xiu fu chong jian wai ke za zhi [Chinese journal of reparative and reconstructive surgery]. 2008;22(10):1200-4p. Exclusion: E10.

155. Cao ZG, Xia G, Wan J, et al. Comparison of ROI - C and traditional cage combined with titanium plate internal fixation for anterior cervical discectomy and fusion. Chinese J Contemp Neurol Neurosurg. 2022 Aug;22(8):687-95. doi: 10.3969/j.issn.1672-6731.2022.08.007. Exclusion: E10.

156. Capen DA, Garland DE, Waters RL. Surgical stabilization of the cervical spine. A comparative analysis of anterior and posterior spine fusions. Clin Orthop. 1985 Jun;196(196):229-37. PMID: 3995822. Exclusion: E11.

157. Caplan I, Sinha S, Schuster J, et al. The utility of cervical spine bracing as a postoperative adjunct to single-level anterior cervical spine surgery. Asian J Neurosurg. 2019 Apr-Jun;14(2):461-6. doi: 10.4103/ajns.AJNS_236_18. PMID: 31143262. Exclusion: E11.

158. Cappelletto B, Giorgiutti F, Veltri C, et al. Disc prosthesis replacement and interbody fusion in the treatment of degenerative cervical disc disease: comparative analysis of 176 consecutive cases. Eur Spine J. 2013 Nov;22 Suppl 6(Suppl 6):S894-9. doi: 10.1007/s00586-013-3023-y. PMID: 24045980. Exclusion: E11.

159. Cardoso MJ, Mendelsohn A, Rosner MK. Cervical hybrid arthroplasty with 2 unique fusion techniques. J Neurosurg Spine. 2011 Jul;15(1):48-54. doi: 10.3171/2011.3.SPINE10385. PMID: 21456894. Exclusion: E7.

160. Carol MP, Ducker TB. Cervical spondylitic myelopathies: surgical treatment. J Spinal Disord. 1988;1(1):59-65. PMID: 2980063. Exclusion: E5.

161. Carreon L, Glassman SD, Campbell MJ. Treatment of anterior cervical pseudoarthrosis: posterior fusion versus anterior revision. Spine J. 2006 Mar-Apr;6(2):154-6. doi: 10.1016/j.spinee.2005.07.003. PMID: 16517386. Exclusion: E11.

162. Carreon LY, Glassman SD, Campbell MJ, et al. Neck Disability Index, short form-36 physical component summary, and pain scales for neck and arm pain: the minimum clinically important difference and substantial clinical benefit after cervical spine fusion. Spine J. 2010 Jun;10(6):469-74. doi: 10.1016/j.spinee.2010.02.007. PMID: 20359958. Exclusion: E4.

163. Carrier CS, Bono CM, Lebl DR. Evidence-based analysis of adjacent segment degeneration and disease after ACDF: a systematic review. Spine J. 2013 Oct;13(10):1370-8. doi: 10.1016/j.spinee.2013.05.050. PMID: 23891293. Exclusion: E8.

164. Caspar W, Geisler FH, Pitzen T, et al. Anterior cervical plate stabilization in one- and two-level degenerative disease: overtreatment or benefit? J Spinal Disord. 1998 Feb;11(1):1-11. PMID: 9493763. Exclusion: E3.

165. Cauthen JC, Theis RP, Allen AT. Anterior cervical fusion: a comparison of cage, dowel and dowel-plate constructs. Spine J. 2003 Mar-Apr;3(2):106-17; discussion 17. doi: 10.1016/s1529-9430(02)00533-8. PMID: 14589223. Exclusion: E11.

166. Celestre PC, Pazmino PR, Mikhael MM, et al. Minimally invasive approaches to the cervical spine. Orthop Clin North Am. 2012 Jan;43(1):137-47, x. doi: 10.1016/j.ocl.2011.08.007. PMID: 22082636. Exclusion: E8.

167. Celik SE, Kara A, Celik S. A comparison of changes over time in cervical foraminal height after tricortical iliac graft or polyetheretherketone cage placement following anterior discectomy. J Neurosurg Spine. 2007 Jan;6(1):10-6. doi: 10.3171/spi.2007.6.1.3. PMID: 17233285. Exclusion: E3.

168. Cepoiu-Martin M, Faris P, Lorenzetti D, et al. Artificial cervical disc arthroplasty: a systematic review. Spine. 2011 Dec 01;36(25):E1623-33. doi: 10.1097/BRS.0b013e3182163814. PMID: 22101705. Exclusion: E8.

169. Chambers JS, Kropp RG, Gardocki RJ. Reoperation rates and patient-reported outcomes of single and two-level anterior cervical discectomy and fusion. Arch Orthop Trauma Surg. 2021 Jul 09;143(1):265-8. doi: 10.1007/s00402-021-04056-y. PMID: 34244874. Exclusion: E3.

170. Chandra AA, Vaishnav A, Shahi P, et al. The role of intraoperative neuromonitoring modalities in anterior cervical spine surgery. Hss J. 2023 Feb;19(1):53-61. doi: 10.1177/15563316221110572. PMID: 36776519. Exclusion: E3.

171. Chang H, Baek DH, Choi BW. Efficacy of zero-profile implant in anterior fusion to treat degenerative cervical spine disease: Comparison with techniques using bone graft and anterior plating. J Neurol Surg A Cent Eur Neurosurg. 2015 Jul;76(4):268-73. doi: 10.1055/s-0034-1389091. PMID: 26140339. Exclusion: E11.

172. Chang H, Kim C, Choi BW. Selective laminectomy for cervical spondylotic myelopathy: a comparative analysis with laminoplasty technique. Arch Orthop Trauma Surg. 2017 May;137(5):611-6. doi: 10.1007/s00402-017-2670-6. PMID: 28289891. Exclusion: E11.

173. Chang HK, Huang WC, Wu JC, et al. Should cervical disc arthroplasty be done on patients with increased intramedullary signal intensity on magnetic resonance imaging? World Neurosurg. 2016 May;89:489-96. doi: 10.1016/j.wneu.2016.02.029. PMID: 26893039. Exclusion: E3.

174. Chang KE, Pham MH, Hsieh PC. Adjacent segment disease requiring reoperation in cervical total disc arthroplasty: a literature review and update. J Clin Neurosci. 2017 Mar;37:20-4. doi: 10.1016/j.jocn.2016.10.047. PMID: 27865820. Exclusion: E8.

175. Chang PY, Chang HK, Wu JC, et al. Is cervical disc arthroplasty good for congenital cervical stenosis? J Neurosurg Spine. 2017 May;26(5):577-85. doi: 10.3171/2016.10.SPINE16317. PMID: 28291414. Exclusion: E7.

176. Chang V, Holly LT. Controversies in the management of cervical spondylotic myelopathy. J Neurosurg Sci. 2013 Sep;57(3):241-52. PMID: 23877269. Exclusion: E9.

177. Chatley A, Kumar R, Jain VK, et al. Effect of spinal cord signal intensity changes on clinical outcome after surgery for cervical spondylotic myelopathy. J Neurosurg Spine. 2009 Nov;11(5):562-7. doi: 10.3171/2009.6.Spine091. PMID: 19929358. Exclusion: E11.

178. Chaudhary SK, Yu B, Pan F, et al. Manual preoperative tracheal retraction exercise decreases the occurrence of postoperative oropharyngeal dysphagia after anterior cervical discectomy and fusion. J. 2017 Sep-Dec;25(3):2309499017731446. doi: 10.1177/2309499017731446. PMID: 28974146. Exclusion: E2.

179. Chen C, Li J, Liao Z, et al. C3 laminectomy combined with modified unilateral laminoplasty and in situ reconstruction of the midline structures maintained cervical sagittal balance: a retrospective matched-pair case-control study. Spine J. 2020 09;20(9):1403-12. doi: 10.1016/j.spinee.2020.04.023. PMID: 32387294. Exclusion: E3.

180. Chen CJ, Lyu RK, Lee ST, et al. Intramedullary high signal intensity on T2-weighted MR images in cervical spondylotic myelopathy: prediction of prognosis with type of intensity. Radiology. 2001 Dec;221(3):789-94. doi: 10.1148/radiol.2213010365. PMID: 11719680. Exclusion: E9.

181. Chen F, He W, Mahaney K, et al. Alternative grafts in anterior cervical fusion. Clin Neurol Neurosurg. 2013 Oct;115(10):2049-55. doi: 10.1016/j.clineuro.2013.07.013. PMID: 23911002. Exclusion: E7.

182. Chen G, Liu X, Chen N, et al. Ten-year surgical outcomes and prognostic factors for french-door laminoplasty in the treatment of multilevel cervical spondylotic myelopathy. Biomed Res Int. 2020:3627071. doi: 10.1155/2020/3627071. PMID: 32461980. Exclusion: E3.

183. Chen G, Wei F, Li J, et al. Intensity of Intraoperative Spinal Cord Hyperechogenicity as a Novel Potential Predictive Indicator of Neurological Recovery for Degenerative Cervical Myelopathy. Korean J Radiol. 2021 07;22(7):1163-71. doi: 10.3348/kjr.2020.0755. PMID: 33739631. Exclusion: E4.

184. Chen H, Deng Y, Li T, et al. Clinical and radiography results of mini-plate fixation compared to suture suspensory fixation in cervical laminoplasty: a five-year follow-up study. Clin Neurol Neurosurg. 2015 Nov;138:188-95. doi: 10.1016/j.clineuro.2015.09.004. PMID: 26379265. Exclusion: E3.

185. Chen H, Pan J, Nisar M, et al. The value of preoperative magnetic resonance imaging in predicting postoperative recovery in patients with cervical spondylosis myelopathy: a meta-analysis. Clinics. 2016 Mar;71(3):179-84. doi: 10.6061/clinics/2016(03)10. PMID: 27074180. Exclusion: E8.

186. Chen T, Zhang X, Meng F, et al. Is laminoplasty or laminectomy the best strategy for C3 segment in French-door laminoplasty? A systematic review and meta-analysis. J. 2021 Sep 14;16(1):557. doi: 10.1186/s13018-021-02596-y. PMID: 34521434. Exclusion: E2.

187. Chen TL, Cheng MH, Shen YX, et al. Application of MC+ combined with autogenous bone or calcium sulfate artificial bone in anterior cervical fusion: comparative study of therapeutic effects and complications. Journal of clinical rehabilitative tissue engineering research. 2010;14(4):718-21p. doi: 10.3969/j.issn.1673-8225.2010.04.035. Exclusion: E10.

188. Chen X, Shan T, Li Y. Prognostic effect of increased postoperative MRI T2WI high signal intensity in degenerative cervical myelopathy. Spine J. 2022 Dec 22;22(12):1964-73. doi: 10.1016/j.spinee.2022.07.097. PMID: 35878755. Exclusion: E2.

189. Chen Y, Chen D, Guo Y, et al. Subsidence of titanium mesh cage: a study based on 300 cases. J Spinal Disord Tech. 2008 Oct;21(7):489-92. doi: 10.1097/BSD.0b013e318158de22. PMID: 18836360. Exclusion: E3.

190. Chen Y, Li Y, Hai Y, et al. Comparison of radiographic reconstruction and clinical improvement between artificial cervical disc replacement and anterior cervical discectomy and fusion. Pain Res Manag. 2022:3353810. doi: 10.1155/2022/3353810. PMID: 35140830. Exclusion: E11.

191. Chen Y, Liu X, Chen D, et al. Surgical strategy for ossification of the posterior longitudinal ligament in the cervical spine. Orthopedics. 2012 Aug 01;35(8):e1231-7. doi: 10.3928/01477447-20120725-25. PMID: 22868611. Exclusion: E11.

192. Chen Y, Liu Y, Chen H, et al. Comparison of curvature between the zero-p spacer and traditional cage and plate after 3-level anterior cervical discectomy and fusion: Mid-term results. Clin Spine Surg. 2017 Oct;30(8):E1111-E6. doi: 10.1097/BSD.0000000000000440. PMID: 27642818. Exclusion: E11.

193. Chen Y, Lu G, Wang B, et al. A comparison of anterior cervical discectomy and fusion (ACDF) using self-locking stand-alone polyetheretherketone (PEEK) cage with ACDF using cage and plate in the treatment of three-level cervical degenerative spondylopathy: a retrospective study with 2-year follow-up. Eur Spine J. 2016 07;25(7):2255-62. doi: 10.1007/s00586-016-4391-x. PMID: 26906171. Exclusion: E11.

194. Chen Y, Wang X, Lu X, et al. Cervical disk arthroplasty versus ACDF for preoperative reducible kyphosis. Orthopedics. 2013 Jul;36(7):e958-65. doi: 10.3928/01477447-20130624-29. PMID: 23823056. Exclusion: E7.

195. Chen Y, Wang X, Zhang X, et al. Low virulence bacterial infections in cervical intervertebral discs: a prospective case series. Eur Spine J. 2018 10;27(10):2496-505. doi: 10.1007/s00586-018-5582-4. PMID: 29675672. Exclusion: E7.

196. Chen Z, Cen S, Wu J, et al. Use of zero-profile device for contiguous three-level anterior cervical discectomy and fusion: comparison with cage and plate construct. J Neurosurg Spine. 2021 Jun 04:1-8. doi: 10.3171/2020.11.SPINE201319. PMID: 34087791. Exclusion: E11.

197. Cheng Z, Peng B, Zhang L, et al. [Correlation analysis of preoperative T 1 slope in MRI and physiological curvature loss after expansive open-door laminoplasty]. Chung Kuo Hsiu Fu Chung Chien Wai Ko Tsa Chih. 2018 01 15;32(1):64-8. doi: 10.7507/1002-1892.201708116. PMID: 29806368. Exclusion: E10.

198. Cheung ZB, Gidumal S, White S, et al. Comparison of anterior cervical discectomy and fusion with a stand-alone interbody cage versus a conventional cage-plate technique: a systematic review and meta-analysis. Global spine j. 2019 Jun;9(4):446-55. doi: 10.1177/2192568218774576. PMID: 31218204. Exclusion: E8.

199. Chien A, Lai DM, Wang SF, et al. Comparison of cervical kinematics, pain, and functional disability between single- and two-level anterior cervical discectomy and fusion. Spine. 2016 Aug 01;41(15):E915-E22. doi: 10.1097/BRS.0000000000001502. PMID: 26890952. Exclusion: E3.

200. Chien JT, Hsieh MH, Yang CC, et al. Anterior cervical discectomy and fusion versus conservative treatment for cervical angina conservative treatment. Clin Spine Surg. 2021 11 01;34(9):E514-E21. doi: 10.1097/BSD.0000000000001178. PMID: 33828047. Exclusion: E1.

201. Chikhale CB, Khurjekar KS, Shyam AK, et al. Correlation between preoperative magnetic resonance imaging signal intensity changes and clinical outcomes in patients surgically treated for cervical myeloradiculopathy. Asian spine j. 2017 Apr;11(2):174-80. doi: 10.4184/asj.2017.11.2.174. PMID: 28443160. Exclusion: E7.

202. Chin KR, Pencle FJR, Seale JA, et al. Clinical outcomes of outpatient cervical total disc replacement compared with outpatient anterior cervical discectomy and fusion. Spine (Phila Pa 1976). 2017 May 15;42(10):E567-e74. doi: 10.1097/brs.0000000000001936. PMID: 27755491. Exclusion: E11.

203. Cho DY, Lee WY, Sheu PC. Treatment of multilevel cervical fusion with cages. Surg Neurol. 2004 Nov;62(5):378-85, discussion 85-6. doi: 10.1016/j.surneu.2004.01.021. PMID: 15518835. Exclusion: E3.

204. Choi D, Petrik V, Fox S, et al. Motion preservation and clinical outcome of porous coated motion cervical disk arthroplasty. Neurosurgery. 2012 Jul;71(1):30-7. doi: 10.1227/NEU.0b013e31824e512e. PMID: 22314754. Exclusion: E3.

205. Choi G, Arbatti NJ, Modi HN, et al. Transcorporeal tunnel approach for unilateral cervical radiculopathy: a 2-year follow-up review and results. Minim Invasive Neurosurg. 2010 Jun;53(3):127-31. doi: 10.1055/s-0030-1249681. PMID: 20809454. Exclusion: E5.

206. Choi JH, Shin JJ, Kim TH, et al. Does intramedullary signal intensity on MRI affect the surgical outcomes of patients with ossification of posterior longitudinal ligament? J. 2014 Aug;56(2):121-9. doi: 10.3340/jkns.2014.56.2.121. PMID: 25328649. Exclusion: E1.

207. Choi MK, Kim SB, Park CK, et al. Comparison of the clinical and radiologic outcomes obtained with single- versus two-level anterior cervical decompression and fusion using stand-alone PEEK cages filled with allograft. Acta Neurochir (Wien). 2016 Mar;158(3):481-7. doi: 10.1007/s00701-015-2692-1. PMID: 26758609. Exclusion: E3.

208. Chou YC, Chen DC, Hsieh WA, et al. Efficacy of anterior cervical fusion: comparison of titanium cages, polyetheretherketone (PEEK) cages and autogenous bone grafts. J Clin Neurosci. 2008 Nov;15(11):1240-5. doi: 10.1016/j.jocn.2007.05.016. PMID: 18801658. Exclusion: E11.

209. Clark AJ, Safaee M, Chou D, et al. Comparative sensitivity of intraoperative motor evoked potential monitoring in predicting postoperative neurologic deficits: nondegenerative versus degenerative myelopathy. Global spine j. 2016 Aug;6(5):452-8. doi: 10.1055/s-0035-1565258. PMID: 27433429. Exclusion: E3.

210. Clark AJ, Ziewacz JE, Safaee M, et al. Intraoperative neuromonitoring with MEPs and prediction of postoperative neurological deficits in patients undergoing surgery for cervical and cervicothoracic myelopathy. Neurosurg. 2013 Jul;35(1):E7. doi: 10.3171/2013.4.FOCUS13121. PMID: 23815252. Exclusion: E3.

211. Conger A, Cushman DM, Speckman RA, et al. The effectiveness of fluoroscopically guided cervical transforaminal epidural steroid injection for the treatment of radicular pain; a systematic review and meta-analysis. Pain Med. 2020 01 01;21(1):41-54. doi: 10.1093/pm/pnz127. PMID: 31181148. Exclusion: E8.

212. Connor M, Briggs RG, Bonney PA, et al. Tobacco use is associated with increased 90-day readmission among patients undergoing surgery for degenerative spine disease. Global spine j. 2022 Jun;12(5):787-94. doi: 10.1177/2192568220964032. PMID: 33030060. Exclusion: E2.

213. Coric D, Albert T, Radcliff K. Five-year results of 2-level cervical total disc replacement compared with anterior discectomy and fusion: an independent review of a prospective, randomized, controlled multicenter investigational device exemption clinical trial. Clin Neurosurg. 2015;62(221):2015-09. doi: 10.1227/01.neu.0000467132.97525.c3. Exclusion: E6.

214. Coric D, Cassis J, Carew J, et al. Prospective study of cervical arthroplasty in 98 patients involved in 1 of 3 separate investigational device exemption studies from a single investigational site with a minimum 2-year follow-up. Clinical article. J Neurosurg Spine. 2010 Dec;13(6):715-21. doi: 10.3171/2010.5.SPINE09852. PMID: 21121748. Exclusion: E1.

215. Coric D, Finger F, Boltes P. Prospective randomized controlled study of the Bryan Cervical Disc: early clinical results from a single investigational site. J Neurosurg Spine. 2006 Jan;4(1):31-5. doi: 10.3171/spi.2006.4.1.31. PMID: 16506463. Exclusion: E1.

216. Coric D, Guyer RD, Nunley PD, et al. Prospective, randomized multicenter study of cervical arthroplasty versus anterior cervical discectomy and fusion: 5-year results with a metal-on-metal artificial disc. J Neurosurg Spine. 2018 03;28(3):252-61. doi: 10.3171/2017.5.SPINE16824. PMID: 29303467. Exclusion: E2.

217. Coric D, Kim PK, Clemente JD, et al. Prospective randomized study of cervical arthroplasty and anterior cervical discectomy and fusion with long-term follow-up: results in 74 patients from a single site. J Neurosurg Spine. 2013 Jan;18(1):36-42. doi: 10.3171/2012.9.SPINE12555. PMID: 23140129. Exclusion: E9.

218. Coric D, Nunley PD, Guyer RD, et al. Prospective, randomized, multicenter study of cervical arthroplasty: 269 patients from the Kineflex|C artificial disc investigational device exemption study with a minimum 2-year follow-up: clinical article. J Neurosurg Spine. 2011 Oct;15(4):348-58. doi: 10.3171/2011.5.SPINE10769. PMID: 21699471. Exclusion: E2.

219. Cui S, Daffner SD, France JC, et al. The effects of perioperative corticosteroids on dysphagia following surgical procedures involving the anterior cervical spine: a prospective, randomized, controlled, double-blinded clinical trial. J Bone Joint Surg Am. 2019 Nov 20;101(22):2007-14. doi: 10.2106/JBJS.19.00198. PMID: 31764363. Exclusion: E2.

220. Cui S, Emery SE, Daffner SD, et al. The effects of perioperative steroids on dysphagia following anterior cervical spine surgery: a randomized, prospective, double-blind study. Spine journal. 2016 to 2016-10-29;16(10):S206-p. doi: 10.1016/j.spinee.2016.07.117. Exclusion: E6.

221. Cui X, Trinh K, Wang Y-J. Chinese herbal medicine for chronic neck pain due to cervical degenerative disc disease. Cochrane Database Syst Rev. 2010;35(1):2121-7. doi: 10.1002/14651858.CD006556.pub2. PMID: 20091597. Exclusion: E2.

222. Cummins BH, Robertson JT, Gill SS. Surgical experience with an implanted artificial cervical joint. J Neurosurg. 1998 Jun;88(6):943-8. doi: 10.3171/jns.1998.88.6.0943. PMID: 9609285. Exclusion: E7.

223. Cunningham MR, Hershman S, Bendo J. Systematic review of cohort studies comparing surgical treatments for cervical spondylotic myelopathy. Spine. 2010 Mar 01;35(5):537-43. doi: 10.1097/BRS.0b013e3181b204cc. PMID: 20190625. Exclusion: E9.

224. Dagli M, Er U, Simsek S, et al. Late results of anterior cervical discectomy and fusion with interbody cages. Asian spine j. 2013 Mar;7(1):34-8. doi: 10.4184/asj.2013.7.1.34. PMID: 23508467. Exclusion: E3.

225. Dai LY, Jiang LS. Anterior cervical fusion with interbody cage containing beta-tricalcium phosphate augmented with plate fixation: a prospective randomized study with 2-year follow-up. Eur Spine J. 2008 May;17(5):698-705. doi: 10.1007/s00586-008-0643-8. PMID: 18301927. Exclusion: E3.

226. Darden B, Zigler JE, Murrey DB, et al. 5-year results of the prospective, randomized, multicenter investigational device exemption (IDE) ProDisc-C vs. ACDF clinical trial. Eur Spine J. 2010 START: 2010 May 26 CONFERENCE END: 2010 May 29 CSRS-ES Congress 2010 Kurfu Greece;19(6):1053-4p. doi: 10.1007/s00586-010-1436-4. Exclusion: E6.

227. Davies BM, McHugh M, Elgheriani A, et al. The reporting of study and population characteristics in degenerative cervical myelopathy: a systematic review. PLoS ONE. 2017;12(3):e0172564. doi: 10.1371/journal.pone.0172564. PMID: 28249017. Exclusion: E8.

228. Davis R, Bae HW, Gaede S, et al. Radiographic outcomes including adjacent level degeneration of FDA investigational device trial comparing multi-level use of MOBI-C cervical artificial disc to anterior discectomy and fusion. Eur Spine J. 2012;21(28) doi: 10.1007/s00586-012-2269-0. Exclusion: E6.

229. Davis RA. A long-term outcome study of 170 surgically treated patients with compressive cervical radiculopathy. Surg Neurol. 1996 Dec;46(6):523-30; discussion 30-3. doi: 10.1016/s0090-3019(96)00278-9. PMID: 8956883. Exclusion: E5.

230. Davis RJ, Araghi A, Bae HW, et al. Comparison of complication rates associated with two-level cervical arthroplasty versus two-level anterior cervical discectomy and fusion. Spine journal. 2012 START: 2012 Oct 24 CONFERENCE END: 2012 Oct 27 27th Annual Meeting of the North American Spine Society, NASS 2012 Dallas, TX United States;12(9 SUPPL. 1):139S-40Sp. doi: 10.1016/j.spinee.2012.08.366. Exclusion: E6.

231. Davis RJ, Araghi A, Bae HW, et al. Investigational device exemption trial of cervical arthroplasty for treatment of degenerative disc disease at two levels: 24-month results of 330 subjects. Spine journal. 2012 START: 2012 Oct 24 CONFERENCE END: 2012 Oct 27 27th Annual Meeting of the North American Spine Society, NASS 2012 Dallas, TX United States;12(9 SUPPL. 1):95S-6Sp. doi: 10.1016/j.spinee.2012.08.267. Exclusion: E6.

232. Davis RJ, Bae HW, Gaede S, et al. Comparison of the mobi C cervical artificial disc to anterior cervical discectomy and fusion in the treatment of symptomatic cervical degenerative disc disease at 2 levels. Eur Spine J. START: 2011 Oct 19 CONFERENCE END: 2011 Oct 21 EuroSpine 2011 Milan Italy;20(4):S449p. doi: 10.1007/s00586-011-1950-z. Exclusion: E6.

233. Davis RJ, Bae HW, Hisey MS, et al. Two-level treatment with total disc replacement versus ACDF: results from a prospective randomized clinical trial with five years follow-up. Spine journal. 2014 START: 2014 Nov 12 CONFERENCE END: 2014 Nov 15 29th Annual Meeting of the North American Spine Society, NASS 2014 San Francisco, CA United States;14(11 SUPPL. 1):S24p. doi: 10.1016/j.spinee.2014.08.066. Exclusion: E6.

234. de Dios E, Heary RF, Lindhagen L, et al. Laminectomy alone versus laminectomy with fusion for degenerative cervical myelopathy: a long-term study of a national cohort. Eur Spine J. 2022 02;31(2):334-45. doi: 10.1007/s00586-021-07067-w. PMID: 34853923. Exclusion: E3.

235. de Dios E, Laesser M, Bjorkman-Burtscher IM, et al. Improvement rates, adverse events and predictors of clinical outcome following surgery for degenerative cervical myelopathy. Eur Spine J. 2022 Dec;31(12):3433-42. doi: 10.1007/s00586-022-07359-9. PMID: 36053323. Exclusion: E3.

236. De la Garza Ramos R, Nouri A, Nakhla J, et al. Predictors of return to normal neurological function after surgery for moderate and severe degenerative cervical myelopathy: an analysis of a global aospine cohort of patients. Neurosurgery. 2019 11 01;85(5):E917-E23. doi: 10.1093/neuros/nyz178. PMID: 31144725. Exclusion: E1.

237. De Rooij JD, Harhangi BS, Groeneweg JG, et al. Cervical radicular pain: a randomised controlled trial (RCT) comparing percutaneous plasma discectomy (PPD) with anterior cervical discectomy (ACD). Pain pract. 2016;16(139) doi: 10.1111/papr.12451. Exclusion: E2.

238. Decruz J, Kaliya-Perumal AK, Wong KH, et al. Neuromonitoring in cervical spine surgery: when is a signal drop clinically significant? Asian spine j. 2021 Jun;15(3):317-23. doi: 10.31616/asj.2020.0074. PMID: 33260284. Exclusion: E3.

239. Delgado-Lopez PD, Montalvo-Afonso A, Araus-Galdos E, et al. Need for head and neck repositioning to restore electrophysiological signal changes at positioning for cervical myelopathy surgery. Neurocirugia. 2021 Apr 16;16(21):16. doi: 10.1016/j.neucir.2021.03.001. PMID: 33875378. Exclusion: E3.

240. Della Pepa GM, Roselli R, La Rocca G, et al. Laminoplasty is better of laminectomy in cervical stenotic myelopathy: myth or truth? Eur Rev Med Pharmacol Sci. 2014;18(1 Suppl):50-4. PMID: 24825042. Exclusion: E11.

241. Demura S, Murakami H, Kawahara N, et al. Laminoplasty and pedicle screw fixation for cervical myelopathy associated with athetoid cerebral palsy: minimum 5-year follow-up. Spine. 2013 Sep 15;38(20):1764-9. doi: 10.1097/BRS.0b013e31829eca52. PMID: 23759815. Exclusion: E7.

242. Deng H, Yue JK, Ordaz A, et al. Cervical fusion for degenerative disease: a comprehensive cost analysis of hospital complications in the United States from 2002 to 2014. J Craniovertebr Junction Spine. 2018 Jul-Sep;9(3):140-7. doi: 10.4103/jcvjs.JCVJS_62_18. PMID: 30443131. Exclusion: E4.

243. Deng Y, Huang K, Liu H, et al. An absorbable collagen biomembrane help improve swallowing function after anterior cervical spine surgery. Dysphagia. 2020 10;35(5):780-6. doi: 10.1007/s00455-019-10083-0. PMID: 31802198. Exclusion: E3.

244. Deora H, Kim SH, Behari S, et al. Anterior surgical techniques for cervical spondylotic myelopathy: WFNS Spine Committee recommendations. Neurospine. 2019 09;16(3):408-20. doi: 10.14245/ns.1938250.125. PMID: 31607073. Exclusion: E8.

245. Dettori JR, Chapman JR, DeVine JG, et al. Longer follow-up continues to reveal no increased risk of cancer with the use of recombinant human bone morphogenetic protein in spine fusion. Spine J. 2019 10;19(10):1640-7. doi: 10.1016/j.spinee.2019.05.005. PMID: 31108234. Exclusion: E1.

246. Dhar UK, Menzer EL, Lin M, et al. Factors influencing cage subsidence in anterior cervical corpectomy and discectomy: a systematic review. Eur Spine J. 2023 Mar;32(3):957-68. doi: 10.1007/s00586-023-07530-w. PMID: 36708398. Exclusion: E8.

247. Di Martino A, Papalia R, Caldaria A, et al. Should evoked potential monitoring be used in degenerative cervical spine surgery? A systematic review. J. 2019 04 02;20(1):19. doi: 10.1186/s10195-019-0524-4. PMID: 30941518. Exclusion: E3.

248. DiMaria S, Wilent WB, Nicholson KJ, et al. Patient factors impacting baseline motor evoked potentials (meps) in patients undergoing cervical spine surgery for myelopathy or radiculopathy. Clin Spine Surg. 2022 Jul 01;35(6):E527-E33. doi: 10.1097/BSD.0000000000001299. PMID: 35221326. Exclusion: E3.

249. Dimopoulos VG, Chung I, Lee GP, et al. Quantitative estimation of the recurrent laryngeal nerve irritation by employing spontaneous intraoperative electromyographic monitoring during anterior cervical discectomy and fusion. J Spinal Disord Tech. 2009 Feb;22(1):1-7. doi: 10.1097/BSD.0b013e31815ea8b6. PMID: 19190427. Exclusion: E3.

250. Ding C, Hong Y, Liu H, et al. Comparison of cervical disc arthroplasty with anterior cervical discectomy and fusion for the treatment of cervical spondylotic myelopathy. Acta Orthop Belg. 2013 Jun;79(3):338-46. PMID: 23926739. Exclusion: E11.

251. Ding F, Jia Z, Wu Y, et al. Fusion-nonfusion hybrid construct versus anterior cervical hybrid decompression and fusion: a comparative study for 3-level cervical degenerative disc diseases. Spine. 2014 Nov 01;39(23):1934-42. doi: 10.1097/BRS.0000000000000588. PMID: 25365710. Exclusion: E7.

252. Ding X, Pan Z, Ma Z, et al. Clinical application of evoked potentials in the operation of cervical spondylotic myelopathy with different imaging. Contrast Media Mol Imaging. 2022 Oct 10;2022:4154278. doi: 10.1155/2022/4154278. PMID: 36299827. Exclusion: E2.

253. Ding Y, Hu Y, Ruan DK, et al. Value of somatosensory evoked potentials in diagnosis, surgical monitoring and prognosis of cervical spondylotic myelopathy. Chin Med J. 2008 Aug 05;121(15):1374-8. PMID: 18959112. Exclusion: E3.

254. Dong J, Lu M, Lu T, et al. Meta-analysis comparing zero-profile spacer and anterior plate in anterior cervical fusion. PLoS ONE. 2015;10(6):e0130223. doi: 10.1371/journal.pone.0130223. PMID: 26067917. Exclusion: E8.

255. Dong L, Wang D, Chen X, et al. A comprehensive meta-analysis of the adjacent segment parameters in cervical disk arthroplasty versus anterior cervical discectomy and fusion. Clin Spine Surg. 2018 05;31(4):162-73. doi: 10.1097/BSD.0000000000000552. PMID: 28622185. Exclusion: E8.

256. Dong L, Xu Z, Chen X, et al. The change of adjacent segment after cervical disc arthroplasty compared with anterior cervical discectomy and fusion: a meta-analysis of randomized controlled trials. Spine J. 2017 10;17(10):1549-58. doi: 10.1016/j.spinee.2017.06.010. PMID: 28625479. Exclusion: E8.

257. Donk RD, Arnts H, Verhagen WIM, et al. Cervical sagittal alignment after different anterior discectomy procedures for single-level cervical degenerative disc disease: randomized controlled trial. Acta Neurochir (Wien). 2017 12;159(12):2359-65. doi: 10.1007/s00701-017-3312-z. PMID: 28887690. Exclusion: E4.

258. Donk RD, Verhagen WIM, Hosman AJF, et al. Symptomatic adjacent segment disease after anterior cervical discectomy for single-level degenerative disk disease. Clin Spine Surg. 2018 02;31(1):E50-E4. doi: 10.1097/BSD.0000000000000551. PMID: 28604508. Exclusion: E11.

259. Dowd GC, Wirth FP. Anterior cervical discectomy: is fusion necessary? J Neurosurg. 1999 Jan;90(1 Suppl):8-12. doi: 10.3171/spi.1999.90.1.0008. PMID: 10413119. Exclusion: E3.

260. Dowdell JE, Kim JS, Mikhail C, et al. The rate of heterotopic ossification following cervical disc arthroplasty: a systematic review and comparison of data. Spine. 2020 Sep 15;45(18):E1197-E202. doi: 10.1097/BRS.0000000000003524. PMID: 32355139. Exclusion: E8.

261. Du L, Gao Y, Zhao C, et al. Laminoplasty with selective fusion at unstable segment versus laminectomy with fusion for multilevel cervical myelopathy: a case-control study. BMC Musculoskelet Disord. 2021 May 07;22(1):426. doi: 10.1186/s12891-021-04297-3. PMID: 33962588. Exclusion: E1.

262. Du W, Wang L, Shen Y, et al. Long-term impacts of different posterior operations on curvature, neurological recovery and axial symptoms for multilevel cervical degenerative myelopathy. Eur Spine J. 2013 Jul;22(7):1594-602. doi: 10.1007/s00586-013-2741-5. PMID: 23508336. Exclusion: E11.

263. Duan Y, Yang Y, Wang Y, et al. Comparison of anterior cervical discectomy and fusion with the zero-profile device versus plate and cage in treating cervical degenerative disc disease: a meta-analysis. J Clin Neurosci. 2016 Nov;33:11-8. doi: 10.1016/j.jocn.2016.01.046. PMID: 27443497. Exclusion: E8.

264. DuBois CM, Bolt PM, Todd AG, et al. Static versus dynamic plating for multilevel anterior cervical discectomy and fusion. Spine J. 2007 Mar-Apr;7(2):188-93. doi: 10.1016/j.spinee.2006.07.004. PMID: 17321968. Exclusion: E11.

265. Dufour T, Delecrin J, Nguyen JM, et al. Reemergence of symptoms after successful treatment with cervical disc arthroplasty or anterior cervical discectomy and fusion at 7 years. Eur Spine J. 2016 to 2016-12-03;25(11):3824-p. doi: 10.1007/s00586-016-4801-0. Exclusion: E6.

266. Dunn C, Moore J, Sahai N, et al. Minimally invasive posterior cervical foraminotomy with tubes to prevent undesired fusion: a long-term follow-up study. J Neurosurg Spine. 2018 Oct;29(4):358-64. doi: 10.3171/2018.2.SPINE171003. PMID: 29957145. Exclusion: E2.

267. Ebersold MJ, Pare MC, Quast LM. Surgical treatment for cervical spondylitic myelopathy. J Neurosurg. 1995 May;82(5):745-51. doi: 10.3171/jns.1995.82.5.0745. PMID: 7714597. Exclusion: E3.

268. Eggspuehler A, Sutter MA, Grob D, et al. Multimodal intraoperative monitoring (MIOM) during cervical spine surgical procedures in 246 patients. Eur Spine J. 2007 Nov;16 Suppl 2(Suppl 2):S209-15. doi: 10.1007/s00586-007-0424-9. PMID: 17610090. Exclusion: E1.

269. El Baz EA, Sultan AM, Barakat AS, et al. The use of anterior cervical interbody spacer with integrated fixation screws for management of cervical disc disease. Sicot-J. 2019 Jan;5:8. doi: 10.1051/sicotj/2019002. PMID: 30834889. Exclusion: E7.

270. El Yaagoubi Y, Loret JE, Lioret E, et al. 18 F-NaF PET/CT in presumed aseptic pseudarthrosis after spinal fusion: correlation with findings at revision surgery and intraoperative cultures. World j. 2022 Sep 9;21(4):302-13. doi: 10.1055/s-0042-1750400. PMID: 36398308. Exclusion: E7.

271. El-Ghandour NMF, Soliman MAR, Ezzat AAM, et al. The safety and efficacy of anterior versus posterior decompression surgery in degenerative cervical myelopathy: a prospective randomized trial. J Neurosurg Spine. 2020 May 01;33(3):1-9. doi: 10.3171/2020.2.SPINE191272. PMID: 32357329. Exclusion: E1.

272. ElAbed K, Shawky A, Barakat M, et al. Anterior cervical discectomy and fusion with stand-alone trabecular metal cages as a surgical treatment for cervical radiculopathy: mid-term outcomes. Asian spine j. 2016 Apr;10(2):245-50. doi: 10.4184/asj.2016.10.2.245. PMID: 27114764. Exclusion: E5.

273. Eliseev AS, Bokov AE, Mlyavykh SG. Sagittal balance parameters after anterior cervical discectomy with spondylodesis and arthroplasty using endocarbon endoprosthesis: results of randomized study. Sovem Tekhnologii Med. 2022;14(4):50-7. doi: 10.17691/stm2022.14.4.06. PMID: 37179984. Exclusion: E4.

274. Elsamadicy AA, Koo AB, Lee M, et al. Patient risk factors associated with 30- and 90-day readmission after cervical discectomy: a nationwide readmission database study. Clin Spine Surg. 2020 11;33(9):E434-E41. doi: 10.1097/BSD.0000000000001030. PMID: 32568863. Exclusion: E5.

275. Elsenbeck MJ, Pisano AJ, Fredericks DJ, et al. Is anterior cervical discectomy and fusion for ≥4 levels safe and effective for the treatment of degenerative cervical disease? Clinical Spine Surgery. 2018;31(8):319-22. doi: 10.1097/BSD.0000000000000652. PMID: 29771743. Exclusion: E6.

276. Emami A, Coban D, Changoor S, et al. Comparing mid-term outcomes between acdf and minimally invasive posterior cervical foraminotomy in the treatment of cervical radiculopathy. Spine. 2022 Feb 15;47(4):324-30. doi: 10.1097/BRS.0000000000004140. PMID: 34107527. Exclusion: E11.

277. Engquist M, Löfgren H, Öberg B, et al. Surgery versus nonsurgical treatment of cervical radiculopathy: a prospective, randomized study comparing surgery plus physiotherapy with physiotherapy alone with a 2-year follow-up. Spine. 2013;38(20) doi: 10.1097/BRS.0b013e31829ff095. PMID: 23778373. Exclusion: E3.

278. Epstein N. Efficacy of posterior cervical fusions utilizing an artificial bone graft expander, beta tricalcium phosphate. Surg Neurol Int. 2011;2(1):15. doi: 10.4103/2152-7806.76458. PMID: 21427773. Exclusion: E3.

279. Epstein N, Epstein JA, Benjamin V, et al. Traumatic myelopathy in patients with cervical spinal stenosis without fracture or dislocation: methods of diagnosis, management, and prognosis. Spine. 1980 Nov-Dec;5(6):489-96. doi: 10.1097/00007632-198011000-00001. PMID: 7466456. Exclusion: E7.

280. Epstein NE, Agulnick MA. Short review/perspective on Adjacent Segment Disease (ASD) following cervical fusion versus arthroplasty. Surg Neurol Int. 2022 Jul 22;13:313. doi: 10.25259/SNI_541_2022. PMID: 35928322. Exclusion: E8.

281. Epstein NE. Iliac crest autograft versus alternative constructs for anterior cervical spine surgery: Pros, cons, and costs. Surg Neurol Int. 2012;3(Suppl 3):S143-56. doi: 10.4103/2152-7806.98575. PMID: 22905321. Exclusion: E8.

282. Epstein NE. Preliminary documentation of the comparable efficacy of vitoss versus NanOss bioactive as bone graft expanders for posterior cervical fusion. Surg Neurol Int. 2015;6(Suppl 4):S164-71. doi: 10.4103/2152-7806.156559. PMID: 26005578. Exclusion: E3.

283. Etemadifar M, Andalib A, Shafiee H, et al. Comparison of the outcomes of cage-stand-alone with cage-with-plate fixation in one level and two levels for treating cervical disk diseases. J Craniovertebr Junction Spine. 2018 Jul-Sep;9(3):170-4. doi: 10.4103/jcvjs.JCVJS_74_18. PMID: 30443136. Exclusion: E11.

284. Falavigna A, Arruda AO, Righesso Neto O, et al. International and multicenter prospective controlled study of dysphagia after anterior cervical spine surgery. Neurosurgery. 2023 Jun 1;92(6):1287-96. doi: 10.1227/neu.0000000000002364. PMID: 36762900. Exclusion: E1.

285. Faldini C, Chehrassan M, Miscione MT, et al. Single-level anterior cervical discectomy and interbody fusion using PEEK anatomical cervical cage and allograft bone. J. 2011 Dec;12(4):201-5. doi: 10.1007/s10195-011-0169-4. PMID: 22089645. Exclusion: E7.

286. Fallah A, Akl EA, Ebrahim S, et al. Anterior cervical discectomy with arthroplasty versus arthrodesis for single-level cervical spondylosis: a systematic review and meta-analysis. PLoS ONE. 2012;7(8):e43407. doi: 10.1371/journal.pone.0043407. PMID: 22912869. Exclusion: E8.

287. Fan N, Zhao B, Liu L, et al. Dynamic and static amplitude of low-frequency fluctuation is a potential biomarker for predicting prognosis of degenerative cervical myelopathy patients: a preliminary resting-state fMRI study. Frontiers in Neurology. 2022;13:829714. doi: 10.3389/fneur.2022.829714. PMID: 35444605. Exclusion: E3.

288. Fang W, Huang L, Feng F, et al. Anterior cervical discectomy and fusion versus posterior cervical foraminotomy for the treatment of single-level unilateral cervical radiculopathy: a meta-analysis. J. 2020 Jun 01;15(1):202. doi: 10.1186/s13018-020-01723-5. PMID: 32487109. Exclusion: E8.

289. Fang Z, Tian R, Sun TW, et al. Expansion open-door laminoplasty with foraminotomy versus anterior cervical discectomy and fusion for coexisting multilevel cervical myelopathy and unilateral radiculopathy. Clin Spine Surg. 2016 Feb;29(1):E21-7. doi: 10.1097/BSD.0000000000000074. PMID: 24352034. Exclusion: E11.

290. Farrokhi MR, Nikoo Z, Gholami M, et al. Comparison between acrylic cage and polyetheretherketone (PEEK) cage in single-level anterior cervical discectomy and fusion: a randomized clinical trial. Clin Spine Surg. 2017 02;30(1):38-46. doi: 10.1097/BSD.0000000000000251. PMID: 28107234. Exclusion: E3.

291. Fay LY, Huang WC, Tsai TY, et al. Differences between arthroplasty and anterior cervical fusion in two-level cervical degenerative disc disease. Eur Spine J. 2014 Mar;23(3):627-34. doi: 10.1007/s00586-013-3123-8. PMID: 24318106. Exclusion: E11.

292. Fayed I, Conte AG, Keating G, et al. Comparison of clinical and radiographic outcomes after standalone versus cage and plate constructs for anterior cervical discectomy and fusion. Int J Spine Surg. 2021 Jun;15(3):403-12. doi: 10.14444/8060. PMID: 33963034. Exclusion: E12.

293. Fehlings MG, Badhiwala JH, Ahn H, et al. Safety and efficacy of riluzole in patients undergoing decompressive surgery for degenerative cervical myelopathy (CSM-Protect): a multicentre, double-blind, placebo-controlled, randomised, phase 3 trial. Lancet neurol. 2021 02;20(2):98-106. doi: 10.1016/S1474-4422(20)30407-5. PMID: 33357512. Exclusion: E2.

294. Fehlings MG, Kopjar B, Ahn H, et al. Role of the sodium/glutamate blocker riluzole in enhancing functional outcomes in patient undergoing surgery for degenerative cervical myelopathy: results of the prospective, multicenter double-blind controlled csm-protect randomized controlled trial. Clin Neurosurg. 2018;Conference:. Vol.65(Supplement 1):105-6p. doi: 10.1093/neuros/nyy303.172. Exclusion: E6.

295. Fehlings MG, Santaguida C, Kopjar B, et al. Laminectomy and fusion versus laminoplasty for the treatment of cervical spondylotic myelopathy: results from the aospine North America and international prospective multicenter CSM studies. Spine journal. 2015 Netherlands Elsevier Inc;Conference: 30th annual meeting of the north american spine society, NASS. Vol.15(10 Supplement 1):88S-9Sp. doi: 10.1016/j.spinee.2015.07.017. Exclusion: E6.

296. Fehlings MG, Smith JS, Kopjar B, et al. Perioperative and delayed complications associated with the surgical treatment of cervical spondylotic myelopathy based on 302 patients from the AOSpine North America Cervical Spondylotic Myelopathy Study. J Neurosurg Spine. 2012 May;16(5):425-32. doi: 10.3171/2012.1.SPINE11467. PMID: 22324802. Exclusion: E9.

297. Fehlings MG, Tetreault LA, Kurpad S, et al. Change in functional impairment, disability, and quality of life following operative treatment for degenerative cervical myelopathy: a systematic review and meta-analysis. Global spine j. 2017 Sep;7(3 Suppl):53S-69S. doi: 10.1177/2192568217710137. PMID: 29164033. Exclusion: E8.

298. Fehlings MG, Tetreault LA, Riew KD, et al. A clinical practice guideline for the management of patients with degenerative cervical myelopathy: recommendations for patients with mild, moderate, and severe disease and nonmyelopathic patients with evidence of cord compression. Global spine j. 2017 Sep;7(3 Suppl):70S-83S. doi: 10.1177/2192568217701914. PMID: 29164035. Exclusion: E6.

299. Fei Q, Li J, Su N, et al. Comparison between anterior cervical discectomy with fusion and anterior cervical corpectomy with fusion for the treatment of cervical spondylotic myelopathy: a meta-analysis. Therapeutics and Clinical Risk Management. 2015;11:1707-18. doi: 10.2147/TCRM.S94290. PMID: 26604771. Exclusion: E3.

300. Feiz-Erfan I, Harrigan M, Sonntag VK, et al. Effect of autologous platelet gel on early and late graft fusion in anterior cervical spine surgery. J Neurosurg Spine. 2007 Nov;7(5):496-502. doi: 10.3171/SPI-07/11/496. PMID: 17977190. Exclusion: E3.

301. Fellrath Jr RF, Hanley Jr EN. The causes and management of pseudarthrosis following anterior cervical arthrodesis. Seminars in Spine Surgery. 1995;7(1):43-51. Exclusion: E6.

302. Feng SW, Chang MC, Chou PH, et al. Implantation of an empty polyetheretherketone cage in anterior cervical discectomy and fusion: a prospective randomised controlled study with 2 years follow-up. Eur Spine J. 2018 06;27(6):1358-64. doi: 10.1007/s00586-017-5450-7. PMID: 29322313. Exclusion: E3.

303. Feng X, Hu Y, Ma X. Progression prediction of mild cervical spondylotic myelopathy by somatosensory-evoked potentials. Spine. 2020 May 15;45(10):E560-E7. doi: 10.1097/BRS.0000000000003348. PMID: 31770314. Exclusion: E2.

304. Feng YT, Hwang SL, Lin CL, et al. Safety and resource utilization of anterior cervical discectomy and fusion. Kaohsiung J Med Sci. 2012 Sep;28(9):495-9. doi: 10.1016/j.kjms.2012.04.007. PMID: 22974669. Exclusion: E11.

305. Fengbin Y, Jinhao M, Xinyuan L, et al. Evaluation of a new type of titanium mesh cage versus the traditional titanium mesh cage for single-level, anterior cervical corpectomy and fusion. Eur Spine J. 2013 Dec;22(12):2891-6. doi: 10.1007/s00586-013-2976-1. PMID: 24000074. Exclusion: E11.

306. Fernandez de Rota JJ, Meschian S, Fernandez de Rota A, et al. Cervical spondylotic myelopathy due to chronic compression: the role of signal intensity changes in magnetic resonance images. J Neurosurg Spine. 2007 Jan;6(1):17-22. doi: 10.3171/spi.2007.6.1.4. PMID: 17233286. Exclusion: E11.

307. Fernandez-Fairen M, Alvarado E, Torres A. Eleven-year follow-up of two cohorts of patients comparing stand-alone porous tantalum cage versus autologous bone graft and plating in anterior cervical fusions. World Neurosurg; 2019. p. e156-e67. Exclusion: E3.

308. Fernandez-Fairen M, Sala P, Dufoo M, Jr., et al. Anterior cervical fusion with tantalum implant: a prospective randomized controlled study. Spine. 2008 Mar 01;33(5):465-72. doi: 10.1097/BRS.0b013e3181657f49. PMID: 18317188. Exclusion: E3.

309. Filip M, Linzer P, Samal F, et al. Bioactive titan cage Implaspin in treatment of degenerative disease of the cervcal spine--the results from 2007 till 2008. Chir Narzadow Ruchu Ortop Pol. 2010 Jan-Feb;75(1):69-73. PMID: 20496781. Exclusion: E5.

310. Findlay C, Ayis S, Demetriades AK. Total disc replacement versus anterior cervical discectomy and fusion: a systematic review with meta-analysis of data from a total of 3160 patients across 14 randomized controlled trials with both short- and medium- to long-term outcomes. Bone Joint J. 2018 08;100-B(8):991-1001. doi: 10.1302/0301-620X.100B8.BJJ-2018-0120.R1. PMID: 30062947. Exclusion: E2.

311. Fineberg SJ, Ahmadinia K, Oglesby M, et al. Hospital outcomes and complications of anterior and posterior cervical fusion with bone morphogenetic protein. Spine. 2013 Jul 01;38(15):1304-9. doi: 10.1097/BRS.0b013e31828f494c. PMID: 23462577. Exclusion: E11 - per Shelley's email 1/17.

312. Fineberg SJ, Oglesby M, Patel AA, et al. Incidence and mortality of perioperative cardiac events in cervical spine surgery. Spine. 2013 Jul 01;38(15):1268-74. doi: 10.1097/BRS.0b013e318290fdac. PMID: 23486411. Exclusion: E3.

313. Fineberg SJ, Oglesby M, Patel AA, et al. Incidence, risk factors, and mortality associated with aspiration in cervical spine surgery. Spine. 2013 Sep 01;38(19):E1189-95. doi: 10.1097/BRS.0b013e31829cc19b. PMID: 23715029. Exclusion: E4.

314. Fisahn C, Schmidt C, Rustagi T, et al. Comparison of chronic dysphagia in standalone versus conventional plate and cage fusion. World Neurosurg. 2018 Jan;109:e382-e8. doi: 10.1016/j.wneu.2017.09.188. PMID: 28987856. Exclusion: E12.

315. Floyd T, Ohnmeiss D. A meta-analysis of autograft versus allograft in anterior cervical fusion. Eur Spine J. 2000 Oct;9(5):398-403. doi: 10.1007/s005860000160. PMID: 11057533. Exclusion: E8.

316. Formica M, Zanirato A, Cavagnaro L, et al. Extreme lateral interbody fusion in spinal revision surgery: clinical results and complications. Eur Spine J. 2017 10;26(Suppl 4):464-70. doi: 10.1007/s00586-017-5115-6. PMID: 28488095. Exclusion: E2.

317. Fountas K, Kapsalaki E, Nikolakakos L, et al. Anterior cervical discectomy and fusion associated complications. Spine. 2007 Oct 1;32(21):2310-7. doi: 10.1097/BRS.0b013e318154c57e. PMID: 17906571. Exclusion: E11.

318. Fourney D, Skelly A, DeVine J. Treatment of cervical adjacent segment pathology: a systematic review. Spine. 2012 Oct 15;37(22 Suppl):S113-S22. doi: 10.1097/BRS.0b013e31826d6284. PMID: 22885831. Exclusion: E8.

319. Fouyas IP, Statham PF, Sandercock PA, et al. Surgery for cervical radiculomyelopathy. Cochrane Database Syst Rev. 2001(3):Cd001466. doi: 10.1002/14651858.Cd001466. PMID: 11686992. Exclusion: E8.

320. Franco A, Nina P, Arpino L, et al. Use of resorbable implants for symptomatic cervical spondylosis: experience on 16 consecutive patients. J Neurosurg Sci. 2007 Dec;51(4):169-75. PMID: 18176526. Exclusion: E5.

321. Fransen P, Hansen-Algenstaedt N, Chatzisotiriou A, et al. Radiographic outcome and adjacent segment evaluation two years after cervical disc replacement with the Baguera® C prosthesis as treatment of degenerative cervical disc disease. J Spine. 2016;5(2):1-7. Exclusion: E2.

322. Fraser JF, Hartl R. Anterior approaches to fusion of the cervical spine: a metaanalysis of fusion rates. J Neurosurg Spine. 2007 Apr;6(4):298-303. PMID: 17436916. Exclusion: E8.

323. Fu S, Zhang C, Yan X, et al. Volumetric Changes in Cervical Disc Herniation: Comparison of Cervical Expansive Open-door Laminoplasty and Cervical Microendoscopic Laminoplasty. Spine. 2022 04 01;47(7):E296-E303. doi: 10.1097/BRS.0000000000004197. PMID: 34381000. Exclusion: E4.

324. Fujibayashi S, Neo M, Nakamura T. Stand-alone interbody cage versus anterior cervical plate for treatment of cervical disc herniation: sequential changes in cage subsidence. J Clin Neurosci. 2008 Sep;15(9):1017-22. doi: 10.1016/j.jocn.2007.05.011. PMID: 18653347. Exclusion: E7.

325. Fujiwara K, Yonenobu K, Ebara S, et al. The prognosis of surgery for cervical compression myelopathy. An analysis of the factors involved. J Bone Joint Surg Br. 1989 May;71(3):393-8. doi: 10.1302/0301-620x.71b3.2722928. PMID: 2722928. Exclusion: E5.

326. Funaba M, Kanchiku T, Yoshida G, et al. Efficacy of Intraoperative Neuromonitoring Using Transcranial Motor-Evoked Potentials for Degenerative Cervical Myelopathy: a Prospective Multicenter Study by the Monitoring Committee of the Japanese Society for Spine Surgery and Related Research. Spine. 2022 Jan 01;47(1):E27-E37. doi: 10.1097/BRS.0000000000004156. PMID: 34224513. Exclusion: E5.

327. Gabr MA, Touko E, Yadav AP, et al. Improved dysphagia outcomes in anchored spacers versus plate-screw systems in anterior cervical discectomy and fusion: a systematic review. Global spine j. 2020 Dec;10(8):1057-65. doi: 10.1177/2192568219895266. PMID: 32875838. Exclusion: E8.

328. Galivanche AR, Gala R, Bagi PS, et al. Perioperative outcomes in 17,947 patients undergoing 2-level anterior cervical discectomy and fusion versus 1-level anterior cervical corpectomy for treatment of cervical degenerative conditions: a propensity score matched national surgical quality improvement program analysis. Neurospine. 2020 Dec;17(4):871-8. doi: 10.14245/ns.2040134.067. PMID: 33401865. Exclusion: E5.

329. Ganau M, Holly LT, Mizuno J, et al. Future directions and new technologies for the management of degenerative cervical myelopathy. Neurosurg Clin N Am. 2018 Jan;29(1):185-93. doi: 10.1016/j.nec.2017.09.006. PMID: 29173432. Exclusion: E9.

330. Gao F, Mao T, Sun W, et al. An updated meta-analysis comparing artificial cervical disc arthroplasty (CDA) versus anterior cervical discectomy and fusion (ACDF) for the treatment of cervical degenerative disc disease (CDDD). Spine. 2015 Dec;40(23):1816-23. doi: 10.1097/BRS.0000000000001138. PMID: 26571063. Exclusion: E8.

331. Gao QY, Wei FL, Zhu KL, et al. Clinical efficacy and safety of surgical treatments in patients with pure cervical radiculopathy. Front Public Health. 2022 July 14;10:892042. doi: 10.3389/fpubh.2022.892042. PMID: 35910906. Exclusion: E8.

332. Gao X, Yang Y, Liu H, et al. A comparison of cervical disc arthroplasty and anterior cervical discectomy and fusion in patients with two-level cervical degenerative disc disease: 5-year follow-up results. World Neurosurg. 2019 Feb;122:e1083-e9. doi: 10.1016/j.wneu.2018.10.231. PMID: 30415055. Exclusion: E11.

333. Gao Y, Liu M, Li T, et al. A meta-analysis comparing the results of cervical disc arthroplasty with anterior cervical discectomy and fusion (ACDF) for the treatment of symptomatic cervical disc disease. J Bone Joint Surg Am. 2013 Mar 20;95(6):555-61. doi: 10.2106/JBJS.K.00599. PMID: 23515991. Exclusion: E8.

334. Garcia RM, Qureshi SA, Cassinelli EH, et al. Detection of postoperative neurologic deficits using somatosensory-evoked potentials alone during posterior cervical laminoplasty. Spine J. 2010 Oct;10(10):890-5. doi: 10.1016/j.spinee.2010.08.018. PMID: 20869003. Exclusion: E3.

335. Garcia S, Schaffer NE, Wallace N, et al. Perioperative corticosteroids reduce dysphagia severity following anterior cervical spinal fusion: a meta-analysis of randomized controlled trials. J Bone Joint Surg Am. 2021 05 05;103(9):821-8. doi: 10.2106/JBJS.20.01756. PMID: 33617164. Exclusion: E2.

336. Garrido BJ, Taha TA, Sasso RC. Clinical outcomes of Bryan cervical disc arthroplasty a prospective, randomized, controlled, single site trial with 48-month follow-up. J Spinal Disord Tech. 2010 Aug;23(6):367-71. doi: 10.1097/BSD.0b013e3181bb8568. PMID: 20087223. Exclusion: E5.

337. Garrido BJ, Wilhite J, Nakano M, et al. Adjacent-level cervical ossification after Bryan cervical disc arthroplasty compared with anterior cervical discectomy and fusion. J Bone Joint Surg Am. 2011 Jul 06;93(13):1185-9. doi: 10.2106/JBJS.J.00029. PMID: 21776570. Exclusion: E1.

338. Garringer SM, Sasso RC. Safety of anterior cervical discectomy and fusion performed as outpatient surgery. J Spinal Disord Tech. 2010 Oct;23(7):439-43. doi: 10.1097/BSD.0b013e3181bd0419. PMID: 20087224. Exclusion: E3.

339. Gause PR, Davis RA, Smith PN, et al. Success of junctional anterior cervical discectomy and fusion. Spine J. 2008 Sep-Oct;8(5):723-8. doi: 10.1016/j.spinee.2007.07.002. PMID: 17983842. Exclusion: E3.

340. Gebremariam L, Koes BW, Peul WC, et al. Evaluation of treatment effectiveness for the herniated cervical disc: a systematic review. Spine. 2012 Jan 15;37(2):E109-18. doi: 10.1097/BRS.0b013e318221b5af. PMID: 21587105. Exclusion: E9.

341. Gebreyohanes A, Erotocritou M, Choi D. Appraising the evidence for conservative versus surgical management of motor deficits in degenerative cervical radiculopathy. Global spine j. 2022 Jun 16 doi: 10.1177/21925682221109562. PMID: 35708971. Exclusion: E8 - exclude but use for KQ 3 background.

342. Geisler FH, Caspar W, Pitzen T, et al. Reoperation in patients after anterior cervical plate stabilization in degenerative disease. Spine. 1998 Apr 15;23(8):911-20. doi: 10.1097/00007632-199804150-00013. PMID: 9580959. Exclusion: E12.

343. Gembruch O, Jabbarli R, Rashidi A, et al. Degenerative cervical myelopathy in higher-aged patients: How do they benefit from surgery? J. 2019 Dec 26;9(1):26. doi: 10.3390/jcm9010062. PMID: 31888031. Exclusion: E11.

344. Gendreau JL, Kim LH, Prins PN, et al. Outcomes after cervical disc arthroplasty versus stand-alone anterior cervical discectomy and fusion: a meta-analysis. Global spine j. 2020 Dec;10(8):1046-56. doi: 10.1177/2192568219888448. PMID: 32875831. Exclusion: E8.

345. Genitiempo M, Perna A, Santagada DA, et al. Single-level Bryan cervical disc arthroplasty: evaluation of radiological and clinical outcomes after 18 years of follow-up. Eur Spine J. 2020 11;29(11):2823-30. doi: 10.1007/s00586-020-06486-5. PMID: 32529522. Exclusion: E3.

346. Gerszten PC, Paschel E, Mashaly H, et al. Outcomes evaluation of zero-profile devices compared to stand-alone peek cages for the treatment of three- and four-level cervical disc disease. Cureus. 2016 Sep 10;8(9):e775. doi: 10.7759/cureus.775. PMID: 27738574. Exclusion: E11.

347. Ghobrial GM, Harrop JS, Sasso RC, et al. Anterior cervical infection: presentation and incidence of an uncommon postoperative complication. Global spine j. 2017 Apr;7(1 Suppl):12S-6S. doi: 10.1177/2192568216687546. PMID: 28451485. Exclusion: E5.

348. Ghogawala Z, Benzel EC, Heary RF, et al. Cervical spondylotic myelopathy surgical trial: randomized, controlled trial design and rationale. Neurosurgery. 2014 Oct;75(4):334-46. doi: 10.1227/NEU.0000000000000479. PMID: 24991714. Exclusion: E3.

349. Ghogawala Z, Brook M, Benzel EC, et al. Comparative effectiveness of ventral versus dorsal surgery for cervical spondylotic myelopathy. Eur Spine J. 2010 START: 2010 May 26 CONFERENCE END: 2010 May 29 CSRS-ES Congress 2010 Kurfu Greece;19(6):1054p. doi: 10.1007/s00586-010-1436-4. Exclusion: E6.

350. Ghogawala Z, Kanter A, Mummaneni P, et al. Early results from the multi-center prospective, randomized CSM-S study: overall quality of life improvement, complications, and heath resource utilization. J Neurosurg. 2020 to 2020-04-29;132(4):70-p. doi: 10.3171/2020.4.JNS.AANS2020abstracts. Exclusion: E6.

351. Ghogawala Z, Martin B, Benzel EC, et al. Comparative effectiveness of ventral vs dorsal surgery for cervical spondylotic myelopathy. Neurosurgery. 2011 Mar;68(3):622-30; discussion 30-1. doi: 10.1227/NEU.0b013e31820777cf. PMID: 21164373. Exclusion: E2.

352. Ghogawala Z, Terrin N, Dunbar MR, et al. Effect of ventral vs dorsal spinal surgery on patient-reported physical functioning in patients with cervical spondylotic myelopathy: a randomized clinical trial. JAMA. 2021 03 09;325(10):942-51. doi: 10.1001/jama.2021.1233. PMID: 33687463. Exclusion: E1.

353. Gibson A, Feroze A, Greil M, et al. Cellular allograft for multilevel stand-alone anterior cervical discectomy and fusion. Neurosurg Focus. 2021 Jun;50(6):E7. doi: 10.3171/2021.3.FOCUS2150. PMID: 34062509. Exclusion: E11.

354. Godlewski B, Bebenek A, Dominiak M, et al. Subsidence following cervical discectomy and implant-to-bone ratio. BMC Musculoskelet Disord. 2022 Aug 4;23(1):750. doi: 10.1186/s12891-022-05698-8. PMID: 35927645. Exclusion: E4.

355. Godlewski B, Dominiak M. Advantages and disadvantages of the use of various types of interbody implants in cervical spine surgery. Critical review of the literature. Ortop. 2020 Aug 31;22(4):213-20. doi: 10.5604/01.3001.0014.3457. PMID: 32986004. Exclusion: E5.

356. Goedmakers CMW, de Vries F, Bosscher L, et al. Long-term results of the NECK trial: implanting a disc prosthesis after cervical anterior discectomy cannot prevent adjacent segment disease. 5-years clinical follow-up of a double-blinded randomised controlled trial. Spine J. 2022 Mar;23(3):350-60. doi: 10.1016/j.spinee.2022.11.006. PMID: 36396007. Exclusion: E2.

357. Goedmakers CMW, Janssen T, Yang X, et al. Cervical radiculopathy: is a prosthesis preferred over fusion surgery? A systematic review. Eur Spine J. 2020 11;29(11):2640-54. doi: 10.1007/s00586-019-06175-y. PMID: 31641906. Exclusion: E8.

358. Goel A, Vutha R, Shah A, et al. Cervical spondylosis in patients presenting with 'severe' myelopathy: analysis of treatment by multisegmental spinal fixation - A case series. Journal of Craniovertebral Junction and Spine. 2019;10(3):144-51. doi: 10.4103/jcvjs.JCVJS_82_19. PMID: 31772426. Exclusion: E5.

359. Goh BC, Lightsey HMt, Lopez WY, et al. Magnetic resonance imaging is inadequate to assess cervical sagittal alignment parameters. Clin Spine Surg. 2022 Mar 1;36(2):E70-E4. doi: 10.1097/BSD.0000000000001382. PMID: 35969678. Exclusion: E4.

360. Goh GS, Yue WM, Guo CM, et al. Does the predominant pain location influence functional outcomes, satisfaction and return to work after anterior cervical discectomy and fusion for cervical radiculopathy? Spine. 2021 May 15;46(10):E568-E75. doi: 10.1097/BRS.0000000000003855. PMID: 33290363. Exclusion: E4.

361. Gok B, Sciubba DM, McLoughlin GS, et al. Revision surgery for cervical spondylotic myelopathy: surgical results and outcome. Neurosurgery. 2008 Aug;63(2):292-8; discussion 8. doi: 10.1227/01.NEU.0000320441.86936.99. PMID: 18797359. Exclusion: E2.

362. Goldberg G, Albert TJ, Vaccaro AR, et al. Short-term comparison of cervical fusion with static and dynamic plating using computerized motion analysis. Spine. 2007 Jun 01;32(13):E371-5. doi: 10.1097/BRS.0b013e318060cca9. PMID: 17545900. Exclusion: E4.

363. Goldberg JL, Meaden RM, Hussain I, et al. Titanium versus polyetheretherketone versus structural allograft in anterior cervical discectomy and fusion: a systematic review. Brain Spine. 2022 Aug 22;2:100923. doi: 10.1016/j.bas.2022.100923. PMID: 36248133. Exclusion: E8.

364. Goldstein ZH, Boody B, Sasso R. Two-level anterior cervical discectomy and fusion versus cervical disc arthroplasty-long-term evidence update. Int J Spine Surg. 2020 Aug;14(s2):S36-S40. doi: 10.14444/7089. PMID: 32994304. Exclusion: E8.

365. González-Feria L, Peraita-Peraita P. Cervical spondylotic myelopathy: a cooperative study. Clin Neurol Neurosurg. 1975;78(1):19-33. doi: 10.1016/s0303-8467(75)80004-7. PMID: 1157427. Exclusion: E11.

366. Gonzalez GA, Corso K, Kr S, et al. Incidence of pseudarthrosis and subsequent surgery after cervical fusion surgery: a retrospective review of a national health care claims database. World Neurosurg. 2022 Nov;167:e806-e45. doi: 10.1016/j.wneu.2022.08.094. PMID: 36041719. Exclusion: E4.

367. Gornet MF, Burkus JK, Shaffrey ME, et al. Cervical disc arthroplasty with PRESTIGE LP disc versus anterior cervical discectomy and fusion: a prospective, multicenter investigational device exemption study. J Neurosurg Spine. 2015 Nov;23(5):558-73. doi: 10.3171/2015.1.SPINE14589. PMID: 26230424. Exclusion: E3.

368. Gornet MF, Burkus JK, Shaffrey ME, et al. Cervical disc arthroplasty with prestige LP disc versus anterior cervical discectomy and fusion: seven-year outcomes. Spine journal. 2015 Netherlands Elsevier Inc;Conference: 30th annual meeting of the north american spine society, NASS. Vol.15(10 Supplement 1):127S-8Sp. doi: 10.1016/j.spinee.2015.07.116. Exclusion: E6.

369. Gornet MF, Lanman T, McConnell J, et al. Two-level cervical disc arthroplasty vs. ACDF: a prospective, randomized, controlled multicenter clinical trial with 5-year results. Eur Spine J. 2015 START: 2015 Sep 2 CONFERENCE END: 2015 Sep 4 EUROSPINE Meetings 2015 Copenhagen Denmark;24(var.pagings). Vol.24(6 SUPPL. 1):S704p. doi: 10.1007/s00586-015-4129-1. Exclusion: E6.

370. Gornet MF, Lanman TH, Burkus JK, et al. Two-level cervical disc arthroplasty with prestige LP disc versus anterior cervical discectomy and fusion: seven-year outcomes of a prospective, randomized IDE clinical trial. Spine journal. 2016 to 2016-10-29;16(10):S283-S4p. doi: 10.1016/j.spinee.2016.07.201. Exclusion: E6.

371. Gornet MF, Lanman TH, Burkus JK, et al. 76. Reduction in opioid medication use after arthroplasty with Prestige LP cervical disc as compared to ACDF in patients with two-level surgery: a randomized study with 10-year follow-up. Spine journal. 2020 to 2020-10-10;20(9):S37-p. doi: 10.1016/j.spinee.2020.05.179. Exclusion: E6.

372. Gornet MF, Lanman TH, Kenneth Burkus J, et al. One-level versus 2-level treatment with cervical disc arthroplasty or fusion: Outcomes up to 7 years. Int J Spine Surg. 2019;13(6):551-60. doi: 10.14444/6076. PMID: 31970051. Exclusion: E5.

373. Gornet MF, McConnell JR, Burkus JK, et al. Two-level cervical disc arthroplasty with PRESTIGE LP disc versus ACDF: a Prospective, randomized, controlled multicenter clinical trial with 24-month results. Spine journal. 2015 START: 2015 Oct 14 CONFERENCE END: 2015 Oct 17 30th Annual Meeting of the North American Spine Society, NASS 2015 Chicago, IL United States;15(10 SUPPL. 1):S130p. doi: 10.1016/j.spinee.2015.07.120. Exclusion: E6.

374. Gornet MF, Schranck FW, Sorensen KM, et al. Multilevel cervical disc arthroplasty: long-term outcomes at 3 and 4 levels. Int J Spine Surg. 2020 Aug;14(s2):S41-S9. doi: 10.14444/7090. PMID: 32994305. Exclusion: E5.

375. Gorter K. Influence of laminectomy on the course of cervical myelopathy. Acta Neurochir (Wien). 1976;33(3-4):265-81. doi: 10.1007/bf01886675. PMID: 941717. Exclusion: E6.

376. Gould H, Sohail OA, Haines CM. Anterior cervical discectomy and fusion: techniques, complications, and future directives. Seminars in Spine Surgery. 2020;32(1) doi: 10.1016/j.semss.2019.100772. Exclusion: E6.

377. Goyal A, Akhras A, Wahood W, et al. Should multilevel posterior cervical fusions involving c7 cross the cervicothoracic junction? A systematic review and meta-analysis. World Neurosurg. 2019 Jul;127:588-95.e5. doi: 10.1016/j.wneu.2019.03.283. PMID: 30954754. Exclusion: E3.

378. Goz V, Buser Z, D'Oro A, et al. Complications and risk factors using structural allograft versus synthetic cage: analysis 17 783 anterior cervical discectomy and fusions using a national registry. Global spine j. 2019 Jun;9(4):388-92. doi: 10.1177/2192568218797096. PMID: 31218196. Exclusion: E3 - per Shelley's email 1/17.

379. Graham N, Gross A, Goldsmith CH, et al. Mechanical traction for neck pain with or without radiculopathy. Cochrane Database Syst Rev. 2011(2). Exclusion: E9.

380. Graham RS, Samsell BJ, Proffer A, et al. Evaluation of glycerol-preserved bone allografts in cervical spine fusion: a prospective, randomized controlled trial. J Neurosurg Spine. 2015 Jan;22(1):1-10. doi: 10.3171/2014.9.SPINE131005. PMID: 25360528. Exclusion: E3 - per Shelley's email 1/17.

381. Grasso G, Landi A. Long-term clinical and radiological outcomes following anterior cervical discectomy and fusion by zero-profile anchored cage. J Craniovertebr Junction Spine. 2018 Apr-Jun;9(2):87-92. doi: 10.4103/jcvjs.JCVJS_36_18. PMID: 30008525. Exclusion: E5.

382. Gregorius FK, Estrin T, Crandall PH. Cervical spondylotic radiculopathy and myelopathy. A long-term follow-up study. Arch Neurol. 1976 Sep;33(9):618-25. doi: 10.1001/archneur.1976.00500090024005. PMID: 962644. Exclusion: E5.

383. Grieve JP, Kitchen ND, Moore AJ, et al. Results of posterior cervical foraminotomy for treatment of cervical spondylitic radiculopathy. Br J Neurosurg. 2000 Feb;14(1):40-3. doi: 10.1080/02688690042898. PMID: 10884883. Exclusion: E5.

384. Grob D, Peyer JV, Dvorak J. The use of plate fixation in anterior surgery of the degenerative cervical spine: a comparative prospective clinical study. Eur Spine J. 2001 Oct;10(5):408-13. doi: 10.1007/s005860000210. PMID: 11718195. Exclusion: E3.

385. Grochmal JK, Lozen AM, Klein AP, et al. Interobserver reliability of magnetic resonance imaging predictors of outcome in cervical spine degenerative conditions. World Neurosurg. 2018 Sep;117:e215-e20. doi: 10.1016/j.wneu.2018.05.242. PMID: 29913296. Exclusion: E5.

386. Grodzinski B, Bestwick H, Bhatti F, et al. Research activity amongst DCM research priorities. Acta Neurochir (Wien). 2021 06;163(6):1561-8. doi: 10.1007/s00701-021-04767-6. PMID: 33625603. Exclusion: E8.

387. Guan J, Mummaneni P, Kanter A, et al. Preliminary return to work data from the multi-center prospective, randomized CSM-S study: approach matters. J Neurosurg. 2018 to 2018-05-02;128(4):19-20p. doi: 10.3171/2018.4.JNS.AANS2018abstracts. Exclusion: E6.

388. Guan T, Hu Z, Xiu L, et al. [Effect of cervical disc arthroplasty and anterior cervical decompression and fusion on adjacent segment degeneration]. Chinese journal of reparative and reconstructive surgery. 2014 Sep;28(9):1100-5. PMID: 25509774. Exclusion: E10.

389. Guigui P, Benoist M, Deburge A. Spinal deformity and instability after multilevel cervical laminectomy for spondylotic myelopathy. Spine (Phila Pa 1976). 1998 Feb 15;23(4):440-7. doi: 10.1097/00007632-199802150-00006. PMID: 9516698. Exclusion: E5.

390. Guo H, Sheng J, Sheng WB, et al. An eight-year follow-up study on the treatment of single-level cervical spondylosis through intervertebral disc replacement and anterior cervical decompression and fusion. Orthop Surg. 2020 Jun;12(3):717-26. doi: 10.1111/os.12634. PMID: 32291950. Exclusion: E11.

391. Guo L, Wang J, Zhao Z, et al. Microscopic anterior cervical discectomy and fusion versus posterior percutaneous endoscopic cervical keyhole foraminotomy for single-level unilateral cervical radiculopathy: a systematic review and meta-analysis. Clin Spine Surg. 2022 Mar 29;29:29. doi: 10.1097/BSD.0000000000001327. PMID: 35344521. Exclusion: E8.

392. Guo Q, Bi X, Ni B, et al. Outcomes of three anterior decompression and fusion techniques in the treatment of three-level cervical spondylosis. Eur Spine J. 2011 Sep;20(9):1539-44. doi: 10.1007/s00586-011-1735-4. PMID: 21448583. Exclusion: E3.

393. Guo Q, Wang L, Zhang B, et al. Standalone anterior cervical discectomy and fusion versus combination with foraminotomy for the treatment of cervical spondylotic radiculopathy secondary to bony foraminal stenosis. World Neurosurg. 2016 Nov;95:134-42. doi: 10.1016/j.wneu.2016.07.099. PMID: 27506401. Exclusion: E7.

394. Guo S, Lin T, Wu R, et al. The pre-operative duration of symptoms: the most important predictor of post-operative efficacy in patients with degenerative cervical myelopathy. Brain Sci. 2022 Aug 17;12(8):1088. doi: 10.3390/brainsci12081088. PMID: 36009151. Exclusion: E5.

395. Guo YC, Hu WH, Zhang YH, et al. Modified cervical laminoplasty combined with isometric neck muscle exercise for the treatment of cervical myelopathy: 24 months of follow-up. Chinese journal of tissue engineering research. 2016 Journal of Clinical Rehabilitative Tissue Engineering Research (E-mail: lei0415@hotmail;20(37):5545-51p. Exclusion: E10.

396. Guo Z, Wu X, Yang S, et al. Anterior cervical discectomy and fusion using zero-p system for treatment of cervical spondylosis: a meta-analysis. Pain Res Manag. 2021:3960553. doi: 10.1155/2021/3960553. PMID: 34956433. Exclusion: E8.

397. Gutman G, Rosenzweig DH, Golan JD. Surgical treatment of cervical radiculopathy: meta-analysis of randomized controlled trials. Spine. 2018 03 15;43(6):E365-E72. doi: 10.1097/BRS.0000000000002324. PMID: 28700452. Exclusion: E8.

398. Guven M, Cosar M, Alkan B, et al. Comparison of anterior cervical discectomy fusion techniques: bladed and non bladed PEEK cages. Turk. 2016;26(3):404-10. doi: 10.5137/1019-5149.JTN.12797-14.1. PMID: 27161468. Exclusion: E11.

399. Guyer RD, Coric D, Nunley PD, et al. Single-level cervical disc replacement using a PEEK-on-ceramic implant: results of a multicenter FDA IDE trial With 24-month follow-up. Int J Spine Surg. 2021 Aug;15(4):633-44. doi: 10.14444/8084. PMID: 34281951. Exclusion: E12.

400. Ha Y, Shin JJ. Comparison of clinical and radiological outcomes in cervical laminoplasty versus laminectomy with fusion in patients with ossification of the posterior longitudinal ligament. Neurosurg Rev. 2020 Oct;43(5):1409-21. doi: 10.1007/s10143-019-01174-5. PMID: 31512014. Exclusion: E11.

401. Hacker FM, Babcock RM, Hacker RJ. Very late complications of cervical arthroplasty: results of 2 controlled randomized prospective studies from a single investigator site. Spine. 2013 Dec 15;38(26):2223-6. doi: 10.1097/BRS.0000000000000060. PMID: 24335628. Exclusion: E5.

402. Hacker RJ. A randomized prospective study of an anterior cervical interbody fusion device with a minimum of 2 years of follow-up results. J Neurosurg. 2000 Oct;93(2 Suppl):222-6. doi: 10.3171/spi.2000.93.2.0222. PMID: 11012052. Exclusion: E3.

403. Hacker RJ. Cervical disc arthroplasty: a controlled randomized prospective study with intermediate follow-up results. Invited submission from the joint section meeting on disorders of the spine and peripheral nerves, March 2005. J Neurosurg Spine. 2005 Dec;3(6):424-8. doi: 10.3171/spi.2005.3.6.0424. PMID: 16381203. Exclusion: E5.

404. Hacker RJ, Cauthen JC, Gilbert TJ, et al. A prospective randomized multicenter clinical evaluation of an anterior cervical fusion cage. Spine. 2000 Oct 15;25(20):2646-54; discussion 55. doi: 10.1097/00007632-200010150-00017. PMID: 11034651. Exclusion: E2.

405. Halvorsen CM, Lied B, Harr ME, et al. Surgical mortality and complications leading to reoperation in 318 consecutive posterior decompressions for cervical spondylotic myelopathy. Acta Neurol Scand. 2011 May;123(5):358-65. doi: 10.1111/j.1600-0404.2010.01405.x. PMID: 20880266. Exclusion: E11.

406. Hamanishi C, Tanaka S. Bilateral multilevel laminectomy with or without posterolateral fusion for cervical spondylotic myelopathy: relationship to type of onset and time until operation. J Neurosurg. 1996 Sep;85(3):447-51. doi: 10.3171/jns.1996.85.3.0447. PMID: 8751631. Exclusion: E3.

407. Hamdan ARK. The relation between cord signal and clinical outcome after anterior cervical discectomy in patients with degenerative cervical disc herniation. Asian J Neurosurg. 2019 Jan-Mar;14(1):106-10. doi: 10.4103/ajns.AJNS_262_17. PMID: 30937019. Exclusion: E7.

408. Han CF, Hai Y, Liu YZ, et al. [A long-term follow up study of cervical spondylotic myelopathy using diffusion tensor imaging]. Chung Hua I Hsueh Tsa Chih. 2021 Nov 23;101(43):3594-9. doi: 10.3760/cma.j.cn112137-20210429-01030. PMID: 34808754. Exclusion: E10.

409. Han S, Kwon YC, Kim SM, et al. Risk factor analysis of change in intraoperative neurophysiologic monitoring during cervical open door laminoplasty. World Neurosurg. 2018 Nov;119:e235-e43. doi: 10.1016/j.wneu.2018.07.121. PMID: 30048788. Exclusion: E3.

410. Han X, Ma X, Li D, et al. The evaluation and prediction of laminoplasty surgery outcome in patients with degenerative cervical myelopathy using diffusion tensor MRI. AJNR Am J Neuroradiol. 2020 09;41(9):1745-53. doi: 10.3174/ajnr.A6705. PMID: 32816762. Exclusion: E1.

411. Handa Y, Kubota T, Ishii H, et al. Evaluation of prognostic factors and clinical outcome in elderly patients in whom expansive laminoplasty is performed for cervical myelopathy due to multisegmental spondylotic canal stenosis. A retrospective comparison with younger patients. J Neurosurg. 2002 Mar;96(2 Suppl):173-9. doi: 10.3171/spi.2002.96.2.0173. PMID: 12450280. Exclusion: E5.

412. Hansraj KK. Stem cells in spine surgery. Surg Technol Int. 2016 Oct 26;29:348-58. PMID: 27466864. Exclusion: E5.

413. Hao Q, Ding Q, Yang H, et al. Symptomatic postoperative spinal epidural hematoma preferentially occurs after anterior cervical discectomy and fusion versus anterior cervical corpectomy and fusion: a retrospective study. Ann Palliat Med. 2022 Jun;11(6):2025-32. doi: 10.21037/apm-22-488. PMID: 35817737. Exclusion: E3.

414. Hardman J, Graf O, Kouloumberis PE, et al. Clinical and functional outcomes of laminoplasty and laminectomy. Neurol Res. 2010 May;32(4):416-20. doi: 10.1179/174313209X459084. PMID: 19589202. Exclusion: E1.

415. Harel R, Nulman M, Kimchi G, et al. Short-term post-operative complications in 207 patients with multi-level degenerative cervical myelopathy: the effect of surgical approach. Neurol Neurochir Pol. 2022;56(5):404-9. doi: 10.5603/PJNNS.a2022.0052. PMID: 35801653. Exclusion: E11.

416. Harrington JF, Jr., Park MC. Single level arthrodesis as treatment for midcervical fracture subluxation: a cohort study. J Spinal Disord Tech. 2007 Feb;20(1):42-8. doi: 10.1097/01.bsd.0000211255.05626.b0. PMID: 17285051. Exclusion: E1.

417. Harris A, Marrache M, Jami M, et al. Chronic opioid use following anterior cervical discectomy and fusion surgery for degenerative cervical pathology. Spine J. 2020 Jan;20(1):78-86. doi: 10.1016/j.spinee.2019.09.011. PMID: 31536805. Exclusion: E4.

418. Harris O, Runnels J, Matz P. Clinical factors associated with unexpected critical care management and prolonged hospitalization after elective cervical spine surgery. Crit Care Med. 2001 Oct;29(10):1898-902. doi: 10.1097/00003246-200110000-00008. PMID: 11588448. Exclusion: E3.

419. Hasegawa K, Homma T, Chiba Y, et al. Effects of surgical treatment for cervical spondylotic myelopathy in patients > or = 70 years of age: a retrospective comparative study. J Spinal Disord Tech. 2002 Dec;15(6):458-60. doi: 10.1097/00024720-200212000-00004. PMID: 12468970. Exclusion: E5.

420. Hashimoto K, Aizawa T, Kanno H, et al. Adjacent segment degeneration after fusion spinal surgery-a systematic review. Int Orthop. 2019 04;43(4):987-93. doi: 10.1007/s00264-018-4241-z. PMID: 30470865. Exclusion: E5.

421. Hashimoto M, Mochizuki M, Aiba A, et al. C5 palsy following anterior decompression and spinal fusion for cervical degenerative diseases. Eur Spine J. 2010 Oct;19(10):1702-10. doi: 10.1007/s00586-010-1427-5. PMID: 20461418. Exclusion: E3.

422. Hatta Y, Shiraishi T, Hase H, et al. Is posterior spinal cord shifting by extensive posterior decompression clinically significant for multisegmental cervical spondylotic myelopathy? Spine (Phila Pa 1976). 2005 Nov 1;30(21):2414-9. doi: 10.1097/01.brs.0000184751.80857.3e. PMID: 16261118. Exclusion: E7.

423. Hauerberg J, Kosteljanetz M, Boge-Rasmussen T, et al. Anterior cervical discectomy with or without fusion with ray titanium cage: a prospective randomized clinical study. Spine. 2008 Mar 01;33(5):458-64. doi: 10.1097/BRS.0b013e3181657dac. PMID: 18317187. Exclusion: E3.

424. Hawasli AH, Cashin JL, Wright NM. Modular cervical plate system for adjacent segment disease. J Neurosurg Sci. 2020 Oct;64(5):427-33. doi: 10.23736/S0390-5616.18.04172-3. PMID: 29480680. Exclusion: E3.

425. Haws BE, Khechen B, Narain AS, et al. Impact of local steroid application on dysphagia following an anterior cervical discectomy and fusion: results of a prospective, randomized single-blind trial. J Neurosurg Spine. 2018 07;29(1):10-7. doi: 10.3171/2017.11.SPINE17819. PMID: 29676673. Exclusion: E1.

426. He B, Sheldrick K, Das A, et al. Clinical and research MRI techniques for assessing spinal cord integrity in degenerative cervical myelopathy- a scoping review. Biomedicines. 2022 Oct 18;10(10):2621. doi: 10.3390/biomedicines10102621. PMID: 36289883. Exclusion: E4.

427. He S, Zhou Z, Lv N, et al. Comparison of clinical outcomes following anterior cervical discectomy and fusion with zero-profile anchored spacer-roi-c-fixation and combined intervertebral cage and anterior cervical discectomy and fusion: a retrospective study from a single center. Med Sci Monit. 2021 Aug 15;27:e931050. doi: 10.12659/MSM.931050. PMID: 34392301. Exclusion: E11.

428. He S, Zhou Z, Shao X, et al. Comparing the bridge-type zero-profile anchored spacer (roi-c) interbody fusion cage system and anterior cervical discectomy and fusion (ACDF) with plating and cage system in cervical spondylotic myelopathy. Orthop Surg. 2022 Jun;14(6):1100-8. doi: 10.1111/os.13268. PMID: 35478487. Exclusion: E7.

429. He W, He D, Wang QL, et al. Longitudinal Spinous-Splitting Laminoplasty with Coral Bone for the Treatment of Cervical Adjacent Segment Degenerative Disease: a 5-Year Follow-up Study. Orthop Surg. 2022 Feb;14(2):435-42. doi: 10.1111/os.13027. PMID: 34939333. Exclusion: E2.

430. He Z, Liu Y, Xue F, et al. Surgical management of congenital cervical kyphosis. Orthopedics. 2012 Sep;35(9):e1396-401. doi: 10.3928/01477447-20120822-28. PMID: 22955408. Exclusion: E1.

431. Health Quality O. Cervical artificial disc replacement versus fusion for cervical degenerative disc disease: a health technology assessment. Ont Health Technol Assess Ser. 2019;19(3):1-223. PMID: 30847009. Exclusion: E8.

432. Heary RF, Ryken TC, Matz PG, et al. Cervical laminoforaminotomy for the treatment of cervical degenerative radiculopathy. J Neurosurg Spine. 2009 Aug;11(2):198-202. doi: 10.3171/2009.2.SPINE08722. PMID: 19769499. Exclusion: E6 - background.

433. Heary RF, Schlenk RP, Sacchieri TA, et al. Persistent iliac crest donor site pain: independent outcome assessment. Neurosurgery. 2002 Mar;50(3):510-6; discussion 6-7. doi: 10.1097/00006123-200203000-00015. PMID: 11841718. Exclusion: E5.

434. Heider FC, Sauer D, Pehlivanoglu T, et al. Does the design of an artifical disc device influence the clinical and radiological outcome of total cervical disc replacement-a prospective comparison trial with 2 years follow-up. Eur Spine J. 2017 to 2017-12-02;26(11):2987-p. doi: 10.1007/s00586-017-5336-8. Exclusion: E6.

435. Heidt ST, Louie PK, Khan JM, et al. Comparing allografts to autografts for maintenance of cervical sagittal parameters and clinical outcomes following anterior cervical discectomy and fusion with anterior cervical plating. Neurospine. 2019 Sep;16(3):618-25. doi: 10.14245/ns.1836202.101. PMID: 31154695. Exclusion: E12.

436. Heller JG, Edwards CC, 2nd, Murakami H, et al. Laminoplasty versus laminectomy and fusion for multilevel cervical myelopathy: an independent matched cohort analysis. Spine. 2001 Jun 15;26(12):1330-6. PMID: 11426147. Exclusion: E7.

437. Heller JG, Silcox DH, 3rd, Sutterlin CE, 3rd. Complications of posterior cervical plating. Spine. 1995 Nov 15;20(22):2442-8. doi: 10.1097/00007632-199511001-00013. PMID: 8578396. Exclusion: E3.

438. Helseth O, Lied B, Heskestad B, et al. Retrospective single-centre series of 1300 consecutive cases of outpatient cervical spine surgery: complications, hospital readmissions, and reoperations. Br J Neurosurg. 2019 Dec;33(6):613-9. doi: 10.1080/02688697.2019.1675587. PMID: 31607163. Exclusion: E3.

439. Henderson CM, Hennessy RG, Shuey HM, Jr., et al. Posterior-lateral foraminotomy as an exclusive operative technique for cervical radiculopathy: a review of 846 consecutively operated cases. Neurosurgery. 1983 Nov;13(5):504-12. doi: 10.1227/00006123-198311000-00004. PMID: 6316196. Exclusion: E5.

440. Herkowitz HN, Kurz LT, Overholt DP. Surgical management of cervical soft disc herniation. A comparison between the anterior and posterior approach. Spine (Phila Pa 1976). 1990 Oct;15(10):1026-30. doi: 10.1097/00007632-199015100-00009. PMID: 2263967. Exclusion: E7.

441. Hermansen A, Peolsson A, Hedlund R, et al. Balance problems and dizziness after neck surgery - associations with pain and health-related quality of life. Physiother. 2020 Oct;36(10):1145-52. doi: 10.1080/09593985.2019.1571137. PMID: 30686102. Exclusion: E4.

442. Hernandez-Duran S, Rohde V, Zafar N, et al. Clinical and imaging outcome in patients with cervical spondylotic myelopathy undergoing unilateral laminotomy and bilateral decompression in undercutting technique. Eur Spine J. 2018 to 2018-12-08;27(11):2916-p. doi: 10.1007/s00586-018-5770-2. Exclusion: E6.

443. Hey HW, Wong KL, Long AS, et al. Single-level anterior corpectomy with fusion versus 2-level anterior cervical decompression with fusion: a prospective controlled study with 2-year follow-up using cages for fusion. Ann Acad Med Singapore. 2015 May;44(5):188-90. PMID: 26198326. Exclusion: E3.

444. Hida T, Sakai Y, Ito K, et al. Cervical alignment and pain after laminoplasty for cervical compressive myelopathy with or without collar fixation: a randomized controlled study. Eur Spine J. 2012 to 2012-12-08;21(5):1029-p. doi: 10.1007/s00586-012-2317-9. Exclusion: E6.

445. Hida T, Sakai Y, Ito K, et al. Collar fixation is not mandatory after cervical laminoplasty-a randomized controlled study. Spine. 2015:288-9. Exclusion: E6.

446. Hida T, Yukawa Y, Ito K, et al. Intrathecal morphine for postoperative pain control after laminoplasty in patients with cervical spondylotic myelopathy. J Orthop Sci. 2016;21(4):425-30p. doi: 10.1016/j.jos.2016.03.004. Exclusion: E2.

447. Highsmith JM, Dhall SS, Haid RW, Jr., et al. Treatment of cervical stenotic myelopathy: a cost and outcome comparison of laminoplasty versus laminectomy and lateral mass fusion. J Neurosurg Spine. 2011 May;14(5):619-25. doi: 10.3171/2011.1.SPINE10206. PMID: 21388285. Exclusion: E11.

448. Hilibrand AS, Fye MA, Emery SE, et al. Increased rate of arthrodesis with strut grafting after multilevel anterior cervical decompression. Spine (Phila Pa 1976). 2002 Jan 15;27(2):146-51. doi: 10.1097/00007632-200201150-00005. PMID: 11805659. Exclusion: E11.

449. Hilton B, Tempest-Mitchell J, Davies BM, et al. Cord compression defined by MRI is the driving factor behind the decision to operate in Degenerative Cervical Myelopathy despite poor correlation with disease severity. PLoS ONE. 2019;14(12):e0226020. doi: 10.1371/journal.pone.0226020. PMID: 31877151. Exclusion: E4.

450. Hipp JA, Reitman CA, Wharton N. Defining pseudoarthrosis in the cervical spine with differing motion thresholds. Spine (Phila Pa 1976). 2005 Jan 15;30(2):209-10. doi: 10.1097/01.brs.0000151011.32573.f1. PMID: 15644758. Exclusion: E3.

451. Hirai T, Yoshii T, Arai Y, et al. A comparative study of anterior decompression with fusion and posterior decompression with laminoplasty for the treatment of cervical spondylotic myelopathy patients with large anterior compression of the spinal cord. Clin Spine Surg. 2017 Oct;30(8):E1137-E42. doi: 10.1097/BSD.0000000000000500. PMID: 28099187. Exclusion: E11 - email from tamara 12/9.

452. Hirai T, Yoshii T, Sakai K, et al. Long-term results of a prospective study of anterior decompression with fusion and posterior decompression with laminoplasty for treatment of cervical spondylotic myelopathy. J Orthop Sci. 2018 Jan;23(1):32-8. doi: 10.1016/j.jos.2017.07.012. PMID: 29054553. Exclusion: E11 - email from tamara 12/9.

453. Hiremath GK, Steinmetz MP, Krishnaney AA. Is it safe to use recombinant human bone morphogenetic protein in posterior cervical fusion? Spine. 2009 Apr 20;34(9):885-9. doi: 10.1097/BRS.0b013e31819e334a. PMID: 19531997. Exclusion: E11.

454. Hirota R, Miyakoshi N, Yoshimoto M, et al. Comparison of health-related quality of life between double-door laminoplasty and selective laminoplasty for degenerative cervical myelopathy, with a minimum follow-up of 5 years. Spine. 2019 Feb 15;44(4):E211-E8. doi: 10.1097/BRS.0000000000002814. PMID: 30059486. Exclusion: E2.

455. Hisey MS, Bae HW, Davis R, et al. Reduction in the incidence of adjacent segment degeneration at 2 years: results of a multi center, prospective, randomized, controlled trial comparing mobi c° cervical artificial disc to anterior cervical discectomy and fusion. Eur Spine J. 2011 START: 2011 Oct 19 CONFERENCE END: 2011 Oct 21 EuroSpine 2011 Milan Italy;20(4):S488-p. doi: 10.1007/s00586-011-1951-y. Exclusion: E6.

456. Hisey MS, Davis RJ, Hoffman GA, et al. Sagittal alignment of one-level TDR and acdf patients: an analysis of patient outcomes from a randomized, prospective, clinical trial. Spine journal. 2014 START: 2014 Nov 12 CONFERENCE END: 2014 Nov 15 29th Annual Meeting of the North American Spine Society, NASS 2014 San Francisco, CA United States;14(11 SUPPL. 1):S124-S5p. doi: 10.1016/j.spinee.2014.08.308. Exclusion: E6.

457. Hisey MS, Davis RJ, Nunley PD, et al. One-level treatment with total disc replacement and ACDF: five-year results from a prospective randomized clinical trial. Spine journal. 2014 START: 2014 Nov 12 CONFERENCE END: 2014 Nov 15 29th Annual Meeting of the North American Spine Society, NASS 2014 San Francisco, CA United States;14(11 SUPPL. 1):S25p. doi: 10.1016/j.spinee.2014.08.068. Exclusion: E6.

458. Hisey MS, Ohnmeiss DD, Bae HW, et al. Impact of adverse events on clinical outcome: results through five-year follow-up. Spine. 2015:232-3. Exclusion: E6.

459. Hisey MS, Zigler JE, Davis RJ, et al. Total disc replacement versus ACDF: results from an FDA clinical trial on single-level treatment through 84 months. Spine journal. 2016 to 2016-10-29;16(10):S261-S2p. doi: 10.1016/j.spinee.2016.07.178. Exclusion: E6.

460. Hodges SD, Gornet MF, Lanman TH, et al. Prestige cervical disc arthroplasty vs. anterior cervical discectomy/fusion: 84 month ide outcomes of two level, prospective, randomized clinical trial. Spine. 2016;Vol.Conference: 44th Annual Meeting of the Cervical Spine Research Society, CSRS 2016. Canada. 2016(Supplement 1):106-7p. Exclusion: E6.

461. Hofler RC, Frazzetta J, Zakaria J, et al. C5 palsy after cervical laminectomy: natural history in a 10-year series. Spine J. 2021 09;21(9):1473-8. doi: 10.1016/j.spinee.2021.04.003. PMID: 33848689. Exclusion: E3.

462. Hofler RC, Swong K, Martin B, et al. Risk of pseudoarthrosis after spinal fusion: analysis from the healthcare cost and utilization project. World Neurosurg. 2018 Dec;120:e194-e202. doi: 10.1016/j.wneu.2018.08.026. PMID: 30114540. Exclusion: E2.

463. Hofstetter CP, Kesavabhotla K, Boockvar JA. Zero-profile anchored spacer reduces rate of dysphagia compared with ACDF with anterior plating. J Spinal Disord Tech. 2015 Jun;28(5):E284-90. doi: 10.1097/BSD.0b013e31828873ed. PMID: 23429316. Exclusion: E11.

464. Holly LT, Matz PG, Anderson PA, et al. Functional outcomes assessment for cervical degenerative disease. J Neurosurg Spine. 2009 Aug;11(2):238-44. doi: 10.3171/2009.2.SPINE08715. PMID: 19769503. Exclusion: E6 - background guidelines.

465. Hollyer MA, Gill EC, Ayis S, et al. The safety and efficacy of hybrid surgery for multilevel cervical degenerative disc disease versus anterior cervical discectomy and fusion or cervical disc arthroplasty: a systematic review and meta-analysis. Acta Neurochir (Wien). 2020 02;162(2):289-303. doi: 10.1007/s00701-019-04129-3. PMID: 31848789. Exclusion: E8.

466. Holy M, MacDowall A, Sigmundsson FG, et al. Operative treatment of cervical radiculopathy: anterior cervical decompression and fusion compared with posterior foraminotomy: study protocol for a randomized controlled trial. Trials. 2021 Sep 08;22(1):607. doi: 10.1186/s13063-021-05492-2. PMID: 34496941. Exclusion: E6.

467. Hong JY, Park JS, Suh SW, et al. Transforaminal epidural steroid injections in cervical spinal disease with moderate to severe disability: Comparative study in patients with or without surgery. Medicine (Baltimore). 2020 Feb;99(7):e19266. doi: 10.1097/MD.0000000000019266. PMID: 32049868. Exclusion: E3.

468. Hong SW, Lee SH, Khoo LT, et al. A Comparison of fixed-hole and slotted-hole dynamic plates for anterior cervical discectomy and fusion. J Spinal Disord Tech. 2010 Feb;23(1):22-6. doi: 10.1097/BSD.0b013e31819877e7. PMID: 20051923. Exclusion: E4.

469. Hong WJ, Kim WK, Park CW, et al. Comparison between transuncal approach and upper vertebral transcorporeal approach for unilateral cervical radiculopathy - a preliminary report. Minim Invasive Neurosurg. 2006 Oct;49(5):296-301. doi: 10.1055/s-2006-954828. PMID: 17163344. Exclusion: E3.

470. Hosono N, Yonenobu K, Ono K. Neck and shoulder pain after laminoplasty. A noticeable complication. Spine (Phila Pa 1976). 1996 Sep 1;21(17):1969-73. doi: 10.1097/00007632-199609010-00005. PMID: 8883196. Exclusion: E11.

471. Hotchkiss WR, Clavenna AL, Nimmons SJB, et al. Anterior cervical discectomy and fusion in professional athletes: allograft versus autograft. Clin Spine Surg. 2022 May 16;16(9):16. doi: 10.1097/BSD.0000000000001343. PMID: 35580852. Exclusion: E1.

472. Houten JK, Weinstein GR, Collins M. Long-term fate of C3-7 arthrodesis: 4-level ACDF versus cervical laminectomy and fusion. J Neurosurg Sci. 2021 Aug;65(4):402-7. doi: 10.23736/s0390-5616.18.04563-0. PMID: 30290695. Exclusion: E11.

473. Howell K, Phillips FM, Geisler F, et al. Seven-year results from the PCM Cervical Disc US FDA IDE Clinical Trial. Spine journal. 2015 START: 2015 Oct 14 CONFERENCE END: 2015 Oct 17 30th Annual Meeting of the North American Spine Society, NASS 2015 Chicago, IL United States;15(10 SUPPL. 1):S129p. doi: 10.1016/j.spinee.2015.07.118. Exclusion: E6.

474. Hsu WK, Kannan A, Mai HT, et al. Epidemiology and outcomes of vertebral artery injury in 16 582 cervical spine surgery patients: an aospine north america multicenter study. Global spine j. 2017 Apr;7(1 Suppl):21S-7S. doi: 10.1177/2192568216686753. PMID: 28451487. Exclusion: E4.

475. Hu B, Wang L, Song Y, et al. A comparison of long-term outcomes of nanohydroxyapatite/polyamide-66 cage and titanium mesh cage in anterior cervical corpectomy and fusion: a clinical follow-up study of least 8 years. Clin Neurol Neurosurg. 2019 01;176:25-9. doi: 10.1016/j.clineuro.2018.11.015. PMID: 30481654. Exclusion: E2.

476. Hu B, Yang X, Hu Y, et al. The n-HA/PA66 cage versus the PEEK cage in anterior cervical fusion with single-level discectomy during 7 years of follow-up. World Neurosurg. 2019 Mar;123:e678-e84. doi: 10.1016/j.wneu.2018.11.251. PMID: 30576825. Exclusion: E11.

477. Hu W, Shen X, Sun T, et al. Laminar reclosure after single open-door laminoplasty using titanium miniplates versus suture anchors. Orthopedics. 2014;37(1):e71-e8p. doi: 10.3928/01477447-20131219-20. Exclusion: E3.

478. Hu X, Liu H, Wang B, et al. Cervical disc arthroplasty versus anterior cervical discectomy and fusion for the treatment of single-level disc degenerative disease with preoperative reversible kyphosis. Clin Neurol Neurosurg. 2021 Mar;202:106493. doi: 10.1016/j.clineuro.2021.106493. PMID: 33493880. Exclusion: E11.

479. Hu Y, Lv G, Ren S, et al. Mid- to long-term outcomes of cervical disc arthroplasty versus anterior cervical discectomy and fusion for treatment of symptomatic cervical disc disease: a systematic review and meta-analysis of eight prospective randomized controlled trials. PLoS ONE. 2016;11(2):e0149312. doi: 10.1371/journal.pone.0149312. PMID: 26872258. Exclusion: E8.

480. Huang C, Mobbs R, Selby M, et al. Adjacent-level ossification development in single-level standalone anterior cervical discectomy and fusion versus anterior cervical discectomy and fusion with plate. Global spine j. 2021 Apr;11(3):292-8. doi: 10.1177/2192568220902749. PMID: 32875862. Exclusion: E12.

481. Huang CY, Meng Y, Wang BY, et al. The effect of the difference in C2-7 angle on the occurrence of dysphagia after anterior cervical discectomy and fusion with the zero-P implant system. BMC Musculoskelet Disord. 2020 Oct 06;21(1):649. doi: 10.1186/s12891-020-03691-7. PMID: 33023551. Exclusion: E3.

482. Huang K, Liu H, Wang B, et al. Cervical disc arthroplasty combined with two-level ACDF for the treatment of contiguous three-level cervical degenerative disc disease: a comparative study. J Orthop Res. 2022 May;41(5):1105-14. doi: 10.1002/jor.25436. PMID: 36058620. Exclusion: E3.

483. Huang KT, Harary M, Abd-El-Barr MM, et al. Crossing the cervicothoracic junction in posterior cervical decompression and fusion: a cohort analysis. World Neurosurg. 2019 Nov;131:e514-e20. doi: 10.1016/j.wneu.2019.07.219. PMID: 31394365. Exclusion: E3.

484. Huang M, Gao X, Cheng J, et al. Laminoplasty versus laminectomy and fusion for multilevel cervical compressive myelopathy: a meta-analysis. Medicine (Baltimore). 2016 Jun;95(23):e03588. doi: 10.1097/MD.0000000000003588. PMID: 27281067. Exclusion: E8.

485. Huang ZY, Wu AM, Li QL, et al. Comparison of two anterior fusion methods in two-level cervical spondylosis myelopathy: a meta-analysis. BMJ Open. 2014 Jul 16;4(7):e004581. doi: 10.1136/bmjopen-2013-004581. PMID: 25031189. Exclusion: E3.

486. Hui N, Phan K, Cheng HMK, et al. Complications of cervical total disc replacement and their associations with heterotopic ossification: a systematic review and meta-analysis. Eur Spine J. 2020 11;29(11):2688-700. doi: 10.1007/s00586-020-06400-z. PMID: 32279116. Exclusion: E3.

487. Hui N, Phan K, Kerferd J, et al. Comparison of M6-C and Mobi-C cervical total disc replacement for cervical degenerative disc disease in adults. J. 2019 Dec;5(4):393-403. doi: 10.21037/jss.2019.09.27. PMID: 32042989. Exclusion: E3.

488. Huppert J, Beaurain J, Steib JP, et al. Comparison between single- and multi-level patients: clinical and radiological outcomes 2 years after cervical disc replacement. Eur Spine J. 2011 Sep;20(9):1417-26. doi: 10.1007/s00586-011-1722-9. PMID: 21336970. Exclusion: E3.

489. Hwang SL, Hwang YF, Lieu AS, et al. Outcome analyses of interbody titanium cage fusion used in the anterior discectomy for cervical degenerative disc disease. J Spinal Disord Tech. 2005 Aug;18(4):326-31. doi: 10.1097/01.bsd.0000164198.30725.2d. PMID: 16021013. Exclusion: E5.

490. Hwang SL, Lee KS, Su YF, et al. Anterior corpectomy with iliac bone fusion or discectomy with interbody titanium cage fusion for multilevel cervical degenerated disc disease. J Spinal Disord Tech. 2007 Dec;20(8):565-70. doi: 10.1097/BSD.0b013e318036b463. PMID: 18046168. Exclusion: E3.

491. Ian Dhar S, Wegner AM, Rodnoi P, et al. Fluoroscopic swallowing abnormalities in dysphagic patients following anterior cervical spine surgery. Ann Otol Rhinol Laryngol. 2020 Nov;129(11):1101-9. doi: 10.1177/0003489420929046. PMID: 32500729. Exclusion: E1.

492. Ibrahim MZ, Abdel-Rahman AFM, El Zahlawy H. Zero-profile implant versus integrated cage-plate implant in treatment of single level cervical disc disease. Acta Orthop Belg. 2022 Jun;88(2):285-91. doi: 10.52628/88.2.7727. PMID: 36001834. Exclusion: E11.

493. Igarashi H, Hoshino M, Omori K, et al. Factors influencing interbody cage subsidence following anterior cervical discectomy and fusion. Clin Spine Surg. 2019 08;32(7):297-302. doi: 10.1097/BSD.0000000000000843. PMID: 31169615. Exclusion: E3.

494. Ikenaga M, Shikata J, Tanaka C. Long-term results over 10 years of anterior corpectomy and fusion for multilevel cervical myelopathy. Spine. 2006 Jun 15;31(14):1568-74; discussion 75. doi: 10.1097/01.brs.0000221985.37468.0f. PMID: 16778689. Exclusion: E7.

495. Inose H, Yoshii T, Kimura A, et al. Comparison of clinical and radiographic outcomes of laminoplasty, anterior decompression with fusion, and posterior decompression with fusion for degenerative cervical myelopathy: a prospective multicenter study. Spine. 2020 Oct 15;45(20):E1342-E8. doi: 10.1097/BRS.0000000000003592. PMID: 32576779. Exclusion: E11.

496. Ishida Y, Suzuki K, Ohmori K, et al. Critical analysis of extensive cervical laminectomy. Neurosurgery. 1989 Feb;24(2):215-22. doi: 10.1227/00006123-198902000-00010. PMID: 2918972. Exclusion: E11.

497. Ishihara H, Kanamori M, Kawaguchi Y, et al. Adjacent segment disease after anterior cervical interbody fusion. Spine J. 2004 Nov-Dec;4(6):624-8. doi: 10.1016/j.spinee.2004.04.011. PMID: 15541693. Exclusion: E3.

498. Ito K, Imagama S, Ito K, et al. MRI signal intensity classification in cervical ossification of the posterior longitudinal ligament: predictor of surgical outcomes. Spine. 2017 Jan 15;42(2):E98-E103. doi: 10.1097/BRS.0000000000001717. PMID: 27244260. Exclusion: E11.

499. Ito S, Sakai Y, Ando K, et al. Association between postoperative neck pain and intraoperative transcranial motor-evoked potential waveforms of the trapezius muscles in patients with cervical myelopathy who underwent cervical laminoplasty. Asian spine j. 2023 Apr;17(2):330-7. doi: 10.31616/asj.2022.0120. PMID: 36740952. Exclusion: E3.

500. Iunes EA, Barletta EA, Barba Belsuzarri TA, et al. Correlation between different interbody grafts and pseudarthrosis after anterior cervical discectomy and fusion compared with control group: systematic review. World Neurosurg. 2020 Feb;134:272-9. doi: 10.1016/j.wneu.2019.10.100. PMID: 31669245. Exclusion: E8.

501. Iunes EA, Barletta EA, Belsuzarri TAB, et al. Pseudarthrosis in anterior cervical discectomy and fusion with a self-locking, stand-alone cage filled with hydroxyapatite: a retrospective study with clinical and radiological outcomes of 98 levels with a minimum 2-year follow-up. J Neurosurg Spine. 2020 Jul 31;33(6):1-10. doi: 10.3171/2020.4.SPINE20357. PMID: 32736356. Exclusion: E3.

502. Iwama T, Ohba T, Okita G, et al. Utility and validity of neurite orientation dispersion and density imaging with diffusion tensor imaging to quantify the severity of cervical spondylotic myelopathy and assess postoperative neurological recovery. Spine J. 2020 03;20(3):417-25. doi: 10.1016/j.spinee.2019.10.019. PMID: 31683067. Exclusion: E7.

503. Iwasaki M, Kawaguchi Y, Kimura T, et al. Long-term results of expansive laminoplasty for ossification of the posterior longitudinal ligament of the cervical spine: more than 10 years follow up. J Neurosurg. 2002 Mar;96(2 Suppl):180-9. doi: 10.3171/spi.2002.96.2.0180. PMID: 12450281. Exclusion: E3.

504. Jack MM, Lundy P, Reeves AR, et al. Four-level anterior cervical discectomy and fusions: results following multilevel cervical fusion with a minimum 1-year follow-up. Clin Spine Surg. 2021 05 01;34(4):E243-E7. doi: 10.1097/BSD.0000000000001116. PMID: 33769972. Exclusion: E5.

505. Jackson R, Johnson DE. Neurological outcomes of two-level total disk replacement versus anterior discectomy and fusion: 7-Year results from a prospective, randomized, multicenter trial. Clin Neurosurg. 2016;63(164):2016-09. doi: 10.1227/01.neu.0000489728.54111.6e. Exclusion: E6.

506. Jackson RJ, Bae HW, Davis RJ, et al. Subsequent surgery rates after treatment with TDR or ACDF at one or two levels: results from an IDE clinical trial with five years follow-up. Spine journal. 2014 START: 2014 Nov 12 CONFERENCE END: 2014 Nov 15 29th Annual Meeting of the North American Spine Society, NASS 2014 San Francisco, CA United States;14(11 SUPPL. 1):S22-S3p. doi: 10.1016/j.spinee.2014.08.063. Exclusion: E6.

507. Jackson RJ, Davis RJ, Bae HW, et al. Subsequent surgery rates after treatment with TDR or ACDF at one or two levels: results from an FDA clinical trial at 7 years. Spine journal. 2016 to 2016-10-29;16(10):S204-S5p. doi: 10.1016/j.spinee.2016.07.114. Exclusion: E6.

508. Jacobs W, Willems P, Kruyt M, et al. Systematic review of anterior interbody fusion techniques for single- and double-level cervical degenerative disc disease. Spine. 2011 Jun 15;36(14):E950-E60. doi: 10.1097/BRS.0b013e31821cbba5. PMID: 21522044. Exclusion: E8.

509. Jacobs W, Willems PC, van Limbeek J, et al. Single or double-level anterior interbody fusion techniques for cervical degenerative disc disease. Cochrane Database Syst Rev. 2011 Jan 19(1):CD004958. doi: 10.1002/14651858.CD004958.pub2. PMID: 21249667. Exclusion: E3.

510. Jacobs WC, Anderson PG, Limbeek J, et al. Single or double-level anterior interbody fusion techniques for cervical degenerative disc disease. Cochrane Database Syst Rev. 2004 Oct 18(4):CD004958. doi: 10.1002/14651858.CD004958. PMID: 15495130. Exclusion: E3.

511. Jagannathan J, Shaffrey CI, Oskouian RJ, et al. Radiographic and clinical outcomes following single-level anterior cervical discectomy and allograft fusion without plate placement or cervical collar. J Neurosurg Spine. 2008 May;8(5):420-8. doi: 10.3171/SPI/2008/8/5/420. PMID: 18447687. Exclusion: E3.

512. Jain A, Marrache M, Harris A, et al. Structural allograft versus PEEK implants in anterior cervical discectomy and fusion: a systematic review. Global spine j. 2020 Sep;10(6):775-83. doi: 10.1177/2192568219883256. PMID: 32707023. Exclusion: E8.

513. Jain D, Kelly MP, Gornet MF, et al. Impact of cervical disc arthroplasty vs anterior cervical discectomy and fusion on driving disability: post hoc analysis of a randomized controlled trial with 10-year follow-up. Int J Spine Surg. 2022 Feb;16(1):95-101. doi: 10.14444/8199. PMID: 35273107. Exclusion: E4.

514. Jain S, Singh S, Joshi AK, et al. Comparative study of anterior versus posterior decompression in elderly patients of cervical myelopathy with co-morbid conditions. European Journal of Orthopaedic Surgery and Traumatology. 2009;19(6):397-401. doi: 10.1007/s00590-009-0444-8. Exclusion: E7.

515. Jang SR, Lee SB, Cho KS. A comparison of anterior cervical discectomy and fusion versus fusion combined with artificial disc replacement for treating 3-level cervical spondylotic disease. J. 2017 Korean Neurosurgical Society (E-mail: JKNS@paran;60(6):676-83p. doi: 10.3340/jkns.2016.1010.013. Exclusion: E7.

516. Jannelli G, Nouri A, Molliqaj G, et al. Degenerative cervical myelopathy: review of surgical outcome predictors and need for multimodal approach. World Neurosurg. 2020 08;140:541-7. doi: 10.1016/j.wneu.2020.04.233. PMID: 32389875. Exclusion: E6.

517. Janssen M, Kopjar B, Zigler JE, et al. Long-term efficacy and safety of anterior cervical discectomy and fusion in single-level cervical disk disease: 7 years follow-up of food and drug administration investigational exemption ProDisc-C study. Global spine j. 2014;4:2014-05. doi: 10.1055/s-0034-1376678. Exclusion: E6.

518. Jawahar A, Cavanaugh DA, Kerr EJ, 3rd, et al. Total disc arthroplasty does not affect the incidence of adjacent segment degeneration in cervical spine: results of 93 patients in three prospective randomized clinical trials. Spine J. 2010 Dec;10(12):1043-8. doi: 10.1016/j.spinee.2010.08.014. PMID: 20869326. Exclusion: E6.

519. Jawahar A, Nunley PD, Araghi A, et al. Number of levels involved at index surgery significantly affects the outcomes after anterior cervical discectomy and fusion: analysis of data from a multicenter prospective randomized controlled trial. Spine journal. 2012 START: 2012 Oct 24 CONFERENCE END: 2012 Oct 27 27th Annual Meeting of the North American Spine Society, NASS 2012 Dallas, TX United States;12(9):98S-p. doi: 10.1016/j.spinee.2012.08.273. Exclusion: E6.

520. Jenkins TJ, Nair R, Bhatt S, et al. The effect of local versus intravenous corticosteroids on the likelihood of dysphagia and dysphonia following anterior cervical discectomy and fusion: a single-blinded, prospective, randomized controlled trial. J Bone Joint Surg Am. 2018 Sep 05;100(17):1461-72. doi: 10.2106/JBJS.17.01540. PMID: 30180054. Exclusion: E2.

521. Jenkins TJ, Nair R, Rosenthal BD, et al. The effect of local vs. intravenous steroids on dysphagia and dysphonia following anterior cervical discectomy and fusion (ACDF): a single-blinded, prospective, randomized control trial. Spine. 2016:94-6. Exclusion: E6.

522. Jensen L, Peroutka R, Shaffrey M, et al. Trabecular metalbeta cervical interbody fusion device versus bone graft for one-level plated anterior cervical fusion: a prospective study. Spine journal. 2011 START: 2011 Nov 2 CONFERENCE END: 2011 Nov 5 26th Annual Meeting of the North American Spine Society, NASS 2011 Chicago, IL United States;11(10 SUPPL. 1):122S-3Sp. doi: 10.1016/j.spinee.2011.08.301. Exclusion: E6.

523. Ji GY, Oh CH, Shin DA, et al. Artificial Disk Replacement Combined With Fusion Versus 2-Level Fusion in Cervical 2-Level Disk Disease With a 5-Year Follow-up. Clin Spine Surg. 2017 Jun;30(5):E620-E7. doi: 10.1097/BSD.0000000000000316. PMID: 28525488. Exclusion: E7.

524. Ji-Jun H, Hui-Hui S, Zeng-Wu S, et al. Posterior full-endoscopic cervical discectomy in cervical radiculopathy: a prospective cohort study. Clin Neurol Neurosurg. 2020 08;195:105948. doi: 10.1016/j.clineuro.2020.105948. PMID: 32512476. Exclusion: E11.

525. Jia Z, Mo Z, Ding F, et al. Hybrid surgery for multilevel cervical degenerative disc diseases: a systematic review of biomechanical and clinical evidence. Eur Spine J. 2014 Aug;23(8):1619-32. doi: 10.1007/s00586-014-3389-5. PMID: 24908252. Exclusion: E3.

526. Jiang H, Zhu Z, Qiu Y, et al. Cervical disc arthroplasty versus fusion for single-level symptomatic cervical disc disease: a meta-analysis of randomized controlled trials. Arch Orthop Trauma Surg. 2012 Feb;132(2):141-51. doi: 10.1007/s00402-011-1401-7. PMID: 21984009. Exclusion: E8.

527. Jiang J, Sun K, Lin F, et al. The effect of diabetes mellitus on the neurological function of patients with cervical spondylotic myelopathy. Orthop Surg. 2022 Dec;14(12):3242-50. doi: 10.1111/os.13542. PMID: 36259631. Exclusion: E1.

528. Jiang L, Tan M, Dong L, et al. Comparison of anterior decompression and fusion with posterior laminoplasty for multilevel cervical compressive myelopathy: a systematic review and meta-analysis. Journal of Spinal Disorders and Techniques. 2015;28(8):282-90. doi: 10.1097/BSD.0000000000000317. Exclusion: E8.

529. Jiang SD, Jiang LS, Dai LY. Degenerative cervical spondylolisthesis: a systematic review. Int Orthop. 2011 Jun;35(6):869-75. doi: 10.1007/s00264-010-1203-5. PMID: 21264670. Exclusion: E8.

530. Jiang SD, Jiang LS, Dai LY. Anterior cervical discectomy and fusion versus anterior cervical corpectomy and fusion for multilevel cervical spondylosis: a systematic review. Arch Orthop Trauma Surg. 2012 Feb;132(2):155-61. doi: 10.1007/s00402-011-1402-6. PMID: 21968573. Exclusion: E3.

531. Jiang ZH, Zhang XL, Zhu RS, et al. Anterior cervical discectomy with fusion and posterior cervical expansive open-door laminoplasty for multilevel cervical spondylotic myelopathy: its postoperative stability. Chinese journal of tissue engineering research. 2017 Journal of Clinical Rehabilitative Tissue Engineering Research (E-mail: lei0415@hotmail;21(27):4306-11p. Exclusion: E10.

532. Jin YJ, Park SB, Kim MJ, et al. An analysis of heterotopic ossification in cervical disc arthroplasty: a novel morphologic classification of an ossified mass. Spine J. 2013 Apr;13(4):408-20. doi: 10.1016/j.spinee.2012.11.048. PMID: 23332520. Exclusion: E3.

533. Jin YZ, Zhao B, Lu XD, et al. Mid- and long-term follow-up efficacy analysis of 3d-printed interbody fusion cages for anterior cervical discectomy and fusion. Orthop Surg. 2021 Oct;13(7):1969-78. doi: 10.1111/os.13005. PMID: 34523808. Exclusion: E3.

534. Jin ZY, Teng Y, Wang HZ, et al. Comparative analysis of cage subsidence in anterior cervical decompression and fusion: zero profile anchored spacer (ROI-C) vs. conventional cage and plate construct. Frontiers in Surgery. 2021;8:736680. doi: 10.3389/fsurg.2021.736680. PMID: 34778358. Exclusion: E12.

535. Joaquim AF, Lee NJ, Lehman RA, Jr., et al. Osteolysis after cervical disc arthroplasty. Eur Spine J. 2020 11;29(11):2723-33. doi: 10.1007/s00586-020-06578-2. PMID: 32865650. Exclusion: E8.

536. Joaquim AF, Lee NJ, Riew KD. Circumferential operations of the cervical spine. Neurospine. 2021 Mar;18(1):55-66. doi: 10.14245/ns.2040528.264. PMID: 33819936. Exclusion: E6.

537. Joaquim AF, Riew KD. Multilevel cervical arthroplasty: current evidence. A systematic review. Neurosurg. 2017 Feb;42(2):E4. doi: 10.3171/2016.10.FOCUS16354. PMID: 28142256. Exclusion: E8.

538. Johansen TO, Sundseth J, Fredriksli OA, et al. Effect of arthroplasty vs fusion for patients with cervical radiculopathy: a randomized clinical trial. JAMA netw. 2021 08 02;4(8):e2119606. doi: 10.1001/jamanetworkopen.2021.19606. PMID: 34351401. Exclusion: E2.

539. Johansen TO, Vangen-Lonne V, Holmberg ST, et al. Surgery for degenerative cervical myelopathy in the elderly: a nationwide registry-based observational study with patient-reported outcomes. Acta Neurochir (Wien). 2022 Sep;164(9):2317-26. doi: 10.1007/s00701-022-05282-y. PMID: 35852626. Exclusion: E3.

540. Joo PY, Zhu JR, Kammien AJ, et al. Clinical outcomes following one-, two-, three-, and four-level anterior cervical discectomy and fusion: a national database study. Spine J. 2022 04;22(4):542-8. doi: 10.1016/j.spinee.2021.11.002. PMID: 34774751. Exclusion: E5.

541. Joo YH, Lee JW, Kwon KY, et al. Comparison of fusion with cage alone and plate instrumentation in two-level cervical degenerative disease. J. 2010;48(4):342-6. doi: 10.3340/jkns.2010.48.4.342. PMID: 21113362. Exclusion: E7.

542. Joung YI, Oh SH, Ko Y, et al. Subsidence of cylindrical cage (AMSLUtrade mark Cage) : postoperative 1 year follow-up of the cervical anterior interbody fusion. J. 2007 Nov;42(5):367-70. doi: 10.3340/jkns.2007.42.5.367. PMID: 19096571. Exclusion: E3.

543. Junaid M, Rashid MU, Bukhari SS, et al. Radiological and clinical outcomes in patients undergoing anterior cervical discectomy and fusion: Comparing titanium and PEEK (polyetheretherketone) cages. Pak. 2018 Nov-Dec;34(6):1412-7. doi: 10.12669/pjms.346.15833. PMID: 30559795. Exclusion: E11.

544. Kadanka Z, Bednarík J, Vohánka S, et al. Conservative treatment versus surgery in spondylotic cervical myelopathy: a prospective randomised study. Eur Spine J. 2000 Dec;9(6):538-44. doi: 10.1007/s005860000132. PMID: 11189924. Exclusion: E9.

545. Kahaer A, Chen R, Maitusong M, et al. Zero-profile implant versus conventional cage-plate construct in anterior cervical discectomy and fusion for the treatment of single-level degenerative cervical spondylosis: a systematic review and meta-analysis. J Orthop Surg Res. 2022 Nov 24;17(1):506. doi: 10.1186/s13018-022-03387-9. PMID: 36434694. Exclusion: E8.

546. Kaiser MG, Mummaneni PV, Matz PG, et al. Management of anterior cervical pseudarthrosis. J Neurosurg Spine. 2009 Aug;11(2):228-37. doi: 10.3171/2009.2.SPINE08729. PMID: 19769502. Exclusion: E6.

547. Kaiser MG, Mummaneni PV, Matz PG, et al. Radiographic assessment of cervical subaxial fusion. J Neurosurg Spine. 2009 Aug;11(2):221-7. doi: 10.3171/2009.3.SPINE08719. PMID: 19769501. Exclusion: E6.

548. Kamilijiang R, Wubulihasimu A, Zhang Y. Comparison of anterior cervical discectomy and fusion versus anterior cervical corpectomy and fusion for the treatment of contiguous two-level cervical spondylotic myelopathy. Int J Clin Exp Med. 2017;10(1):255-65. doi: 10.3340/jkns.2016.1010.013. Exclusion: E3.

549. Kamizono J, Matsunaga S, Hayashi K, et al. Occupational recovery after open-door type laminoplasty for patients with ossification of the posterior longitudinal ligament. Spine (Phila Pa 1976). 2003 Aug 15;28(16):1889-92. doi: 10.1097/01.Brs.0000083206.24176.C8. PMID: 12923480. Exclusion: E3.

550. Kan SL, Yuan ZF, Ning GZ, et al. Cervical disc arthroplasty for symptomatic cervical disc disease: Traditional and Bayesian meta-analysis with trial sequential analysis. Int J Surg. 2016 Nov;35:111-9. doi: 10.1016/j.ijsu.2016.09.088. PMID: 27693477. Exclusion: E8.

551. Kandel H, Soliman M, ElMallawany M, et al. 21. The safety and efficacy of cervical laminectomy and fusion vs cervical laminoplasty surgery in degenerative cervical myelopathy: a prospective randomized trial. Spine journal. 2020 to 2020-10-10;20(9):S11-p. doi: 10.1016/j.spinee.2020.05.124. Exclusion: E6.

552. Kaneko K, Hashiguchi A, Kato Y, et al. Investigation of motor dominant C5 paralysis after laminoplasty from the results of evoked spinal cord responses. J Spinal Disord Tech. 2006 Jul;19(5):358-61. doi: 10.1097/01.bsd.0000210112.09521.e3. PMID: 16826009. Exclusion: E11.

553. Kang KC, Suk KS, Kim HS, et al. Preoperative risk factors of C5 nerve root palsy after laminectomy and fusion in patients with cervical myelopathy: analysis of 70 consecutive patients. Clin Spine Surg. 2017 Nov;30(9):419-24. doi: 10.1097/BSD.0000000000000505. PMID: 28225364. Exclusion: E2.

554. Kang KT, Son DW, Kwon O, et al. Effect of modic changes in cervical degenerative disease. Korean J. 2017 Jun;14(2):41-3. doi: 10.14245/kjs.2017.14.2.41. PMID: 28704907. Exclusion: E4.

555. Kao TH, Wu CH, Chou YC, et al. Risk factors for subsidence in anterior cervical fusion with stand-alone polyetheretherketone (PEEK) cages: a review of 82 cases and 182 levels. Arch Orthop Trauma Surg. 2014 Oct;134(10):1343-51. doi: 10.1007/s00402-014-2047-z. PMID: 25099076. Exclusion: E5.

556. Karhade AV, Ogink PT, Thio Q, et al. Discharge disposition after anterior cervical discectomy and fusion. World Neurosurg. 2019 Dec;132:e14-e20. doi: 10.1016/j.wneu.2019.09.026. PMID: 31521753. Exclusion: E4.

557. Karikari I, Ghogawala Z, Ropper AE, et al. Utility of cervical collars following cervical fusion surgery. Does it improve fusion rates or outcomes? A systematic review. World Neurosurg. 2018 Dec 26;26:26. doi: 10.1016/j.wneu.2018.12.066. PMID: 30593959. Exclusion: E2.

558. Karpova A, Arun R, Kalsi-Ryan S, et al. Do quantitative magnetic resonance imaging parameters correlate with the clinical presentation and functional outcomes after surgery in cervical spondylotic myelopathy? A prospective multicenter study. Spine. 2014 Aug 15;39(18):1488-97. doi: 10.1097/BRS.0000000000000436. PMID: 24859570. Exclusion: E11.

559. Kasai Y, Uchida A. New evaluation method using preoperative magnetic resonance imaging for cervical spondylotic myelopathy. Arch Orthop Trauma Surg. 2001 Oct;121(9):508-10. doi: 10.1007/s004020100288. PMID: 11599752. Exclusion: E11.

560. Kasliwal MK, Baskin DS, Traynelis VC. Failure of porous tantalum cervical interbody fusion devices: two-year results from a prospective, randomized, multicenter clinical study. J Spinal Disord Tech. 2013 Jul;26(5):239-45. doi: 10.1097/BSD.0b013e318241e70f. PMID: 22198323. Exclusion: E7.

561. Kasliwal MK, O'Toole JE. Clinical experience using polyetheretherketone (PEEK) intervertebral structural cage for anterior cervical corpectomy and fusion. J Clin Neurosci. 2014 Feb;21(2):217-20. doi: 10.1016/j.jocn.2013.03.018. PMID: 24018256. Exclusion: E3.

562. Kast E, Derakhshani S, Bothmann M, et al. Subsidence after anterior cervical inter-body fusion. A randomized prospective clinical trial. Neurosurg Rev. 2009 Apr;32(2):207-14; discussion 14. doi: 10.1007/s10143-008-0168-y. PMID: 18797946. Exclusion: E3.

563. Kato S, Nouri A, Reihani-Kermani H, et al. Postoperative resolution of magnetic resonance imaging signal intensity changes and the associated impact on outcomes in degenerative cervical myelopathy: analysis of a global cohort of patients. Spine. 2018 06 15;43(12):824-31. doi: 10.1097/BRS.0000000000002426. PMID: 28953706. Exclusion: E2.

564. Kato S, Nouri A, Wu D, et al. Comparison of anterior and posterior surgery for degenerative cervical myelopathy: an mri-based propensity-score-matched analysis using data from the prospective multicenter aospine csm north america and international studies. J Bone Joint Surg Am. 2017 Jun 21;99(12):1013-21. doi: 10.2106/JBJS.16.00882. PMID: 28632590. Exclusion: E2.

565. Kato S, Nouri A, Wu D, et al. Comparisons of anterior and posterior surgery for cervical spondylotic myelopathy-a propensity score matched analysis using aospine CSM North America and international database. Spine. 2016:114-5. Exclusion: E6.

566. Kato Y, Iwasaki M, Fuji T, et al. Long-term follow-up results of laminectomy for cervical myelopathy caused by ossification of the posterior longitudinal ligament. J Neurosurg. 1998 Aug;89(2):217-23. doi: 10.3171/jns.1998.89.2.0217. PMID: 9688116. Exclusion: E3.

567. Katonis P, Papadakis SA, Galanakos S, et al. Lateral mass screw complications: analysis of 1662 screws. J Spinal Disord Tech. 2011 Oct;24(7):415-20. doi: 10.1097/BSD.0b013e3182024c06. PMID: 21150657. Exclusion: E2.

568. Katsumi K, Yamazaki A, Watanabe K, et al. Can prophylactic bilateral C4/C5 foraminotomy prevent postoperative C5 palsy after open-door laminoplasty?: a prospective study. Spine. 2012;37(9):748-54p. doi: 10.1097/BRS.0b013e3182326957. Exclusion: E2.

569. Katsuura Y, York PJ, Goto R, et al. Sagittal reconstruction and clinical outcome using traditional ACDF, versus stand-alone ACDF Versus TDR: a systematic review and quantitative analysis. Spine. 2019 Oct 01;44(19):E1151-E8. doi: 10.1097/BRS.0000000000003077. PMID: 31261280. Exclusion: E8.

570. Kawaguchi Y, Kanamori M, Ishiara H, et al. Preventive measures for axial symptoms following cervical laminoplasty. J Spinal Disord Tech. 2003 Dec;16(6):497-501. doi: 10.1097/00024720-200312000-00002. PMID: 14657744. Exclusion: E7.

571. Kawaguchi Y, Kanamori M, Ishihara H, et al. Pathomechanism of myelopathy and surgical results of laminoplasty in elderly patients with cervical spondylosis. Spine (Phila Pa 1976). 2003 Oct 1;28(19):2209-14. doi: 10.1097/01.Brs.0000085029.65713.B0. PMID: 14520033. Exclusion: E5.

572. Kawaguchi Y, Kanamori M, Ishihara H, et al. Minimum 10-year followup after en bloc cervical laminoplasty. Clin Orthop Relat Res. 2003 Jun(411):129-39. doi: 10.1097/01.blo.0000069889.31220.62. PMID: 12782868. Exclusion: E5.

573. Kawaguchi Y, Matsui H, Ishihara H, et al. Surgical outcome of cervical expansive laminoplasty in patients with diabetes mellitus. Spine (Phila Pa 1976). 2000 Mar 1;25(5):551-5. doi: 10.1097/00007632-200003010-00004. PMID: 10749630. Exclusion: E5.

574. Kawakami M, Tamaki T, Iwasaki H, et al. A comparative study of surgical approaches for cervical compressive myelopathy. Clin Orthop Relat Res. 2000 Dec;381(381):129-36. doi: 10.1097/00003086-200012000-00016. PMID: 11127649. Exclusion: E11.

575. Kaye ID, Sebastian AS, Wagner SC, et al. No difference in neck pain or health-related quality measures between patients with or without degenerative cervical spondylolisthesis. Global spine j. 2021 doi: 10.1177/21925682211046906. PMID: 34570993. Exclusion: E3.

576. Kelly MP, Mok JM, Frisch RF, et al. Adjacent segment motion after anterior cervical discectomy and fusion versus Prodisc-c cervical total disk arthroplasty: analysis from a randomized, controlled trial. Spine. 2011 Jul 01;36(15):1171-9. doi: 10.1097/BRS.0b013e3181ec5c7d. PMID: 21217449. Exclusion: E4.

577. Khalid SI, Adogwa O, Ni A, et al. A comparison of 30-day hospital readmission and complication rates after outpatient versus inpatient 1 and 2 level anterior cervical discectomy and fusion surgery: an analysis of a medicare patient sample. World Neurosurg. 2019 Sep;129:e233-e9. doi: 10.1016/j.wneu.2019.05.120. PMID: 31128307. Exclusion: E3.

578. Khalid SI, Kelly R, Carlton A, et al. Outpatient and inpatient readmission rates of 3- and 4-level anterior cervical discectomy and fusion surgeries. J Neurosurg Spine. 2019 03 29;31(1):70-5. doi: 10.3171/2019.1.SPINE181019. PMID: 30925482. Exclusion: E3.

579. Khalid SI, Kelly R, Wu R, et al. A comparison of readmission and complication rates and charges of inpatient and outpatient multiple-level anterior cervical discectomy and fusion surgeries in the Medicare population. J Neurosurg Spine. 2019 Jun 07;31(4):1-7. doi: 10.3171/2019.3.SPINE181257. PMID: 31174183. Exclusion: E3.

580. Khalooeifard R, Rahmani J, Tavanaei R, et al. The effect of vitamin D deficiency on outcomes of patients undergoing elective spinal fusion surgery: a systematic review and meta-analysis. Int J Spine Surg. 2022;16(1):53-60. doi: 10.14444/8177. PMID: 35273110. Exclusion: E1.

581. Khan I, Archer KR, Wanner JP, et al. Trajectory of improvement in myelopathic symptoms from 3 to 12 months following surgery for degenerative cervical myelopathy. Neurosurgery. 2020 06 01;86(6):763-8. doi: 10.1093/neuros/nyz325. PMID: 31435676. Exclusion: E5.

582. Khattab MF, Kotb A. Cervical stand-alone PEEK cage versus anchored cage with screws in single-level anterior cervical discectomy and fusion: a prospective cohort study. Current Orthopaedic Practice. 2020;31(2):179-85. doi: 10.1097/BCO.0000000000000853. Exclusion: E3.

583. Kieser DC, Cawley DT, Roscop C, et al. Spondylolisthesis adjacent to a cervical disc arthroplasty does not increase the risk of adjacent level degeneration. Eur Spine J. 2018 06;27(6):1440-6. doi: 10.1007/s00586-018-5574-4. PMID: 29605898. Exclusion: E2.

584. Kihara S, Umebayashi T, Hoshimaru M. Technical improvements and results of open-door expansive laminoplasty with hydroxyapatite implants for cervical myelopathy. Neurosurgery. 2005 Oct;57(4 Suppl):348-56; discussion -56. doi: 10.1227/01.neu.0000176646.88909.82. PMID: 16234684. Exclusion: E3.

585. Kim B, Yoon DH, Shin HC, et al. Surgical outcome and prognostic factors of anterior decompression and fusion for cervical compressive myelopathy due to ossification of the posterior longitudinal ligament. Spine J. 2015 May 01;15(5):875-84. doi: 10.1016/j.spinee.2015.01.028. PMID: 25637468. Exclusion: E11 - email from Tamara 12/9.

586. Kim BJ, Kim SH, Lee SH, et al. Segmental motion of the cervical spine after total disc replacement using activc versus discectomy and fusion using stand-alone cage. World Neurosurg. 2019 Jun;126:e1228-e34. doi: 10.1016/j.wneu.2019.02.233. PMID: 30885861. Exclusion: E11.

587. Kim BS, Dhillon RS. Cervical laminectomy with or without lateral mass instrumentation: a comparison of outcomes. Clin Spine Surg. 2019 07;32(6):226-32. doi: 10.1097/BSD.0000000000000852. PMID: 31206395. Exclusion: E3.

588. Kim CH, Chung CK, Choi Y, et al. The efficacy of ultrasonic bone scalpel for unilateral cervical open-door laminoplasty: a randomized controlled trial. Neurosurgery. 2020;86(6):825-34p. doi: 10.1093/neuros/nyz301. Exclusion: E3.

589. Kim CH, Chung CK, Hahn S. Autologous iliac bone graft with anterior plating is advantageous over the stand-alone cage for segmental lordosis in single-level cervical disc disease. Neurosurgery. 2013 Feb;72(2):257-65; discussion 66. doi: 10.1227/NEU.0b013e31827b94d4. PMID: 23149973. Exclusion: E4 - per Shelley's email 1/17.

590. Kim DH, Lee CH, Ko YS, et al. The clinical implications and complications of anterior versus posterior surgery for multilevel cervical ossification of the posterior longitudinal ligament; an updated systematic review and meta-analysis. Neurospine. 2019 Sep;16(3):530-41. doi: 10.14245/ns.1938326.163. PMID: 31607084. Exclusion: E8.

591. Kim DH, Zaremski J, Kwon B, et al. Risk factors for false positive transcranial motor evoked potential monitoring alerts during surgical treatment of cervical myelopathy. Spine. 2007 Dec 15;32(26):3041-6. doi: 10.1097/BRS.0b013e31815d0072. PMID: 18091499. Exclusion: E3.

592. Kim EJ, Chotai S, Wick JB, et al. Factors associated with return-to-work following cervical spine surgery in non-worker's compensation setting. Spine. 2019 Jul 01;44(13):903-7. doi: 10.1097/BRS.0000000000002978. PMID: 31205165. Exclusion: E4.

593. Kim GU, Lee GW. Selective blocking laminoplasty in cervical laminectomy and fusion to prevent postoperative C5 palsy. Spine J. 2019 04;19(4):617-23. doi: 10.1016/j.spinee.2018.11.001. PMID: 30414991. Exclusion: E4.

594. Kim HC, Oh JK, Kim DS, et al. Comparison of the effectiveness and safety of bioactive glass ceramic to allograft bone for anterior cervical discectomy and fusion with anterior plate fixation. Neurosurg Rev. 2020 Oct;43(5):1423-30. doi: 10.1007/s10143-019-01225-x. PMID: 31919700. Exclusion: E11.

595. Kim HJ, Kelly MP, Ely CG, et al. The risk of adjacent-level ossification development after surgery in the cervical spine: are there factors that affect the risk? A systematic review. Spine. 2012 Oct 15;37(22 Suppl):S65-74. doi: 10.1097/BRS.0b013e31826cb8f5. PMID: 22872223. Exclusion: E9.

596. Kim HJ, Nemani VM, Piyaskulkaew C, et al. Cervical radiculopathy: incidence and treatment of 1,420 consecutive cases. Asian spine j. 2016 Apr;10(2):231-7. doi: 10.4184/asj.2016.10.2.231. PMID: 27114762. Exclusion: E11.

597. Kim J, Ryu H, Kim TH. Early reoperation rates and its risk factors after instrumented spinal fusion surgery for degenerative spinal disease: a nationwide cohort study of 65,355 patients. J. 2022 Jun 10;11(12):10. doi: 10.3390/jcm11123338. PMID: 35743419. Exclusion: E1.

598. Kim J, Shankar DS, Bienstock DM, et al. Postoperative C5 palsy following cervical laminectomy with instrumented fusion versus cervical laminoplasty with reconstruction: Single surgeon and national inpatient cohort analyses. Clin Spine Surg. 2022 05 01;35(4):181-6. doi: 10.1097/BSD.0000000000001311. PMID: 35344513. Exclusion: E2 - per Andrea email 12/23.

599. Kim JE, Kim JS, Yang S, et al. Neurophysiological monitoring during anterior cervical discectomy and fusion for ossification of the posterior longitudinal ligament. Clin Neurophysiol Pract. 2021;6:56-62. doi: 10.1016/j.cnp.2021.01.001. PMID: 33665517. Exclusion: E11.

600. Kim JY, Riew KD. Arthroplasty and ACDF compared to ACDF alone for two-and three-level cervical disc disease. Spine. 2015;Vol.Conference: 43rd Annual Meeting of the Cervical Spine Research Society, CSRS 2015. United States. 2015(Supplement 2):338-40p. Exclusion: E6.

601. Kim N, Kim TH, Oh JK, et al. Analysis of the incidence and risk factors of postoperative delirium in patients with degenerative cervical myelopathy. Neurospine. 2022 Jun;19(2):323-33. doi: 10.14245/ns.2142778.389. PMID: 35577342. Exclusion: E4.

602. Kim S, Alan N, Sansosti A, et al. Complications After 3- and 4-Level Anterior Cervical Diskectomy and Fusion. World Neurosurg. 2019 Oct;130:e1105-e10. doi: 10.1016/j.wneu.2019.07.099. PMID: 31323419. Exclusion: E3.

603. Kim S, Lee SH, Kim ES, et al. Clinical and radiographic analysis of c5 palsy after anterior cervical decompression and fusion for cervical degenerative disease. J Spinal Disord Tech. 2014 Dec;27(8):436-41. doi: 10.1097/BSD.0b013e31826a10b0. PMID: 22832559. Exclusion: E3.

604. Kim SJ, Kim SD. Anterior cervical discectomy and fusion using a double cylindrical cage versus an anterior cervical plating system with iliac crest autografts for the treatment of cervical degenerative disc disease. J. 2014 Jan;55(1):12-7. doi: 10.3340/jkns.2014.55.1.12. PMID: 24570812. Exclusion: E11.

605. Kim SJ, Seo JS, Lee SH, et al. Comparison of anterior cervical foraminotomy and posterior cervical foraminotomy for treating single level unilateral cervical radiculopathy. Spine. 2019 Oct 01;44(19):1339-47. doi: 10.1097/BRS.0000000000003081. PMID: 31022153. Exclusion: E11.

606. Kim SW, Limson MA, Kim SB, et al. Comparison of radiographic changes after ACDF versus Bryan disc arthroplasty in single and bi-level cases. Eur Spine J. 2009 Feb;18(2):218-31. doi: 10.1007/s00586-008-0854-z. PMID: 19127374. Exclusion: E11.

607. Kim SY, Yoon SH, Kim D, et al. A prospective study with cage-only or cage-with-plate fixation in anterior cervical discectomy and interbody fusion of one and two levels. J. 2017 Nov;60(6):691-700. doi: 10.3340/jkns.2017.0211. PMID: 29142629. Exclusion: E11.

608. Kimchi G, Michaeli N, Nulman M, et al. Post-operative dysphagia following ventral cervical approach: complication or side-effect? Retrospective analysis and review of the literature. Br J Neurosurg. 2022 Feb;37(1):86-9. doi: 10.1080/02688697.2022.2107179. PMID: 35943396. Exclusion: E8.

609. Kimura A, Endo T, Inoue H, et al. Impact of axial neck pain on quality of life after laminoplasty. Spine. 2015;40(24):E1292-E8p. doi: 10.1097/BRS.0000000000001167. Exclusion: E3.

610. King JT, Jr., Abbed KM, Gould GC, et al. Cervical spine reoperation rates and hospital resource utilization after initial surgery for degenerative cervical spine disease in 12,338 patients in Washington State. Neurosurgery. 2009 Dec;65(6):1011-22; discussion 22-3. doi: 10.1227/01.NEU.0000360347.10596.BD. PMID: 19934960. Exclusion: E1.

611. Kitamura K, de Dios E, Bodon G, et al. Evaluating a paradigm shift from anterior decompression and fusion to muscle-preserving selective laminectomy: a single-center study of degenerative cervical myelopathy. J Neurosurg Spine. 2022 Jun 3:1-9. doi: 10.3171/2022.4.SPINE211562. PMID: 35901775. Exclusion: E2.

612. Klimo P, Jr., Peelle MW. Use of polyetheretherketone spacer and recombinant human bone morphogenetic protein-2 in the cervical spine: a radiographic analysis. Spine J. 2009 Dec;9(12):959-66. doi: 10.1016/j.spinee.2009.05.008. PMID: 19574105. Exclusion: E3.

613. Klingler J-H, Krüger MT, Sircar R, et al. PEEK cages versus PMMA spacers in anterior cervical discectomy: Comparison of fusion, subsidence, sagittal alignment, and clinical outcome with a minimum 1-year follow-up. The Scientific World Journal. 2014 2014/07/02;2014:398396. doi: 10.1155/2014/398396. PMID: 25110734. Exclusion: E11.

614. Koakutsu T, Aizawa T, Sasaki M, et al. Anterior decompression and fusion versus laminoplasty for cervical myelopathy caused by soft disk herniation: a long-term prospective multicenter study. Clin Spine Surg. 2020 12;33(10):E478-E85. doi: 10.1097/BSD.0000000000000986. PMID: 32282403. Exclusion: E11.

615. Koakutsu T, Morozumi N, Ishii Y, et al. Anterior decompression and fusion versus laminoplasty for cervical myelopathy caused by soft disc herniation: a prospective multicenter study. J Orthop Sci. 2010 Jan;15(1):71-8. doi: 10.1007/s00776-009-1429-4. PMID: 20151254. Exclusion: E2.

616. Koller H, Ames C, Mehdian H, et al. Characteristics of deformity surgery in patients with severe and rigid cervical kyphosis (CK): results of the CSRS-Europe multi-centre study project. Eur Spine J. 2019 Feb;28(2):324-44. doi: 10.1007/s00586-018-5835-2. PMID: 30483961. Exclusion: E1.

617. Komagata M, Nishiyama M, Endo K, et al. Prophylaxis of C5 palsy after cervical expansive laminoplasty by bilateral partial foraminotomy. Spine J. 2004 Nov-Dec;4(6):650-5. doi: 10.1016/j.spinee.2004.03.022. PMID: 15541697. Exclusion: E3.

618. Kommu R, Sahu BP, Purohit AK. Surgical outcome in patients with cervical ossified posterior longitudinal ligament: a single institutional experience. Asian J Neurosurg. 2014 Oct-Dec;9(4):196-202. doi: 10.4103/1793-5482.146602. PMID: 25685216. Exclusion: E1.

619. Komura S, Miyamoto K, Hosoe H, et al. Lower incidence of adjacent segment degeneration after anterior cervical fusion found with those fusing C5-6 and C6-7 than those leaving C5-6 or C6-7 as an adjacent level. J Spinal Disord Tech. 2012 Feb;25(1):23-9. doi: 10.1097/BSD.0b013e31820bb1f8. PMID: 21430572. Exclusion: E3.

620. Kong L, Cao J, Wang L, et al. Prevalence of adjacent segment disease following cervical spine surgery: a PRISMA-compliant systematic review and meta-analysis. Medicine (Baltimore). 2016 Jul;95(27):e4171. doi: 10.1097/MD.0000000000004171. PMID: 27399140. Exclusion: E8.

621. Konopka JA, Grabel ZJ, Segal DN, et al. Intraoperative neuromonitoring use patterns in degenerative, nondeformity cervical spine surgery: a survey of the cervical spine research society. Clin Spine Surg. 2021 04 01;34(3):E160-E5. doi: 10.1097/BSD.0000000000001083. PMID: 32991365. Exclusion: E1.

622. Kontakis M, Marques C, Lofgren H, et al. Artificial disc replacement and adjacent-segment pathology: 10-year outcomes of a randomized trial. J Neurosurg Spine. 2021 Dec 17;36(6):1-9. doi: 10.3171/2021.9.SPINE21904. PMID: 34920425. Exclusion: E2.

623. Korge A, Siepe CJ, Heider F, et al. [Total cervical disk replacement--implant-specific approaches: keel implant (Prodisc-C intervertebral disk prosthesis)]. Oper. 2010 Nov;22(5-6):480-94. doi: 10.1007/s00064-010-9024-7. PMID: 21153007. Exclusion: E10.

624. Korinth MC, Kruger A, Oertel MF, et al. Posterior foraminotomy or anterior discectomy with polymethyl methacrylate interbody stabilization for cervical soft disc disease: results in 292 patients with monoradiculopathy. Spine. 2006 May 15;31(11):1207-14; discussion 15-6. doi: 10.1097/01.brs.0000217604.02663.59. PMID: 16688033. Exclusion: E11.

625. Kotani Y, Abumi K, Ito M, et al. Impact of deep extensor muscle-preserving approach on clinical outcome of laminoplasty for cervical spondylotic myelopathy: comparative cohort study. Eur Spine J. 2012 Aug;21(8):1536-44. doi: 10.1007/s00586-012-2260-9. PMID: 22441562. Exclusion: E3.

626. Kotani Y, Abumi K, Ito M, et al. Minimum 2-year outcome of cervical laminoplasty with deep extensor muscle-preserving approach: impact on cervical spine function and quality of life. Eur Spine J. 2009;18(5):663-71p. doi: 10.1007/s00586-009-0892-1. Exclusion: E3.

627. Kotsias A, Mularski S, Kuhn B, et al. Does partial coating with titanium improve the radiographic fusion rate of empty PEEK cages in cervical spine surgery? A comparative analysis of clinical data. Patient Saf Surg. 2017;11:13. doi: 10.1186/s13037-017-0127-z. PMID: 28465722. Exclusion: E5.

628. Kotter MRN, Tetreault L, Badhiwala JH, et al. Surgical outcomes following laminectomy with fusion versus laminectomy alone in patients with degenerative cervical myelopathy. Spine. 2020 Dec 15;45(24):1696-703. doi: 10.1097/BRS.0000000000003677. PMID: 32890295. Exclusion: E2.

629. Koyanagi T, Hirabayashi K, Satomi K, et al. Predictability of operative results of cervical compression myelopathy based on preoperative computed tomographic myelography. Spine (Phila Pa 1976). 1993 Oct 15;18(14):1958-63. doi: 10.1097/00007632-199310001-00006. PMID: 8272943. Exclusion: E2.

630. Kuang L, Chen Y, Wang B, et al. Cervical disk arthroplasty versus anterior cervical decompression and fusion for the treatment of 2-level cervical spondylopathy: a systematic review and meta-analysis. Clin Spine Surg. 2016 11;29(9):372-82. PMID: 27295435. Exclusion: E8.

631. Kudo H, Takeuchi K, Wada K, et al. Ten-year long-term results of modified cervical double-door laminoplasty with C3 laminectomy preserving the semispinalis cervicis inserted into the axis compared with those of conventional cervical laminoplasty. Clin Spine Surg. 2021 04 01;34(3):E147-E53. doi: 10.1097/BSD.0000000000001068. PMID: 32941312. Exclusion: E1.

632. Kumar C, Dietz N, Sharma M, et al. Long-term comparison of health care utilization and reoperation rates in patients undergoing cervical disc arthroplasty and anterior cervical discectomy and fusion for cervical degenerative disc disease. World Neurosurg. 2020 Feb;134:e855-e65. doi: 10.1016/j.wneu.2019.11.012. PMID: 31733395. Exclusion: E5.

633. Kumar GR, Maurice-Williams RS, Bradford R. Cervical foraminotomy: an effective treatment for cervical spondylotic radiculopathy. Br J Neurosurg. 1998 Dec;12(6):563-8. doi: 10.1080/02688699844448. PMID: 10070468. Exclusion: E3.

634. Kurian SJ, Wahood W, Alvi MA, et al. Assessing the effects of publication bias on reported outcomes of cervical disc replacement and anterior cervical discectomy and fusion: a meta-epidemiologic study. World Neurosurg. 2020 05;137:443-50.e13. doi: 10.1016/j.wneu.2019.12.129. PMID: 31926357. Exclusion: E8.

635. Kurokawa R, Kim P. Cervical Laminoplasty: The History and the Future. Neurol Med Chir (Tokyo). 2015;55(7):529-39. doi: 10.2176/nmc.ra.2014-0387. PMID: 26119898. Exclusion: E6.

636. Kusin DJ, Ahn UM, Ahn NU. The effect of smoking on spinal cord healing following surgical treatment of cervical myelopathy. Spine. 2015 Sep 15;40(18):1391-6. doi: 10.1097/BRS.0000000000001014. PMID: 26426709. Exclusion: E1.

637. Kwok SSS, Cheung JPY. Surgical decision-making for ossification of the posterior longitudinal ligament versus other types of degenerative cervical myelopathy: anterior versus posterior approaches. BMC Musculoskelet Disord. 2020 Dec 08;21(1):823. doi: 10.1186/s12891-020-03830-0. PMID: 33292175. Exclusion: E8.

638. Kwok WCH, Wong CYY, Law JHW, et al. Risk factors for adjacent segment disease following anterior cervical discectomy and fusion with plate fixation: a systematic review and meta-analysis. J Bone Joint Surg Am. 2022 Nov 2;104(21):1915-45. doi: 10.2106/JBJS.21.01494. PMID: 36321969. Exclusion: E4.

639. Kwon OI, Son DW, Lee SW, et al. Comparison of radiologic outcomes of different methods in single-level anterior cervical discectomy and fusion. Korean J. 2016 Sep;13(3):91-6. doi: 10.14245/kjs.2016.13.3.91. PMID: 27799985. Exclusion: E11.

640. Lai B, Wu J, Gao Z, et al. Efficacy of anterior cervical discectomy and fusion versus artificial cervical disc replacement for cervical degenerative disease. Int J Clin Exp Med. 2018;11(7):7384-91p. Exclusion: E11.

641. Lambrechts MJ, Brush PL, Lee Y, et al. Patient reported outcomes following anterior and posterior surgical approaches for multilevel cervical myelopathy. Spine (Phila Pa 1976). 2023 Apr 15;48(8):526-33. doi: 10.1097/BRS.0000000000004586. PMID: 36716386. Exclusion: E11.

642. Lan T, Lin JZ, Hu SY, et al. Comparison between zero-profile spacer and plate with cage in the treatment of single level cervical spondylosis. J Back Musculoskeletal Rehabil. 2018;31(2):299-304. doi: 10.3233/BMR-169708. PMID: 29171978. Exclusion: E11.

643. Lan X, Wang Z, Huang Y, et al. Clinical and radiological comparisons of percutaneous low-power laser discectomy and low-temperature plasma radiofrequency ablation for cervical radiculopathy: a prospective, multicenter, cohort study. Frontiers in Surgery. 2021;8:779480. doi: 10.3389/fsurg.2021.779480. PMID: 35223967. Exclusion: E3.

644. Landriel FA, Hem S, Goldschmidt E, et al. Polyetheretherketone interbody cages versus autogenous iliac crest bone grafts with anterior fixation for cervical disc disease. J Spinal Disord Tech. 2013 Apr;26(2):61-7. doi: 10.1097/BSD.0b013e3182323274. PMID: 21964451. Exclusion: E11.

645. Lanman T, Hodges S, Gornet M, et al. Long-term clinical and radiographic outcomes of an artificial cervical disc replacement at two levels: results from a level 1 prospective randomized controlled clinical trial. Eur Spine J. 2016;25:S309-S10. doi: 10.1007/s00586-016-4722-y. Exclusion: E6.

646. Lanman TH. Comparison of 7-year results of one-level versus two-level cervical disc arthroplasty and fusion. Clin Neurosurg. 2017;Conference:. Vol.64(Supplement 1):245p. doi: 10.1093/neuros/nyx417. Exclusion: E6.

647. Lanman TH, Gornet M, Dryer R, et al. Two-level cervical disc arthroplasty vs. anterior cervical discectomy and fusion: 10 year outcomes of a prospective, randomized IDE clinical trial. J Neurosurg. 2019 to 2019-04-17;131(1):20-p. doi: 10.3171/2019.7.JNS.AANS2019abstracts. Exclusion: E6.

648. Lantz JM, Abedi A, Tran F, et al. The impact of physical therapy following cervical spine surgery for degenerative spine disorders: a systematic review. Clin Spine Surg. 2021 10 01;34(8):291-307. doi: 10.1097/BSD.0000000000001108. PMID: 33323701. Exclusion: E8.

649. Lantz JM, Roberts C, Formanek B, et al. Incidence of complications associated with cervical spine surgery and post-operative physical therapy and implications for timing of initiation of post-operative physical therapy: a retrospective database study. Eur Spine J. 2023 Jan;32(1):382-8. doi: 10.1007/s00586-022-07466-7. PMID: 36401668. Exclusion: E3.

650. Lao L, Zhong G, Li X, et al. Laminoplasty versus laminectomy for multi-level cervical spondylotic myelopathy: a systematic review of the literature. J. 2013 Dec 01;8:45. doi: 10.1186/1749-799X-8-45. PMID: 24289653. Exclusion: E8.

651. Latka D, Kozlowska K, Miekisiak G, et al. Safety and efficacy of cervical disc arthroplasty in preventing the adjacent segment disease: a meta-analysis of mid- to long-term outcomes in prospective, randomized, controlled multicenter studies. Ther Clin Risk Manag. 2019;15:531-9. doi: 10.2147/TCRM.S196349. PMID: 30992666. Exclusion: E8.

652. Lau D, Chou D, Mummaneni PV. Two-level corpectomy versus three-level discectomy for cervical spondylotic myelopathy: a comparison of perioperative, radiographic, and clinical outcomes. J Neurosurg Spine. 2015 Sep;23(3):280-9. doi: 10.3171/2014.12.SPINE14545. PMID: 26091438. Exclusion: E3.

653. Lau D, Winkler EA, Than KD, et al. Laminoplasty versus laminectomy with posterior spinal fusion for multilevel cervical spondylotic myelopathy: influence of cervical alignment on outcomes. J Neurosurg Spine. 2017 Nov;27(5):508-17. doi: 10.3171/2017.4.SPINE16831. PMID: 28862572. Exclusion: E5.

654. Lee CH, Hyun SJ, Kim MJ, et al. Comparative analysis of 3 different construct systems for single-level anterior cervical discectomy and fusion: stand-alone cage, iliac graft plus plate augmentation, and cage plus plating. J Spinal Disord Tech. 2013 Apr;26(2):112-8. doi: 10.1097/BSD.0b013e318274148e. PMID: 23027363. Exclusion: E11.

655. Lee CH, Jahng TA, Hyun SJ, et al. Expansive laminoplasty versus laminectomy alone versus laminectomy and fusion for cervical ossification of the posterior longitudinal ligament: Is there a difference in the clinical outcome and sagittal alignment? Clin Spine Surg. 2016 Feb;29(1):E9-15. doi: 10.1097/BSD.0000000000000058. PMID: 25075990. Exclusion: E11.

656. Lee CH, Lee J, Kang JD, et al. Laminoplasty versus laminectomy and fusion for multilevel cervical myelopathy: a meta-analysis of clinical and radiological outcomes. J Neurosurg Spine. 2015 Jun;22(6):589-95. doi: 10.3171/2014.10.SPINE1498. PMID: 25815808. Exclusion: E8.

657. Lee DH, Cho JH, Hwang CJ, et al. Can C3 laminectomy reduce interlaminar bony fusion and preserve the range of motion after cervical laminoplasty? Spine. 2016 Dec 15;41(24):1884-90. doi: 10.1097/BRS.0000000000001852. PMID: 27517513. Exclusion: E3.

658. Lee DH, Lee JS, Yi JS, et al. Anterior cervical plating technique to prevent adjacent-level ossification development. Spine J. 2013 Jul;13(7):823-9. doi: 10.1016/j.spinee.2013.03.009. PMID: 23602376. Exclusion: E3.

659. Lee DH, Park S, Hong CG, et al. Fusion and subsidence rates of vertebral body sliding osteotomy: Comparison of 3 reconstructive techniques for multilevel cervical myelopathy. Spine J. 2021 07;21(7):1089-98. doi: 10.1016/j.spinee.2021.03.023. PMID: 33774212. Exclusion: E3.

660. Lee GW, Cho CW, Shin JH, et al. Which technique is better option for c3 segment in multilevel open-door laminoplasty of the cervical spine?: laminectomy versus laminoplasty. Spine. 2017 Jul 15;42(14):E833-E40. doi: 10.1097/BRS.0000000000001974. PMID: 27851661. Exclusion: E11.

661. Lee JC, Jang HD, Ahn J, et al. Comparison of cortical ring allograft and plate fixation with autologous iliac bone graft for anterior cervical discectomy and fusion. Asian spine j. 2019 Apr;13(2):258-64. doi: 10.31616/asj.2018.0174. PMID: 30472821. Exclusion: E7.

662. Lee JC, Lee SH, Peters C, et al. Risk-factor analysis of adjacent-segment pathology requiring surgery following anterior, posterior, fusion, and nonfusion cervical spine operations: survivorship analysis of 1358 patients. J Bone Joint Surg Am. 2014 Nov 05;96(21):1761-7. doi: 10.2106/JBJS.M.01482. PMID: 25378502. Exclusion: E3.

663. Lee JC, Lee SH, Peters C, et al. Adjacent segment pathology requiring reoperation after anterior cervical arthrodesis: the influence of smoking, sex, and number of operated levels. Spine. 2015 May 15;40(10):E571-7. doi: 10.1097/BRS.0000000000000846. PMID: 25705959. Exclusion: E5.

664. Lee JS, Son DW, Lee SH, et al. The effect of hounsfield unit value with conventional computed tomography and intraoperative distraction on postoperative intervertebral height reduction in patients following stand-alone anterior cervical discectomy and fusion. J. 2022;65(1):96-106. doi: 10.3340/jkns.2021.0131. PMID: 34963207. Exclusion: E7.

665. Lee JY, Hilibrand AS, Lim MR, et al. Characterization of neurophysiologic alerts during anterior cervical spine surgery. Spine. 2006 Aug 01;31(17):1916-22. doi: 10.1097/01.brs.0000228724.01795.a2. PMID: 16924208. Exclusion: E3.

666. Lee MJ, Bazaz R, Furey CG, et al. Risk factors for dysphagia after anterior cervical spine surgery: a two-year prospective cohort study. Spine J. 2007 Mar-Apr;7(2):141-7. doi: 10.1016/j.spinee.2006.02.024. PMID: 17321961. Exclusion: E3.

667. Lee MJ, Dettori JR, Standaert CJ, et al. Indication for spinal fusion and the risk of adjacent segment pathology: does reason for fusion affect risk? A systematic review. Spine. 2012 Oct 15;37(22 Suppl):S40-51. doi: 10.1097/BRS.0b013e31826ca9b1. PMID: 22872219. Exclusion: E3.

668. Lee MJ, Kalfas I, Holmer H, et al. Outpatient surgery in the cervical spine: is it safe? Evid. 2014 Oct;5(2):101-11. doi: 10.1055/s-0034-1389088. PMID: 25278884. Exclusion: E3.

669. Lee NJ, Joaquim AF, Boddapati V, et al. Revision anterior cervical disc arthroplasty: a national analysis of the associated indications, procedures, and postoperative outcomes. Global spine j. 2022 Sep;12(7):1338-44. doi: 10.1177/2192568220979140. PMID: 33464126. Exclusion: E3.

670. Lee R, Lee D, Iweala U, et al. Outcomes following outpatient anterior cervical discectomy and fusion for the treatment of myelopathy. J. 2021 Apr;15:161-7. doi: 10.1016/j.jcot.2020.07.030. PMID: 33717932. Exclusion: E3.

671. Lee SH, Kim KT, Suk KS, et al. Effect of retropharyngeal steroid on prevertebral soft tissue swelling following anterior cervical discectomy and fusion a prospective, randomized study. Spine. 2011;36(26):2286-92. doi: 10.1097/BRS.0b013e318237e5d0. PMID: 22020609. Exclusion: E4.

672. Lee SH, Suk KS, Kang KC, et al. Outcomes and related factors of C5 palsy following cervical laminectomy with instrumented fusion compared with laminoplasty. Spine. 2016 May;41(10):E574-9. doi: 10.1097/BRS.0000000000001343. PMID: 26650877. Exclusion: E11.

673. Lee TT, Manzano GR, Green BA. Modified open-door cervical expansive laminoplasty for spondylotic myelopathy: operative technique, outcome, and predictors for gait improvement. J Neurosurg. 1997 Jan;86(1):64-8. doi: 10.3171/jns.1997.86.1.0064. PMID: 8988083. Exclusion: E7.

674. Lee YS, Kim YB, Park SW. Risk factors for postoperative subsidence of single-level anterior cervical discectomy and fusion: the significance of the preoperative cervical alignment. Spine. 2014 Jul 15;39(16):1280-7. doi: 10.1097/BRS.0000000000000400. PMID: 24827519. Exclusion: E3.

675. Lee YS, Kim YB, Park SW. Does a zero-profile anchored cage offer additional stabilization as anterior cervical plate? Spine. 2015 May 15;40(10):E563-70. doi: 10.1097/BRS.0000000000000864. PMID: 25955093. Exclusion: E11.

676. Lei T, Liu Y, Wang H, et al. Clinical and radiological analysis of Bryan cervical disc arthroplasty: eight-year follow-up results compared with anterior cervical discectomy and fusion. Int Orthop. 2016 Jun;40(6):1197-203. doi: 10.1007/s00264-015-3098-7. PMID: 26744166. Exclusion: E11.

677. Lemcke J, Al-Zain F, Meier U, et al. Polyetheretherketone (PEEK) Spacers for Anterior Cervical Fusion: a Retrospective Comparative Effectiveness Clinical Trial. Open Orthop J. 2011;5:348-53. doi: 10.2174/1874325001105010348. PMID: 22016753. Exclusion: E3.

678. Leonova O, Baykov E, Sanginov A, et al. Cervical disc degeneration and vertebral endplate defects after the fused operation. Spine. 2021 Sep 15;46(18):1234-40. doi: 10.1097/BRS.0000000000004007. PMID: 33595261. Exclusion: E2.

679. Li C, He Q, Zhu Y, et al. Is the anterior cervical dynamic plate fixation better than the anterior static plate fixation: a retrospective review with over 5 years follow-up. BMC Musculoskelet Disord. 2023 Jan 18;24(1):37. doi: 10.1186/s12891-023-06156-9. PMID: 36650488. Exclusion: E3.

680. Li FH, Qiao HH, Yang YC, et al. Incidence and outcomes of C5 palsy and axial pain after open-door laminoplasty or laminectomy and fusion: a meta-analysis. World Neurosurg. 2019 Aug;128:e1002-e9. doi: 10.1016/j.wneu.2019.05.060. PMID: 31108254. Exclusion: E8.

681. Li GL, Hu JZ, Lu HB, et al. Anterior cervical discectomy with arthroplasty versus anterior cervical discectomy and fusion for cervical spondylosis. J Clin Neurosci. 2015 Mar;22(3):460-7. doi: 10.1016/j.jocn.2014.09.010. PMID: 25533051. Exclusion: E8.

682. Li H, Dai LY. A systematic review of complications in cervical spine surgery for ossification of the posterior longitudinal ligament. Spine J. 2011 Nov;11(11):1049-57. doi: 10.1016/j.spinee.2011.09.008. PMID: 22015235. Exclusion: E8.

683. Li H, Min J, Zhang Q, et al. Dynamic cervical plate versus static cervical plate in the anterior cervical discectomy and fusion: a systematic review. Eur. 2013 Jul;23 Suppl 1:S41-6. doi: 10.1007/s00590-013-1244-8. PMID: 23736870. Exclusion: E8.

684. Li L, Wang H, Cui S. Effect of modified unilaterally-open expansive laminoplasty using bridge grafting and restructing posterior ligamentous complex methods on axial symptoms and cervical curvature change. Zhongguo xiu fu chong jian wai ke za zhi [Chinese journal of reparative and reconstructive surgery]. 2007;21(5):457-60p. Exclusion: E10.

685. Li L, Yang ZG, Shen HX, et al. [Correlation between magnetic resonance T2-weighted increased signal intensity position and prognosis of cervical spondylotic myelopathy]. Chung Hua I Hsueh Tsa Chih. 2009 Aug 18;89(31):2168-70. PMID: 20058591. Exclusion: E10.

686. Li M, Zhang T, Zhang H, et al. Comparison of clinical efficacy between retention and removal of the vertebral bony endplate in anterior cervical discectomy and fusion for the treatment of cervical spondylotic myelopathy. J Orthop Sci. 2021 Dec 09;09(21):09. doi: 10.1016/j.jos.2021.10.020. PMID: 34895993. Exclusion: E2.

687. Li P, Lei R, Gan L, et al. Comparing clinical and radiographic outcomes between the self-locking stand-alone cage and conventional cage-plate construct: a five-year retrospective cohort study. Spine (Phila Pa 1976). 2023 Jan 1;48(1):56-66. doi: 10.1097/BRS.0000000000004465. PMID: 36083844. Exclusion: E12

688. Li Q, Han X, Wang R, et al. Clinical recovery after 5 level of posterior decompression spine surgeries in patients with cervical spondylotic myelopathy: a retrospective cohort study. Asian J. 2020 May;43(5):613-24. doi: 10.1016/j.asjsur.2019.08.003. PMID: 31481282. Exclusion: E3.

689. Li T, Yang JS, Wang XF, et al. Can zero-profile cage maintain the cervical curvature similar to plate-cage construct for single-level anterior cervical diskectomy and fusion? World Neurosurg. 2020 Mar;135:e300-e6. doi: 10.1016/j.wneu.2019.11.153. PMID: 31805404. Exclusion: E11.

690. Li W, Zhan B, Jiang X, et al. A randomized controlled study of two different fixations in anterior cervical discectomy of multilevel cervical spondylotic myelopathy. J. 2022 Sep-Dec;30(3):10225536221118601. doi: 10.1177/10225536221118601. PMID: 36069629. Exclusion: E2.

691. Li X, Yu H, Welle K, et al. Comparative effectiveness and safety of open-door laminoplasty, french-door laminoplasty, laminectomy and fusion, and laminectomy alone for multilevel degenerative cervical myelopathy: a bayesian network analysis. Adv Ther. 2022 01;39(1):117-39. doi: 10.1007/s12325-021-01980-8. PMID: 34812993. Exclusion: E8.

692. Li Z, Chen L, Li B, et al. Efficacy and safety of surgical interventions for treating multilevel cervical spondylotic myelopathy via anterior approach: a network meta-analysis. Pain physician. 2019 07;22(4):E275-E86. PMID: 31337165. Exclusion: E8.

693. Li Z, Huang J, Zhang Z, et al. A comparison of multilevel anterior cervical discectomy and corpectomy in patients with 4-level cervical spondylotic myelopathy: a minimum 2-year follow-up study: Multilevel anterior cervical discectomy. Clin Spine Surg. 2017 Jun;30(5):E540-E6. doi: 10.1097/BSD.0000000000000212. PMID: 28525475. Exclusion: E3.

694. Li Z, Wang H, Tang J, et al. Comparison of three reconstructive techniques in the surgical management of patients with four-level cervical spondylotic myelopathy. Spine. 2017 May 15;42(10):E575-E83. doi: 10.1097/BRS.0000000000001907. PMID: 27669040. Exclusion: E3.

695. Li Z, Yu S, Zhao Y, et al. Clinical and radiologic comparison of dynamic cervical implant arthroplasty versus anterior cervical discectomy and fusion for the treatment of cervical degenerative disc disease. J Clin Neurosci. 2014 Jun;21(6):942-8. doi: 10.1016/j.jocn.2013.09.007. PMID: 24411326. Exclusion: E3.

696. Li ZJ, Wang Y, Xu GJ, et al. Is PEEK cage better than titanium cage in anterior cervical discectomy and fusion surgery? A meta-analysis. BMC Musculoskelet Disord. 2016 09 01;17:379. doi: 10.1186/s12891-016-1234-1. PMID: 27585553. Exclusion: E8.

697. Lian XF, Xu JG, Zeng BF, et al. Noncontiguous anterior decompression and fusion for multilevel cervical spondylotic myelopathy: a prospective randomized control clinical study. Eur Spine J. 2010 May;19(5):713-9. doi: 10.1007/s00586-010-1319-8. PMID: 20174838. Exclusion: E2.

698. Liang G, Liang C, Zheng X, et al. Sagittal alignment outcomes in lordotic cervical spine: does three-level anterior cervical discectomy and fusion outperform laminoplasty? Spine. 2019 Aug 01;44(15):E882-E8. doi: 10.1097/BRS.0000000000003016. PMID: 30817725. Exclusion: E4.

699. Liang HS, Xiao LJ, Deng DL. Posterior cervical single door and double door laminoplasty for repair of multilevel cervical myelopathy: motion range of cervical vertebrae. Chinese journal of tissue engineering research. 2016 China Journal of Clinical Rehabilitative Tissue Engineering Research (E-mail: lei0415@hotmail;20(22):3235-41p. doi: 10.3969/j.issn.2095-4344.2016.22.006. Exclusion: E10.

700. Liang XJ, Zhong WY, Tang K, et al. Implant complications after one-level or two-level cervical disc arthroplasty: a retrospective single-centre study of 105 patients. Medicine (Baltimore). 2020 Sep 18;99(38):e22184. doi: 10.1097/MD.0000000000022184. PMID: 32957345. Exclusion: E3.

701. Lied B, Roenning PA, Sundseth J, et al. Anterior cervical discectomy with fusion in patients with cervical disc degeneration: a prospective outcome study of 258 patients (181 fused with autologous bone graft and 77 fused with a PEEK cage). BMC surg. 2010 Mar 21;10:10. doi: 10.1186/1471-2482-10-10. PMID: 20302673. Exclusion: E3.

702. Lim S, Haider S, Zakaria H, et al. Comparison of 30-day outcome following anterior cervical discectomy and fusion with or without instrumentation for cervical spondylosis: a review of 2352 elective cases. Surg Neurol Int. 2019;10:246. doi: 10.25259/SNI_513_2019. PMID: 31893147. Exclusion: E3.

703. Lin B, Lu C, Yu H, et al. Comparison of microendoscopic discectomy system and anterior open approach in treatment of unstable odontoid fracture with cannulated screw internal fixation. Acta Orthop Belg. 2014 Dec;80(4):529-36. PMID: 26280726. Exclusion: E1.

704. Lin D, Zhai W, Lian K, et al. Anterior versus posterior approach for four-level cervical spondylotic myelopathy. Orthopedics. 2013;36(11):e1431-e6p. doi: 10.3928/01477447-20131021-28. Exclusion: E11.

705. Lin HL, Cho DY, Liu YF, et al. Change of cervical balance following single to multi-level interbody fusion with cage. Br J Neurosurg. 2008 Dec;22(6):758-63. doi: 10.1080/02688690802379134. PMID: 19085359. Exclusion: E3.

706. Lin JH, Chien LN, Tsai WL, et al. Reoperation rates of anterior cervical discectomy and fusion versus posterior laminoplasty for multilevel cervical degenerative diseases: a population-based cohort study in Taiwan. Spine J. 2016 12;16(12):1428-36. doi: 10.1016/j.spinee.2016.08.017. PMID: 27520080. Exclusion: E1.

707. Lin Q, Lin T, Wang Z, et al. Safety and effectiveness of modified expansive open-door laminoplasty using a ultrasonic bone scalpel compared with a high-speed drill. Clin Spine Surg. 2022 02 01;35(1):E223-E9. doi: 10.1097/BSD.0000000000001188. PMID: 33979104. Exclusion: E7.

708. Lin Q, Zhou X, Wang X, et al. A comparison of anterior cervical discectomy and corpectomy in patients with multilevel cervical spondylotic myelopathy. Eur Spine J. 2012 Mar;21(3):474-81. doi: 10.1007/s00586-011-1961-9. PMID: 21826497. Exclusion: E3.

709. Lin X, Cai J, Qin C, et al. Comparison of clinical outcomes and safety between laminectomy with instrumented fusion versus laminoplasty for the treatment of multilevel cervical spondylotic myelopathy. Medicine (Baltimore). 2019 Feb;98(8):e14651. doi: 10.1097/MD.0000000000014651. PMID: 30813208. Exclusion: E8.

710. Lin X, Li C, Lin Q, et al. Intraoperative neuromonitoring loss in abnormal magnetic resonance imaging signal intensity from patients with cervical compressive myelopathy. J Neurol Sci. 2017 Oct 15;381:235-9. doi: 10.1016/j.jns.2017.08.3261. PMID: 28991689. Exclusion: E3.

711. Lind BI, Zoega B, Rosen H. Autograft versus interbody fusion cage without plate fixation in the cervical spine: a randomized clinical study using radiostereometry. Eur Spine J. 2007 Aug;16(8):1251-6. doi: 10.1007/s00586-007-0337-7. PMID: 17342510. Exclusion: E3.

712. Ling JM, Tiruchelvarayan R. Early clinical and radiographical results of keel-less and shallow keel cervical disc replacement. Asian J Neurosurg. 2015 Jan-Mar;10(1):5-9. doi: 10.4103/1793-5482.151501. PMID: 25767568. Exclusion: E3.

713. Litrico S, Lonjon N, Riouallon G, et al. Adjacent segment disease after anterior cervical interbody fusion: a multicenter retrospective study of 288 patients with long-term follow-up. Orthop Traumatol Surg Res. 2014 Oct;100(6 Suppl):S305-9. doi: 10.1016/j.otsr.2014.07.004. PMID: 25129704. Exclusion: E3.

714. Liu B, Liu X, Chen Y, et al. Clinical effect observation of intravenous application of zoledronic acid in patients with cervical spondylosis and osteoporosis after anterior cervical discectomy and fusion: a randomized controlled study. J. 2019 May-Aug;27(2):2309499019847028. doi: 10.1177/2309499019847028. PMID: 31079567. Exclusion: E3.

715. Liu C, Liu K, Chu L, et al. Posterior percutaneous endoscopic cervical discectomy through lamina-hole approach for cervical intervertebral disc herniation. Int J Neurosci. 2019 Jul;129(7):627-34. doi: 10.1080/00207454.2018.1503176. PMID: 30238849. Exclusion: E7.

716. Liu FJ, Sun YP, Shen Y, et al. Prognostic value of magnetic resonance imaging combined with electromyography in the surgical management of cervical spondylotic myelopathy. Experimental Ther. 2013 Apr;5(4):1214-8. doi: 10.3892/etm.2013.934. PMID: 23596492. Exclusion: E11.

717. Liu JJ, Panchal RR, Kim KD. Functional spinal unit height and sagittal alignment of two-level CDA and ACDF patients. Spine journal. 2015 START: 2015 Oct 14 CONFERENCE END: 2015 Oct 17 30th Annual Meeting of the North American Spine Society, NASS 2015 Chicago, IL United States;15(10 SUPPL. 1):S146p. doi: 10.1016/j.spinee.2015.07.153. Exclusion: E6.

718. Liu JM, Xiong X, Peng AF, et al. A comparison of local bone graft with PEEK cage versus iliac bone graft used in anterior cervical discectomy and fusion. Clin Neurol Neurosurg. 2017 Apr;155:30-5. doi: 10.1016/j.clineuro.2017.02.009. PMID: 28242558. Exclusion: E11.

719. Liu JT, Chen SY, Su CH, et al. Radiographic outcomes of anterior cervical discectomy and fusion surgery by using cushioned titanium cage. Journal of Musculoskeletal Research. 2020;23(2) doi: 10.1142/S0218957720500074. Exclusion: E3.

720. Liu R, Jin A, Liu C, et al. Influence of one-level cervical disc arthroplasty and anterior cervical decompression and fusion on adjacent segment degeneration: a comparative study with two-year follow up. Int J Clin Exp Med. 2016;9(3):6504-10. Exclusion: E11.

721. Liu T, Yang HL, Xu YZ, et al. ACDF with the PCB cage-plate system versus laminoplasty for multilevel cervical spondylotic myelopathy. J Spinal Disord Tech. 2011 Jun;24(4):213-20. doi: 10.1097/BSD.0b013e3181e9f294. PMID: 20736851. Exclusion: E11.

722. Liu WJ, Hu L, Chou PH, et al. Comparison of anterior cervical discectomy and fusion versus posterior cervical foraminotomy in the treatment of cervical radiculopathy: a systematic review. Orthop Surg. 2016 Nov;8(4):425-31. doi: 10.1111/os.12285. PMID: 28032703. Exclusion: E8.

723. Liu X, Chen Y, Yang H, et al. Expansive open-door laminoplasty versus laminectomy and instrumented fusion for cases with cervical ossification of the posterior longitudinal ligament and straight lordosis. Eur Spine J. 2017 Apr;26(4):1173-80. doi: 10.1007/s00586-016-4912-7. PMID: 28028648. Exclusion: E11.

724. Liu Y, Wang H, Li X, et al. Comparison of a zero-profile anchored spacer (ROI-C) and the polyetheretherketone (PEEK) cages with an anterior plate in anterior cervical discectomy and fusion for multilevel cervical spondylotic myelopathy. Eur Spine J. 2016 06;25(6):1881-90. doi: 10.1007/s00586-016-4500-x. PMID: 26968876. Exclusion: E11.

725. Liu Z, Yang Y, Lan J, et al. Changes in cervical alignment of zero-profile device versus conventional cage-plate construct after anterior cervical discectomy and fusion: a meta-analysis. J Orthop Surg Res. 2022 Nov 24;17(1):510. doi: 10.1186/s13018-022-03400-1. PMID: 36434715. Exclusion: E4.

726. Lo YL, Zhu L, Soh RC, et al. Intraoperative motor evoked potential improvement in cervical spondylotic myelopathy: comparison of cortical stimulation parameters. J Clin Neurol. 2020 Jan;16(1):102-7. doi: 10.3988/jcn.2020.16.1.102. PMID: 31942765. Exclusion: E3.

727. Lofgren H, Engquist M, Hoffmann P, et al. Clinical and radiological evaluation of Trabecular Metal and the Smith-Robinson technique in anterior cervical fusion for degenerative disease: a prospective, randomized, controlled study with 2-year follow-up. Eur Spine J. 2010 Mar;19(3):464-73. doi: 10.1007/s00586-009-1161-z. PMID: 19763634. Exclusion: E3.

728. Lofgren H, Johansen F, Skogar O, et al. Reduced pain after surgery for cervical disc protrusion/stenosis: a 2 year clinical follow-up. Disabil Rehabil. 2003 Sep 16;25(18):1033-43. doi: 10.1080/0963828031000159647 8. PMID: 12944158. Exclusion: E2.

729. Lonstein JE, Denis F, Perra JH, et al. Complications associated with pedicle screws. J Bone Joint Surg Am. 1999 Nov;81(11):1519-28. doi: 10.2106/00004623-199911000-00003. PMID: 10565643. Exclusion: E1.

730. Louie PK, Presciutti SM, Iantorno SE, et al. There is no increased risk of adjacent segment disease at the cervicothoracic junction following an anterior cervical discectomy and fusion to C7. Spine J. 2017 09;17(9):1264-71. doi: 10.1016/j.spinee.2017.04.027. PMID: 28456670. Exclusion: E3.

731. Loumeau TP, Darden BV, Kesman TJ, et al. A RCT comparing 7-year clinical outcomes of one level symptomatic cervical disc disease (SCDD) following ProDisc-C total disc arthroplasty (TDA) versus anterior cervical discectomy and fusion (ACDF). Eur Spine J. 2016 07;25(7):2263-70. doi: 10.1007/s00586-016-4431-6. PMID: 26869078. Exclusion: E1.

732. Lowery GL, McDonough RF. The significance of hardware failure in anterior cervical plate fixation. Patients with 2- to 7-year follow-up. Spine. 1998 Jan 15;23(2):181-6; discussion 6-7. doi: 10.1097/00007632-199801150-00006. PMID: 9474723. Exclusion: E3.

733. Lu DC, Tumialan LM, Chou D. Multilevel anterior cervical discectomy and fusion with and without rhBMP-2: a comparison of dysphagia rates and outcomes in 150 patients. J Neurosurg Spine. 2013 Jan;18(1):43-9. doi: 10.3171/2012.10.SPINE10231. PMID: 23157278. Exclusion: E12 - per Shelley's email 1/17.

734. Lu H, Peng L. Efficacy and safety of Mobi-C cervical artificial disc versus anterior discectomy and fusion in patients with symptomatic degenerative disc disease: a meta-analysis. Medicine (Baltimore). 2017 Dec;96(49):e8504. doi: 10.1097/MD.0000000000008504. PMID: 29245217. Exclusion: E8.

735. Lu VM, Mobbs RJ, Fang B, et al. Clinical outcomes of locking stand-alone cage versus anterior plate construct in two-level anterior cervical discectomy and fusion: a systematic review and meta-analysis. Eur Spine J. 2019 01;28(1):199-208. doi: 10.1007/s00586-018-5811-x. PMID: 30390163. Exclusion: E8.

736. Lu VM, Zhang L, Scherman DB, et al. Treating multi-level cervical disc disease with hybrid surgery compared to anterior cervical discectomy and fusion: a systematic review and meta-analysis. Eur Spine J. 2017 02;26(2):546-57. doi: 10.1007/s00586-016-4791-y. PMID: 27679431. Exclusion: E3.

737. Lu Y, Bao W, Wang Z, et al. Comparison of the clinical effects of zero-profile anchored spacer (ROI-C) and conventional cage-plate construct for the treatment of noncontiguous bilevel of cervical degenerative disc disease (CDDD): a minimum 2-year follow-up. Medicine (Baltimore). 2018 Feb;97(5):e9808. doi: 10.1097/MD.0000000000009808. PMID: 29384883. Exclusion: E7.

738. Lu Y, Cho SK, Hecht A, et al. Cervical disc arthroplasty versus anterior cervical discectomy and fusioN: a systematic review. Spine journal. START: 2013 Oct 9 CONFERENCE END: 2013 Oct 12 28th Annual Meeting of the North American Spine Society, NASS 2013 New Orleans, LA United States;13(9):4S-p. doi: 10.1016/j.spinee.2013.07.040. Exclusion: E6.

739. Lu Y, Fang Y, Shen X, et al. Does zero-profile anchored cage accompanied by a higher postoperative subsidence compared with cage-plate construct? A meta-analysis. J. 2020 May 24;15(1):189. doi: 10.1186/s13018-020-01711-9. PMID: 32448320. Exclusion: E8.

740. Lubelski D, Pennington Z, Sciubba DM, et al. Horner syndrome after anterior cervical discectomy and fusion: case series and systematic review. World Neurosurg. 2020 Jan;133:e68-e75. doi: 10.1016/j.wneu.2019.08.101. PMID: 31465851. Exclusion: E8.

741. Lundine KM, Davis G, Rogers M, et al. Prevalence of adjacent segment disc degeneration in patients undergoing anterior cervical discectomy and fusion based on pre-operative MRI findings. J Clin Neurosci. 2014 Jan;21(1):82-5. doi: 10.1016/j.jocn.2013.02.039. PMID: 24035205. Exclusion: E4.

742. Lunsford LD, Bissonette DJ, Jannetta PJ, et al. Anterior surgery for cervical disc disease. Part 1: Treatment of lateral cervical disc herniation in 253 cases. J Neurosurg. 1980 Jul;53(1):1-11. doi: 10.3171/jns.1980.53.1.0001. PMID: 7411195. Exclusion: E3.

743. Luo C, Qu X, Chen B, et al. Cervical disc arthroplasty versus cervical discectomy and fusion for single-level cervical spondylosis: mid-term follow-up of a randomized controlled trial. Chinese journal of tissue engineering research. 2015;19(9):1358-64p. doi: 10.3969/j.issn.2095-4344.2015.09.008. Exclusion: E10.

744. Luo CA, Lim AS, Lu ML, et al. The surgical outcome of multilevel anterior cervical discectomy and fusion in myelopathic elderly and younger patients. Sci. 2022 03 16;12(1):4495. doi: 10.1038/s41598-022-08243-8. PMID: 35296700. Exclusion: E5.

745. Luo J, Cao K, Huang S, et al. Comparison of anterior approach versus posterior approach for the treatment of multilevel cervical spondylotic myelopathy. Eur Spine J. 2015 Aug;24(8):1621-30. doi: 10.1007/s00586-015-3911-4. PMID: 25840781. Exclusion: E8.

746. Luo J, Gong M, Huang S, et al. Incidence of adjacent segment degeneration in cervical disc arthroplasty versus anterior cervical decompression and fusion meta-analysis of prospective studies. Arch Orthop Trauma Surg. 2015 Feb;135(2):155-60. doi: 10.1007/s00402-014-2125-2. PMID: 25424753. Exclusion: E8.

747. Luo J, Huang S, Gong M, et al. Comparison of artificial cervical arthroplasty versus anterior cervical discectomy and fusion for one-level cervical degenerative disc disease: a meta-analysis of randomized controlled trials. Eur. 2015 Jul;25 Suppl 1:S115-25. doi: 10.1007/s00590-014-1510-4. PMID: 25034189. Exclusion: E8.

748. Luo J, Wang H, Peng J, et al. Rate of adjacent segment degeneration of cervical disc arthroplasty versus fusion meta-analysis of randomized controlled trials. World Neurosurg. 2018 May;113:225-31. doi: 10.1016/j.wneu.2018.02.113. PMID: 29499425. Exclusion: E8.

749. Luo W, Li Y, Zhao J, et al. Skip laminectomy compared with laminoplasty for cervical compressive myelopathy: a systematic review and meta-analysis. World Neurosurg. 2018 Dec;120:296-301. doi: 10.1016/j.wneu.2018.08.231. PMID: 30205220. Exclusion: E2.

750. Lynch CP, Cha EDK, Patel MR, et al. Effects of anterior plating on achieving clinically meaningful improvement following single-level anterior cervical discectomy and fusion. Neurospine. 2022 Jan 02;2(2):02. doi: 10.14245/ns.2142214.107. PMID: 34990538. Exclusion: E11.

751. Ma X, Zhao XF, Zhao YB. [A clinical study on different decompression methods in cervical spondylosis]. Chung Hua Wai Ko Tsa Chih. 2009 Apr 15;47(8):607-9. PMID: 19595042. Exclusion: E10.

752. Maccormick AP, Sharma H. Analysis of the variables affecting the incidence, location, and severity of cage subsidence following anterior cervical discectomy and fusion operation. Int J Spine Surg. 2020 Dec;14(6):896-900. doi: 10.14444/7137. PMID: 33560248. Exclusion: E3.

753. MacDowall A, Canto Moreira N, Marques C, et al. Artificial disc replacement versus fusion in patients with cervical degenerative disc disease and radiculopathy: a randomized controlled trial with 5-year outcomes. J Neurosurg Spine. 2019 01 11;30(3):323-31. doi: 10.3171/2018.9.SPINE18659. PMID: 30641852. Exclusion: E2.

754. MacDowall A, Skeppholm M, Lindhagen L, et al. Effects of preoperative mental distress versus surgical modality, arthroplasty, or fusion on long-term outcome in patients with cervical radiculopathy. J Neurosurg Spine. 2018 Oct;29(4):371-9. doi: 10.3171/2018.2.SPINE171378. PMID: 30004317. Exclusion: E2.

755. MacDowall AM, Moreia NC, Skeppholm M, et al. Artificial disc replacements do not prevent adjacent segment degeneration in the cervical spine. Spine. 2016(109):2016-12. Exclusion: E6.

756. Madawi AA, Powell M, Crockard HA. Biocompatible osteoconductive polymer versus iliac graft. A prospective comparative study for the evaluation of fusion pattern after anterior cervical discectomy. Spine (Phila Pa 1976). 1996 Sep 15;21(18):2123-9; discussion 9-30. doi: 10.1097/00007632-199609150-00013. PMID: 8893437. Exclusion: E12.

757. Madhavan K, Chieng L, Foong H, et al. Surgical outcomes of elderly patients with cervical spondylotic myelopathy: a meta-analysis of studies reporting on 2868 patients. Neurosurg Focus. 2016 Jun;40(6):E13. doi: 10.3171/2016.3.FOCUS1657. PMID: 27246483. Exclusion: E8.

758. Maharaj MM, Mobbs RJ, Hogan J, et al. Anterior cervical disc arthroplasty (ACDA) versus anterior cervical discectomy and fusion (ACDF): a systematic review and meta-analysis. J. 2015 Dec;1(1):72-85. doi: 10.3978/j.issn.2414-469X.2015.09.01. PMID: 27683682. Exclusion: E8.

759. Mai HT, Chun DS, Schneider AD, et al. The difference in clinical outcomes after anterior cervical fusion, disk replacement, and foraminotomy in professional athletes. Clin Spine Surg. 2018 02;31(1):E80-E4. doi: 10.1097/BSD.0000000000000570. PMID: 28719454. Exclusion: E11.

760. Maier IL, Hofer S, Eggert E, et al. T1 mapping quantifies spinal cord compression in patients with various degrees of cervical spinal canal stenosis. Frontiers in Neurology. 2020;11:574604. doi: 10.3389/fneur.2020.574604. PMID: 33193022. Exclusion: E2.

761. Maldonado CV, Paz RD, Martin CB. Adjacent-level degeneration after cervical disc arthroplasty versus fusion. Eur Spine J. 2011 Aug;20 Suppl 3(Suppl 3):403-7. doi: 10.1007/s00586-011-1916-1. PMID: 21796395. Exclusion: E11.

762. Mangan JJ, 3rd, Divi SN, McKenzie JC, et al. Proton pump inhibitor use affects pseudarthrosis rates and influences patient-reported outcomes. Global spine j. 2020 Feb;10(1):55-62. doi: 10.1177/2192568219853222. PMID: 32002350. Exclusion: E5.

763. Mangan JJ, Goyal DKC, Divi SN, et al. Does smoking status influence health-related quality of life outcome measures in patients undergoing ACDF? Global spine j. 2021 Jan;11(1):50-6. doi: 10.1177/2192568219890292. PMID: 32875848. Exclusion: E3.

764. Mansfield H, Canar W, Gerard C, et al. Single-level anterior cervical discectomy and fusion versus minimally invasive posterior cervical foraminotomy for patients with cervical radiculopathy: a cost analysis. Neurosurg Focus. 2014 Nov;37(5):E9. doi: 10.3171/2014.8.FOCUS14373. PMID: 25491887. Exclusion: E4.

765. Mao N, Wu J, Zhang Y, et al. A comparison of anterior cervical corpectomy and fusion combined with artificial disc replacement and cage fusion in patients with multilevel cervical spondylotic myelopathy. Spine. 2015 Aug 15;40(16):1277-83. doi: 10.1097/BRS.0000000000000957. PMID: 25929206. Exclusion: E3.

766. Margetic P, Elabjer E, Milosevic M, et al. Anterior neurodecompression of kyphotic spondylogenic myelopathy Ranawat grade III and posterior decompression of lordotic spine improve walking ability. Coll Antropol. 2009 Sep;33(3):899-905. PMID: 19860122. Exclusion: E3.

767. Martin GJ, Jr., Haid RW, Jr., MacMillan M, et al. Anterior cervical discectomy with freeze-dried fibula allograft. Overview of 317 cases and literature review. Spine (Phila Pa 1976). 1999 May 1;24(9):852-8; discussion 8-9. doi: 10.1097/00007632-199905010-00004. PMID: 10327505. Exclusion: E5.

768. Martino V, Nina P, Franco A, et al. Cervical myelopathy caused by median disc herniation: analysis of the complications following anterior discectomy with and without Fusion Report of 90 cases. J Neurosurg Sci. 1997 Jun;41(2):153-8. PMID: 9385565. Exclusion: E4.

769. Maruo K, Moriyama T, Tachibana T, et al. The impact of dynamic factors on surgical outcomes after double-door laminoplasty for ossification of the posterior longitudinal ligament of the cervical spine. J Neurosurg Spine. 2014 Dec;21(6):938-43. doi: 10.3171/2014.8.SPINE131197. PMID: 25279653. Exclusion: E7.

770. Marzluff J, McConnell J, Tomaras C, et al. 2-year multicenter follow-up in a prospective randomized clinical trial: Comparison of a cervical artificial disc to an ACDF treatment. Spine journal. 2010;Vol.Conference: 25th Annual Meeting of the North American Spine Society, NASS Miami, FL United States. Conference Start: 20101005 Conference End: 20101009. Conference Publication:(10 :(9 SUPPL. 1)):135S-6Sp. doi: 10.1016/j.spinee.2010.07.349. Exclusion: E6.

771. Massel DH, Mayo B, Ahn J, et al. The impact of local steroid application on dysphagia following an anterior cervical discectomy and fusion: preliminary results of a prospectively, randomized, single blind trial. Spine journal. 2016 to 2016-10-29;16(10):S205-S6p. doi: 10.1016/j.spinee.2016.07.116. Exclusion: E6.

772. Mastronardi L, Elsawaf A, Roperto R, et al. Prognostic relevance of the postoperative evolution of intramedullary spinal cord changes in signal intensity on magnetic resonance imaging after anterior decompression for cervical spondylotic myelopathy. J Neurosurg Spine. 2007 Dec;7(6):615-22. doi: 10.3171/SPI-07/12/615. PMID: 18074686. Exclusion: E7.

773. Matge G. Cervical cage fusion with 5 different implants: 250 cases. Acta Neurochir (Wien). 2002 Jun;144(6):539-49; discussion 50. doi: 10.1007/s00701-002-0939-0. PMID: 12111486. Exclusion: E4.

774. Matsumoto M, Okada E, Ichihara D, et al. Anterior cervical decompression and fusion accelerates adjacent segment degeneration: comparison with asymptomatic volunteers in a ten-year magnetic resonance imaging follow-up study. Spine. 2010 Jan 01;35(1):36-43. doi: 10.1097/BRS.0b013e3181b8a80d. PMID: 20023606. Exclusion: E3.

775. Matsuyama Y, Kawakami N, Yanase M, et al. Cervical myelopathy due to OPLL: clinical evaluation by MRI and intraoperative spinal sonography. J Spinal Disord Tech. 2004 Oct;17(5):401-4. doi: 10.1097/01.bsd.0000112087.85112.86. PMID: 15385880. Exclusion: E7.

776. Matz PG, Anderson PA, Groff MW, et al. Cervical laminoplasty for the treatment of cervical degenerative myelopathy. J Neurosurg Spine. 2009 Aug;11(2):157-69. doi: 10.3171/2009.1.SPINE08726. PMID: 19769495. Exclusion: E6 - background.

777. Matz PG, Holly LT, Groff MW, et al. Indications for anterior cervical decompression for the treatment of cervical degenerative radiculopathy. J Neurosurg Spine. 2009 Aug;11(2):174-82. doi: 10.3171/2009.3.SPINE08720. PMID: 19769497. Exclusion: E6 - background.

778. Matz PG, Holly LT, Mummaneni PV, et al. Anterior cervical surgery for the treatment of cervical degenerative myelopathy. J Neurosurg Spine. 2009 Aug;11(2):170-3. doi: 10.3171/2009.3.SPINE08724. PMID: 19769496. Exclusion: E6 - background.

779. Matz PG, Pritchard PR, Hadley MN. Anterior cervical approach for the treatment of cervical myelopathy. Neurosurgery. 2007 Jan;60(1 Supp1 1):S64-70. doi: 10.1227/01.NEU.0000215399.67006.05. PMID: 17204888. Exclusion: E6.

780. Matz PG, Ryken TC, Groff MW, et al. Techniques for anterior cervical decompression for radiculopathy. J Neurosurg Spine. 2009 Aug;11(2):183-97. doi: 10.3171/2009.2.SPINE08721. PMID: 19769498. Exclusion: E8.

781. Mayer TG, Anagnostis C, Gatchel RJ, et al. Impact of functional restoration after anterior cervical fusion on chronic disability in work-related neck pain. Spine J. 2002 Jul-Aug;2(4):267-73. doi: 10.1016/s1529-9430(02)00208-5. PMID: 14589478. Exclusion: E3.

782. Mayo BC, Massel DH, Bohl DD, et al. Anterior cervical discectomy and fusion: the surgical learning curve. Spine. 2016 Oct 15;41(20):1580-5. doi: 10.1097/BRS.0000000000001588. PMID: 27035581. Exclusion: E5.

783. Mazzucchi E, La Rocca G, Perna A, et al. Single-level anterior cervical discectomy and interbody fusion: a comparison between porous tantalum and polyetheretherketone cages. J. 2022 Jun 17;12(6):17. doi: 10.3390/jpm12060986. PMID: 35743770. Exclusion: E11.

784. McAfee PC, Cappuccino A, Cunningham BW, et al. Lower incidence of dysphagia with cervical arthroplasty compared with ACDF in a prospective randomized clinical trial. J Spinal Disord Tech. 2010 Feb;23(1):1-8. doi: 10.1097/BSD.0b013e31819e2ab8. PMID: 20051917. Exclusion: E9.

785. McAfee PC, Lee GA, Fedder IL, et al. Anterior BAK instrumentation and fusion: complete versus partial discectomy. Clin Orthop. 2002 Jan;394(394):55-63. doi: 10.1097/00003086-200201000-00007. PMID: 11795752. Exclusion: E5.

786. McAfee PC, Reah C, Gilder K, et al. A meta-analysis of comparative outcomes following cervical arthroplasty or anterior cervical fusion: results from 4 prospective multicenter randomized clinical trials and up to 1226 patients. Spine. 2012 May 15;37(11):943-52. doi: 10.1097/BRS.0b013e31823da169. PMID: 22037535. Exclusion: E8.

787. McAnany SJ, Ahn J, Elboghdady IM, et al. Mesenchymal stem cell allograft as a fusion adjunct in one- and two-level anterior cervical discectomy and fusion: a matched cohort analysis. Spine J. 2016 Feb;16(2):163-7. doi: 10.1016/j.spinee.2015.02.037. PMID: 25725368. Exclusion: E3.

788. McAnany SJ, Baird EO, Overley SC, et al. A meta-analysis of the clinical and fusion results following treatment of symptomatic cervical pseudarthrosis. Global spine j. 2015 Apr;5(2):148-55. doi: 10.1055/s-0035-1544176. PMID: 25844290. Exclusion: E8.

789. McAnany SJ, Merrill RK, Brochin RL, et al. Comparing the 5-year health state utility value of cervical disc replacement and anterior cervical discectomy and fusion. Global spine j. 2018;8(1):6-10. doi: 10.1177/2192568217721893. PMID: 29456909. Exclusion: E4.

790. McClelland S, 3rd, Marascalchi BJ, Passias PG, et al. Impact of race and insurance status on surgical approach for cervical spondylotic myelopathy in the united states: a population-based analysis. Spine. 2017 Feb;42(3):186-94. doi: 10.1097/BRS.0000000000001693. PMID: 27196022. Exclusion: E5.

791. McClure JJ, Desai BD, Shabo LM, et al. A single-center retrospective analysis of 3- or 4-level anterior cervical discectomy and fusion: surgical outcomes in 66 patients. J Neurosurg Spine. 2020 Oct 09;34(1):1-7. doi: 10.3171/2020.6.SPINE20171. PMID: 33036003. Exclusion: E3.

792. McConnell JR, Freeman BJ, Debnath UK, et al. A prospective randomized comparison of coralline hydroxyapatite with autograft in cervical interbody fusion. Spine (Phila Pa 1976). 2003 Feb 15;28(4):317-23. doi: 10.1097/01.Brs.0000048503.51956.E1. PMID: 12590203. Exclusion: E2 - outdated intervention.

793. McConnell JR, Lindley JG, McKee DJ, et al. Motion preservation at the operative level and the incidence of symptomatic adjacent segment disease after treatment with SECURE®-c or ACDF. Spine journal. 2016 to 2016-10-29;16(10):S262-p. doi: 10.1016/j.spinee.2016.07.179. Exclusion: E6.

794. McLaughlin MR, Purighalla V, Pizzi FJ. Cost advantages of two-level anterior cervical fusion with rigid internal fixation for radiculopathy and degenerative disease. Surg Neurol. 1997 Dec;48(6):560-5. doi: 10.1016/s0090-3019(97)00366-2. PMID: 9400636. Exclusion: E11.

795. Medhat H, Sorour O, Ayoub B, et al. The early effect of anterior cervical discectomy and fusion on adjacent segment degeneration in cases of cervical degenerative disease: a clinical and retrospective study. Open Access Maced J Med Sci. 2022 Oct 30;10:2536-42. doi: 10.3889/oamjms.2022.9902. Exclusion: E3.

796. Medical Advisory S. Artificial discs for lumbar and cervical degenerative disc disease -update: an evidence-based analysis. Ont Health Technol Assess Ser. 2006;6(10):1-98. PMID: 23074480. Exclusion: E9.

797. Meier U, Kemmesies D. [Experiences with six different intervertebral disc spacers for spondylodesis of the cervical spine]. Orthopade. 2004 Nov;33(11):1290-9. doi: 10.1007/s00132-004-0707-3. PMID: 15340803. Exclusion: E2.

798. Meisel HJ, Jurak L, Antinheimo J, et al. Four-year results of a prospective single-arm study on 200 semi-constrained total cervical disc prostheses: clinical and radiographic outcome. J Neurosurg Spine. 2016 Nov;25(5):556-65. doi: 10.3171/2016.3.SPINE15810. PMID: 27258476. Exclusion: E3.

799. Mende KC, Eicker SO, Weber F. Cage deviation in the subaxial cervical spine in relation to implant position in the sagittal plane. Neurosurg Rev. 2018 Jan;41(1):267-74. doi: 10.1007/s10143-017-0850-z. PMID: 28374128. Exclusion: E2.

800. Menon N, Turcotte J, Patton C. Structural allograft versus synthetic interbody cage for anterior cervical discectomy and fusion: a comparison of 1-year outcomes from a national database. Global spine j. 2021 Oct;11(8):1215-22. doi: 10.1177/2192568220942217. PMID: 32748651. Exclusion: E3 - per Shelley's email 1/17.

801. Merrill S, Kalani MA, Patel NP, et al. Acute spinal cord contusion in a patient with multiple upper cervical fractures, parkinson's disease, and torticollis: surgical management. Case Rep Orthop. 2020:8897071. doi: 10.1155/2020/8897071. PMID: 32963863. Exclusion: E5.

802. Meyer SA, Wu JC, Mummaneni PV. Laminoplasty outcomes: is there a difference between patients with degenerative stenosis and those with ossification of the posterior longitudinal ligament? Neurosurg. 2011 Mar;30(3):E9. doi: 10.3171/2011.1.FOCUS10279. PMID: 21361755. Exclusion: E3.

803. Mikawa Y, Shikata J, Yamamuro T. Spinal deformity and instability after multilevel cervical laminectomy. Spine (Phila Pa 1976). 1987 Jan-Feb;12(1):6-11. doi: 10.1097/00007632-198701000-00002. PMID: 3576358. Exclusion: E3.

804. Miller J, Sasso R, Anderson P, et al. Adjacent level degeneration: Bryan total disc arthroplasty versus anterior cervical discectomy and fusion. Clin Spine Surg. 2018 03;31(2):E98-E101. doi: 10.1097/BSD.0000000000000598. PMID: 29189218. Exclusion: E4.

805. Miller JW, Sasso RC, Anderson PA, et al. Adjacent-level degeneration after bryan cervical disc arthroplasty compared with anterior discectomy and fusion. Spine. 2016(269):2016-12. Exclusion: E6.

806. Miller LE, Block JE. Safety and effectiveness of bone allografts in anterior cervical discectomy and fusion surgery. Spine. 2011 Nov 15;36(24):2045-50. doi: 10.1097/BRS.0b013e3181ff37eb. PMID: 21304437. Exclusion: E8.

807. Minamide A, Yoshida M, Nakagawa Y, et al. Long-term clinical outcomes of microendoscopic laminotomy for cervical spondylotic myelopathy: a 5-year follow-up study compared with conventional laminoplasty. Clin Spine Surg. 2021 12 01;34(10):383-90. doi: 10.1097/BSD.0000000000001200. PMID: 34121073. Exclusion: E3.

808. Minamide A, Yoshida M, Simpson AK, et al. Microendoscopic laminotomy versus conventional laminoplasty for cervical spondylotic myelopathy: 5-year follow-up study. J Neurosurg Spine. 2017 Oct;27(4):403-9. doi: 10.3171/2017.2.SPINE16939. PMID: 28708041. Exclusion: E11.

809. Mitchell SM, White AM, Campbell DH, et al. Inpatient outcomes in dialysis dependent patients undergoing elective cervical spine surgery for degenerative cervical conditions. Global spine j. 2020 Oct;10(7):856-62. doi: 10.1177/2192568219883257. PMID: 32905731. Exclusion: E3.

810. Miyazaki K, Kirita Y. Extensive simultaneous multisegment laminectomy for myelopathy due to the ossification of the posterior longitudinal ligament in the cervical region. Spine (Phila Pa 1976). 1986 Jul-Aug;11(6):531-42. doi: 10.1097/00007632-198607000-00005. PMID: 3097835. Exclusion: E11.

811. Mizuno J, Nakagawa H, Inoue T, et al. Clinicopathological study of "snake-eye appearance" in compressive myelopathy of the cervical spinal cord. J Neurosurg. 2003 Sep;99(2 Suppl):162-8. doi: 10.3171/spi.2003.99.2.0162. PMID: 12956458. Exclusion: E11.

812. Mobbs RJ, Amin T, Ho D, et al. Integral fixation titanium/polyetheretherketone cages for cervical arthrodesis: Two-year clinical outcomes and fusion rates using beta-tricalcium phosphate or supercritical carbon dioxide treated allograft. J Craniovertebr Junction Spine. 2021 Oct-Dec;12(4):368-75. doi: 10.4103/jcvjs.jcvjs_129_21. PMID: 35068818. Exclusion: E1.

813. Mobbs RJ, Chau AM, Durmush D. Biphasic calcium phosphate contained within a polyetheretherketone cage with and without plating for anterior cervical discectomy and fusion. Orthop Surg. 2012 Aug;4(3):156-65. doi: 10.1111/j.1757-7861.2012.00185.x. PMID: 22927149. Exclusion: E11.

814. Mobbs RJ, Rao P, Chandran NK. Anterior cervical discectomy and fusion: analysis of surgical outcome with and without plating. J Clin Neurosci. 2007 Jul;14(7):639-42. doi: 10.1016/j.jocn.2006.04.003. PMID: 17532499. Exclusion: E2.

815. Molinari RW, Pagarigan K, Dettori JR, et al. Return to play in athletes receiving cervical surgery: a systematic review. Global spine j. 2016 Feb;6(1):89-96. doi: 10.1055/s-0035-1570460. PMID: 26835207. Exclusion: E8.

816. Moo IH, Kam CJW, Lai MWS, et al. A comparison of contiguous two-level anterior cervical discectomy and fusion using a structural allograft versus a Polyetheretherketone (PEEK) cage: the results of a three-year follow-up. BMC Musculoskelet Disord. 2020 May 28;21(1):331. doi: 10.1186/s12891-020-03325-y. PMID: 32466749. Exclusion: E11.

817. Morishita S, Yoshii T, Inose H, et al. Perioperative complications of anterior decompression with fusion in degenerative cervical myelopathy—a comparative study between ossification of posterior longitudinal ligament and cervical spondylotic myelopathy using a nationwide inpatient database. J. 2022;11(12):3398. doi: 10.3390/jcm11123398. PMID: 35743467. Exclusion: E3.

818. Morishita S, Yoshii T, Inose H, et al. Perioperative complications of laminoplasty in degenerative cervical myelopathy -a comparative study between ossification of posterior longitudinal ligament and cervical spondylotic myelopathy using a nationwide inpatient database. Global spine j. 2021 Dec 17:21925682211063867. doi: 10.1177/21925682211063867. PMID: 34920676. Exclusion: E3.

819. Moussellard HP, Meyer A, Biot D, et al. Early neurological recovery course after surgical treatment of cervical spondylotic myelopathy: a prospective study with 2-year follow-up using three different functional assessment tests. Eur Spine J. 2014 Jul;23(7):1508-14. doi: 10.1007/s00586-014-3315-x. PMID: 24777670. Exclusion: E3.

820. Moustafa IM, Diab AA, Harrison DE. The efficacy of cervical lordosis rehabilitation for nerve root function and pain in cervical spondylotic radiculopathy: a randomized trial with 2-year follow-up. J. 2022 Nov 2;11(21):6515. doi: 10.3390/jcm11216515. PMID: 36362743. Exclusion: E2.

821. Mu G, Chen H, Fu H, et al. Anterior cervical discectomy and fusion with zero-profile versus stand-alone cages for two-level cervical spondylosis: a retrospective cohort study. Front Surg. 2022 Nov 2;9:1002744. doi: 10.3389/fsurg.2022.1002744. PMID: 36406351. Exclusion: E11.

822. Muheremu A, Niu X, Wu Z, et al. Comparison of the short- and long-term treatment effect of cervical disk replacement and anterior cervical disk fusion: a meta-analysis. Eur. 2015 Jul;25 Suppl 1:S87-100. doi: 10.1007/s00590-014-1469-1. PMID: 24791930. Exclusion: E8.

823. Mummaneni PV, Amin BY, Wu JC, et al. Cervical artificial disc replacement versus fusion in the cervical spine: a systematic review comparing long-term follow-up results from two FDA trials. Evid. 2012 Feb;3(S1):59-66. doi: 10.1055/s-0031-1298610. PMID: 23236315. Exclusion: E9.

824. Mummaneni PV, Kaiser MG, Matz PG, et al. Cervical surgical techniques for the treatment of cervical spondylotic myelopathy. J Neurosurg Spine. 2009 Aug;11(2):130-41. doi: 10.3171/2009.3.SPINE08728. PMID: 19769492. Exclusion: E8 - background.

825. Mummaneni PV, Traynelis VC, Haid Jr RW, et al. Clinical and radiographic analysis of an artificial cervical disc: seven year clinical and radiographic outcomes from a prospective randomized controlled clinical trial. J Neurosurg. 2014 START: 2014 Apr 5 CONFERENCE END: 2014 Apr 9 2014 AANS Annual Meeting San Francisco, CA United States;122(6):A1554p. doi: 10.3171/2015.6.JNS.AANS2014abstracts. Exclusion: E6.

826. Muralidharan A, Shoap W, Al Robaidi K, et al. Postoperative neurological complications following revision spine surgery: a state inpatient database analysis. Int J Spine Surg. 2020 Aug;14(4):607-14. doi: 10.14444/7081. PMID: 32986585. Exclusion: E3.

827. Murrey DB, Janssen ME, Odum SM, et al. Two-year results of a randomized controlled clinical trial comparing prodisc-c and anterior cervical discectomy and fusion. Sas J. 2008;2(2):76-85. doi: 10.1016/SASJ-2007-0124-RR. PMID: 25802606. Exclusion: E1.

828. Murrey DB, Zigler JE, Delamarter RB, et al. Seven-year results of the prodisc-c multicenter randomized clinical trial. Spine journal. 2012 START: 2012 Oct 24 CONFERENCE END: 2012 Oct 27 27th Annual Meeting of the North American Spine Society, NASS 2012 Dallas, TX United States;12(9 SUPPL. 1):61S-2Sp. doi: 10.1016/j.spinee.2012.08.181. Exclusion: E6.

829. Muzevic D, Splavski B, Boop FA, et al. Anterior cervical discectomy with instrumented allograft fusion: lordosis restoration and comparison of functional outcomes among patients of different age groups. World Neurosurg. 2018 Jan;109:e233-e43. doi: 10.1016/j.wneu.2017.09.146. PMID: 28986227. Exclusion: E5.

830. Myer J, Beutler W, McConnell JR, et al. The incidence of symptomatic adjacent segment disease requiring treatment: cervical arthroplasty versus ACDF. Spine journal. 2014 START: 2014 Nov 12 CONFERENCE END: 2014 Nov 15 29th Annual Meeting of the North American Spine Society, NASS 2014 San Francisco, CA United States;14(11 SUPPL. 1):S160p. doi: 10.1016/j.spinee.2014.08.387. Exclusion: E6.

831. Nabhan A, Ahlhelm F, Pitzen T, et al. Disc replacement using Pro-Disc C versus fusion: a prospective randomised and controlled radiographic and clinical study. Eur Spine J. 2007 Mar;16(3):423-30. doi: 10.1007/s00586-006-0226-5. PMID: 17106665. Exclusion: E5.

832. Nabhan A, Ishak B, Steimer O, et al. Comparison of bioresorbable and titanium plates in cervical spinal fusion: early radiologic and clinical results. J Spinal Disord Tech. 2009 May;22(3):155-61. doi: 10.1097/BSD.0b013e3181761934. PMID: 19412016. Exclusion: E3.

833. Nabhan A, Pape D, Pitzen T, et al. Radiographic analysis of fusion progression following one-level cervical fusion with or without plate fixation. Zentralbl Neurochir. 2007 Aug;68(3):133-8. doi: 10.1055/s-2007-984462. PMID: 17665339. Exclusion: E7.

834. Nabhan A, Pape D, Pitzen T, et al. Cervical spine disc replacement versus fusion: a prospective randomized and controlled radiographic and clinical study EuroSpine 2006. 8th Annual Meeting of the European Spine Society, 25-28 October 2006, Istanbul, Turkey-Abstracts #41. Eur Spine J. 2006;15(Suppl 4):S473p. Exclusion: E6.

835. Nabhan A, Shariat K, Ishak B. Segmental alignment und Subsidence in bisegmental bioresorbable and titanium plates in cervical spinal fusion: radiological and clinical results. Eur Spine J. 2010 START: 2010 Dec 16 CONFERENCE END: 2010 Dec 18 5th German Spine Conference - Annual Meeting of the German Spine Society Bremen Germany;19(11):1968-9p. doi: 10.1007/s00586-010-1601-9. Exclusion: E6.

836. Nagata K, Ohashi T, Abe J, et al. Cervical myelopathy in elderly patients: clinical results and MRI findings before and after decompression surgery. Spinal Cord. 1996 Apr;34(4):220-6. doi: 10.1038/sc.1996.41. PMID: 8963966. Exclusion: E11.

837. Nagoshi N, Tetreault L, Nakashima H, et al. Risk factors for and clinical outcomes of dysphagia after anterior cervical surgery for degenerative cervical myelopathy: results from the aospine international and north america studies. J Bone Joint Surg Am. 2017 Jul 05;99(13):1069-77. doi: 10.2106/JBJS.16.00325. PMID: 28678119. Exclusion: E4.

838. Nakajima H, Watanabe S, Honjoh K, et al. Prognostic factors for the postoperative improvement of spinal cord-related neuropathic pain in patients with degenerative cervical myelopathy. Spine Surg Relat Res. 2022 Nov 27;6(6):610-6. doi: 10.22603/ssrr.2021-0248. PMID: 36561169. Exclusion: E3.

839. Nakajima K, Nakamoto H, Kato S, et al. A multicenter observational study on the postoperative outcomes of C3 laminectomy in cervical double-door laminoplasty. Clin Spine Surg. 2021 05 01;34(4):146-52. doi: 10.1097/BSD.0000000000001100. PMID: 33086255. Exclusion: E2.

840. Nakamae T, Tanaka N, Nakanishi K, et al. Investigation of segmental motor paralysis after cervical laminoplasty using intraoperative spinal cord monitoring with transcranial electric motor-evoked potentials. J Spinal Disord Tech. 2012 Apr;25(2):92-8. doi: 10.1097/BSD.0b013e318211fc4e. PMID: 22454184. Exclusion: E5.

841. Nakanishi Y, Naito K, Yamagata T, et al. Safety of anterior cervical discectomy and fusion using titanium-coated polyetheretherketone stand-alone cages: Multicenter prospective study of incidence of cage subsidence. J Clin Neurosci. 2020 Apr;74:47-54. doi: 10.1016/j.jocn.2020.01.056. PMID: 31983642. Exclusion: E7.

842. Nakashima H, Kato F, Yukawa Y, et al. Comparative effectiveness of open-door laminoplasty versus French-door laminoplasty in cervical compressive myelopathy. Spine. 2014;39(8):642-7p. doi: 10.1097/BRS.0000000000000252. Exclusion: E3.

843. Nakashima H, Tetreault L, Nagoshi N, et al. Comparison of outcomes of surgical treatment for ossification of the posterior longitudinal ligament versus other forms of degenerative cervical myelopathy: results from the prospective, multicenter AOSpine CSM-International Study of 479 patients. J Bone Joint Surg Am. 2016 Mar 2;98(5):370-8. doi: 10.2106/JBJS.O.00397. PMID: 26935459. Exclusion: E5.

844. Nambiar M, Phan K, Cunningham JE, et al. Locking stand-alone cages versus anterior plate constructs in single-level fusion for degenerative cervical disease: a systematic review and meta-analysis. Eur Spine J. 2017 Sep;26(9):2258-66. doi: 10.1007/s00586-017-5015-9. PMID: 28283840. Exclusion: E8.

845. Nanda A, Sharma M, Sonig A, et al. Surgical complications of anterior cervical diskectomy and fusion for cervical degenerative disk disease: a single surgeon's experience of 1,576 patients. World Neurosurg. 2014 Dec;82(6):1380-7. doi: 10.1016/j.wneu.2013.09.022. PMID: 24056095. Exclusion: E3.

846. Nandoe Tewarie RD, Bartels RH, Peul WC. Long-term outcome after anterior cervical discectomy without fusion. Eur Spine J. 2007 Sep;16(9):1411-6. doi: 10.1007/s00586-007-0309-y. PMID: 17262184. Exclusion: E3.

847. Nandyala SV, Marquez-Lara A, Fineberg SJ, et al. Comparison of revision surgeries for one- to two-level cervical TDR and ACDF from 2002 to 2011. Spine J. 2014 Dec 01;14(12):2841-6. doi: 10.1016/j.spinee.2014.03.037. PMID: 24704499. Exclusion: E3.

848. Ng HW, Teo EC, Zhang Q. Influence of cervical disc degeneration after posterior surgical techniques in combined flexion-extension--a nonlinear analytical study. J Biomech Eng. 2005 Feb;127(1):186-92. doi: 10.1115/1.1835364. PMID: 15868801. Exclusion: E1.

849. Nguyen S, Sherrod BA, Paziuk TM, et al. Predictors of dysphagia after anterior cervical discectomy and fusion: a prospective multicenter study. Spine. 2022 Jun 15;47(12):859-64. doi: 10.1097/BRS.0000000000004279. PMID: 34802025. Exclusion: E3.

850. Nikolaidis I, Fouyas IP, Sandercock AGP, et al. Surgery for cervical radiculopathy or myelopathy. Cochrane Database Syst Rev. 2010(1) doi: 10.1002/14651858.CD001466.pub3. Exclusion: E9.

851. Ning GZ, Kan SL, Zhu RS, et al. Comparison of Mobi-C cervical disc arthroplasty versus fusion for the treatment of symptomatic cervical degenerative disc disease. World Neurosurg. 2018 Jun;114:e224-e39. doi: 10.1016/j.wneu.2018.02.169. PMID: 29524714. Exclusion: E8.

852. Ning X, Wen Y, Xiao-Jian Y, et al. Anterior cervical locking plate-related complications; prevention and treatment recommendations. Int Orthop. 2008 Oct;32(5):649-55. doi: 10.1007/s00264-007-0369-y. PMID: 17497150. Exclusion: E1.

853. Nirala AP, Husain M, Vatsal DK. A retrospective study of multiple interbody grafting and long segment strut grafting following multilevel anterior cervical decompression. Br J Neurosurg. 2004 Jun;18(3):227-32. doi: 10.1080/02688690410001732643. PMID: 15327222. Exclusion: E11.

854. Noh SH, Park JY, Kuh SU, et al. Comparison of zero-profile anchored spacer versus plate-and-cage after 1-Level ACDF with complete uncinate process resection: a 3-year assessment of radiographic and clinical outcomes. Clinical Spine Surgery. 2021;34(5):176-82. doi: 10.1097/BSD.0000000000001129. Exclusion: E12.

855. Noh SH, Zhang HY. Comparison among perfect-C R, zero-P R, and plates with a cage in single-level cervical degenerative disc disease. BMC Musculoskelet Disord. 2018 01 25;19(1):33. doi: 10.1186/s12891-018-1950-9. PMID: 29368613. Exclusion: E12.

856. Noordhoek I, Koning MT, Jacobs WCH, et al. Incidence and clinical relevance of cage subsidence in anterior cervical discectomy and fusion: a systematic review. Acta Neurochir (Wien). 2018 04;160(4):873-80. doi: 10.1007/s00701-018-3490-3. PMID: 29468440. Exclusion: E8.

857. Noordhoek I, Koning MT, Vleggeert-Lankamp CLA. Evaluation of bony fusion after anterior cervical discectomy: a systematic literature review. Eur Spine J. 2019 02;28(2):386-99. doi: 10.1007/s00586-018-5820-9. PMID: 30448985. Exclusion: E3.

858. Nori S, Nagoshi N, Aoyama R, et al. Influence of Intervertebral Level of Stenosis on Neurological Recovery and Reduction of Neck Pain After Posterior Decompression Surgery for Cervical Spondylotic Myelopathy: a Retrospective Multicenter Study with Propensity Scoring. Spine. 2022 Mar 15;47(6):476-83. doi: 10.1097/BRS.0000000000004270. PMID: 34738987. Exclusion: E2.

859. Nori S, Shiraishi T, Aoyama R, et al. Muscle-preserving selective laminectomy maintained the compensatory mechanism of cervical lordosis after surgery. Spine. 2018 04 15;43(8):542-9. doi: 10.1097/BRS.0000000000002359. PMID: 28767627. Exclusion: E3.

860. Noriega DC, Ramajo RH, Sánchez-Lite I, et al. Heterotopic Ossification in Cervical Disk Surgery Is Still a Problem. What Are the Key Factors for a Solution? World Neurosurg. 2016 Dec;96:585-90. doi: 10.1016/j.wneu.2016.08.078. PMID: 27567584. Exclusion: E3.

861. Nouri A, Tetreault L, Cote P, et al. Does magnetic resonance imaging improve the predictive performance of a validated clinical prediction rule developed to evaluate surgical outcome in patients with degenerative cervical myelopathy? Spine. 2015 Jul 15;40(14):1092-100. doi: 10.1097/BRS.0000000000000919. PMID: 25893357. Exclusion: E4 - ask Ian.

862. Nouri A, Tetreault L, Dalzell K, et al. The relationship between preoperative clinical presentation and quantitative magnetic resonance imaging features in patients with degenerative cervical myelopathy. Neurosurgery. 2017 Jan 01;80(1):121-8. doi: 10.1227/NEU.0000000000001420. PMID: 27607403. Exclusion: E4.

863. Nouri A, Tetreault L, Nori S, et al. Congenital cervical spine stenosis in a multicenter global cohort of patients with degenerative cervical myelopathy: an ambispective report based on a magnetic resonance imaging diagnostic criterion. Neurosurgery. 2018 09 01;83(3):521-8. doi: 10.1093/neuros/nyx521. PMID: 29462433. Exclusion: E3.

864. Nukala M, Abraham J, Khandige G, et al. Efficacy of diffusion tensor imaging in identification of degenerative cervical spondylotic myelopathy. European Journal of Radiology Open. 2019;6:16-23. doi: 10.1016/j.ejro.2018.08.006. Exclusion: E5.

865. Nunez JH, Escudero B, Omiste I, et al. Outcomes of cervical arthroplasty versus anterior cervical arthrodesis: a systematic review and meta-analysis of randomized clinical trials with a minimum follow-up of 7-year. Eur J Orthop Surg Traumatol. 2022 Jul;33(5):1875-84. doi: 10.1007/s00590-022-03365-1. PMID: 35986813. Exclusion: E8.

866. Nunley P, Bae HW, Davis R, et al. A prospective randomized controlled trial to assess the efficacy of the Mobi-C® artificial cervical disc in the management of intractable cervical myelo-radiculopathy at one or two contiguous level. Eur Spine J. 2012;21(2):S240-S1. doi: 10.1007/s00586-012-2257-4. Exclusion: E6.

867. Nunley P, Jawahar A, Bae H, et al. A prospective randomized controlled trial to assess the efficacy of the Mobi-C&bgr; artificial cervical disc in the management of intractable cervical myelo-radiculopathy at one or two contiguous level. Spine journal. 2011 to 2011-11-05;11(10):47S-8Sp. doi: 10.1016/j.spinee.2011.08.124. Exclusion: E6.

868. Nunley PD, Blumenthal SL, Cavanaugh D, et al. Seven-year radiographic adjacent segment pathology after treatment with TDR or ACDF at one or two levels. Eur Spine J. 2016 to 2016-12-03;25(11):3800-1p. doi: 10.1007/s00586-016-4801-0. Exclusion: E6.

869. Nunley PD, Cavanaugh DA, Kerr IE, et al. Radiographic adjacent segment pathology after treatment with TDR or ACDF at one or two levels at five years. Spine journal. 2014 START: 2014 Nov 12 CONFERENCE END: 2014 Nov 15 29th Annual Meeting of the North American Spine Society, NASS 2014 San Francisco, CA United States;14(11 SUPPL. 1):S23-S4p. doi: 10.1016/j.spinee.2014.08.065. Exclusion: E6.

870. Nunley PD, Coric D, Frank KA, et al. Cervical disc arthroplasty: current evidence and real-world application. Neurosurgery. 2018 12 01;83(6):1087-106. doi: 10.1093/neuros/nyx579. PMID: 29325074. Exclusion: E8.

871. Nunley PD, Jawahar A, Cavanaugh DA, et al. Symptomatic adjacent segment disease after cervical total disc replacement: re-examining the clinical and radiological evidence with established criteria. Spine J. 2013 Jan;13(1):5-12. doi: 10.1016/j.spinee.2012.11.032. PMID: 23318108. Exclusion: E3.

872. Nunley PD, Jawahar A, Kerr EJ, 3rd, et al. Choice of plate may affect outcomes for single versus multilevel ACDF: results of a prospective randomized single-blind trial. Spine J. 2009 Feb;9(2):121-7. doi: 10.1016/j.spinee.2007.11.009. PMID: 18261963. Exclusion: E3.

873. Nunley PD, Kerr EJ, Cavanaugh D, et al. Cervical disc replacement vs. ACDF for single and multilevel treatment of cervical degenerative disc disease: seven-year clinical results from an FDA clinical trial. Spine. 2016(310):2016-12. Exclusion: E6.

874. Nunley PD, Kerr EJ, Cavanaugh DA, et al. Seven-year radiographic adjacent segment pathology after treatment with TDR or ACDF at one or two levels. Spine journal. 2016 to 2016-10-29;16(10):S283-p. doi: 10.1016/j.spinee.2016.07.200. Exclusion: E6.

875. Nunley PD, Kerr EJ, Cavanaugh DA, et al. Prevalence, progression, and clinical implications of heterotopic ossification after cervical disc arthroplasty at seven years. Spine journal. 2016 to 2016-10-29;16(10):S337-p. doi: 10.1016/j.spinee.2016.07.266. Exclusion: E6.

876. Nunley PD, Kerr EJ, 3rd, Cavanaugh DA, et al. Adjacent segment pathology after treatment with cervical disc arthroplasty or anterior cervical discectomy and fusion, Part 1: radiographic results at 7-year follow-up. Int J Spine Surg. 2020 Jun;14(3):269-77. doi: 10.14444/7036. PMID: 32699747. Exclusion: E5.

877. O'Donohoe TJ, Mililli L, Magee A, et al. Effect of the presence and type of plate augmentation on postoperative dysphagia among adult patients undergoing elective anterior cervical discectomy and fusion for spondylosis: a randomized trial. Neurospine. 2020 Mar;17(1):174-83. doi: 10.14245/ns.1938446.223. PMID: 32252167. Exclusion: E7.

878. O'Toole JE, Eichholz KM, Fessler RG. Surgical site infection rates after minimally invasive spinal surgery. J Neurosurg Spine. 2009 Oct;11(4):471-6. doi: 10.3171/2009.5.SPINE08633. PMID: 19929344. Exclusion: E1.

879. Ogawa Y, Toyama Y, Chiba K, et al. Long-term results of expansive open-door laminoplasty for ossification of the posterior longitudinal ligament of the cervical spine. J Neurosurg Spine. 2004 Sep;1(2):168-74. doi: 10.3171/spi.2004.1.2.0168. PMID: 15347002. Exclusion: E5.

880. Oglesby M, Fineberg SJ, Patel AA, et al. The incidence and mortality of thromboembolic events in cervical spine surgery. Spine. 2013 Apr 20;38(9):E521-7. doi: 10.1097/BRS.0b013e3182897839. PMID: 23370688. Exclusion: E1.

881. Oh BH, Kim JY, Lee JB, et al. Failure to obtain baseline signals of transcranial motor-evoked potentials in spine surgery: analysis of the reasons. World Neurosurg. 2023 Feb;170:e144-e50. doi: 10.1016/j.wneu.2022.10.082. PMID: 36328164. Exclusion: E4.

882. Oh HS, Shim CS, Kim JS, et al. Clinical and radiological comparison of femur and fibular allografts for the treatment of cervical degenerative disc diseases. J. 2013 Jan;53(1):6-12. doi: 10.3340/jkns.2013.53.1.6. PMID: 23439721. Exclusion: E11.

883. Oh JK, Kim TY, Lee HS, et al. Stand-alone cervical cages versus anterior cervical plate in 2-level cervical anterior interbody fusion patients: clinical outcomes and radiologic changes. J Spinal Disord Tech. 2013 Dec;26(8):415-20. doi: 10.1097/BSD.0b013e31824c7d22. PMID: 22367466. Exclusion: E11.

884. Oh LJ, Ong S, Ghozy S, et al. Dysphagia rates in single- and multiple-level anterior cervical discectomy and fusion surgery: a meta-analysis. J. 2020 Sep;6(3):581-90. doi: 10.21037/jss-20-506. PMID: 33102895. Exclusion: E6.

885. Ohnmeiss D, Hisey M, Bae H, et al. Does total disc replacement reduce the incidence of adjacent segment degeneration: results of a multicenter, prospective, randomized, controlled trial comparing Mobi-C&bgr; cervical artificial disc to anterior cervical fusion. Spine journal. 2011 START: 2011 Nov 2 CONFERENCE END: 2011 Nov 5 26th Annual Meeting of the North American Spine Society, NASS 2011 Chicago, IL United States;11(10):44S-5Sp. doi: 10.1016/j.spinee.2011.08.118. Exclusion: E6.

886. Ohnmeiss D, Hisey M, Bae H, et al. Multicenter, prospective, randomized, controlled investigational device exemption study comparing Mobi-Cbeta cervical artificial disc to anterior fusion in the treatment of symptomatic cervical degenerative disc disease. Spine journal. 2011 START: 2011 Nov 2 CONFERENCE END: 2011 Nov 5 26th Annual Meeting of the North American Spine Society, NASS 2011 Chicago, IL United States;11(10 SUPPL. 1):16S-7Sp. doi: 10.1016/j.spinee.2011.08.051. Exclusion: E6.

887. Ohnmeiss DD, Bae HW. Influence of adverse events on clinical outcomes of patients in an FDA IDE clinical trial of cervical total disc replacement versus anterior cervical discectomy and fusion. Spine journal. 2015 START: 2015 Oct 14 CONFERENCE END: 2015 Oct 17 30th Annual Meeting of the North American Spine Society, NASS 2015 Chicago, IL United States;15(10 SUPPL. 1):S195-S6p. doi: 10.1016/j.spinee.2015.07.261. Exclusion: E6.

888. Ohtonari T, Kitagawa T, Ota T, et al. Facet Joint- and Nuchal Ligament-Sparing Laminectomy is Not Inferior to Conventional Open-Door Laminoplasty from Clinical and Radiologic Perspectives. World Neurosurg. 2020 05;137:e321-e7. doi: 10.1016/j.wneu.2020.01.187. PMID: 32018050. Exclusion: E2.

889. Okada Y, Ikata T, Yamada H, et al. Magnetic resonance imaging study on the results of surgery for cervical compression myelopathy. Spine. 1993 Oct 15;18(14):2024-9. PMID: 8272953. Exclusion: E7.

890. Okais N, Moussa R, Hage P. [Value of increased MRI signal intensity in cervical arthrosis in myelopathies]. Neurochirurgie. 1997;43(5):285-90; discussion 90-1. PMID: 9686232. Exclusion: E10.

891. Oliver JD, Goncalves S, Kerezoudis P, et al. Comparison of outcomes for anterior cervical discectomy and fusion with and without anterior plate fixation: a systematic review and meta-analysis. Spine. 2018 04 01;43(7):E413-E22. doi: 10.1097/BRS.0000000000002441. PMID: 29016435. Exclusion: E8.

892. Onyedimma C, Jallow O, Yolcu YU, et al. Comparison of outcomes between cage materials used for patients undergoing anterior cervical discectomy and fusion with standalone cages: a systematic review and meta-analysis. World Neurosurg. 2021 Nov 24;24:24. doi: 10.1016/j.wneu.2021.10.084. PMID: 34838765. Exclusion: E5.

893. Opsenak R, Kolarovszki B, Benco M, et al. Dysphagia after anterior cervical discectomy and interbody fusion - prospective study with 1-year follow-up. Rozhl Chir. 2019;98(3):115-20. PMID: 31018643. Exclusion: E5.

894. Orief T, Ramadan I, Seddik Z, et al. Comparative evaluation of bone-filled Polymethylmethacrylate implant, autograft fusion, and Polyetheretherketone cervical cage fusion for the treatment of single -level cervical disc disease. Asian J Neurosurg. 2010 Jul;5(2):46-56. PMID: 22028758. Exclusion: E3.

895. Oshima Y, Kato S, Doi T, et al. Comparison of microendoscopic selective laminectomy versus conventional laminoplasty in patients with degenerative cervcical myelopathy: a minimum 2-year follow-up study. BMC Musculoskelet Disord. 2019 Oct 25;20(1):471. doi: 10.1186/s12891-019-2884-6. PMID: 31651296. Exclusion: E2.

896. Oshina M, Kawamura N, Hara N, et al. A propensity score-matched analysis of clinical outcomes between single-level and multilevel intervertebral decompression for cervical radiculopathy. Spine (Phila Pa 1976). 2023 Feb 15;48(4):247-52. doi: 10.1097/BRS.0000000000004508. PMID: 36255352. Exclusion: E3.

897. Oshina M, Tani S, Yamada T, et al. Limitations of minimally invasive posterior cervical foraminotomy—a decompression method of posteriorly shifting the nerve root—in cases of large anterior osteophytes in cervical radiculopathy: a retrospective multicenter cohort study. J Orthop Sci. 2022;S0949-2658(22):00177-4. doi: 10.1016/j.jos.2022.06.011. PMID: 35817666. Exclusion: E3.

898. Otani K, Sato K, Yabuki S, et al. A segmental partial laminectomy for cervical spondylotic myelopathy: anatomical basis and clinical outcome in comparison with expansive open-door laminoplasty. Spine. 2009 Feb 01;34(3):268-73. doi: 10.1097/BRS.0b013e318195b27a. PMID: 19179921. Exclusion: E1.

899. Ouyang H, Hu Y, Hu W, et al. Incidences, causes and risk factors of unplanned reoperations within 30 days of spine surgery: a single-center study based on 35,246 patients. Spine J. 2022 Nov;22(11):1811-9. doi: 10.1016/j.spinee.2022.07.098. PMID: 35878756. Exclusion: E1.

900. Overley SC, Merrill R, Cho SK, et al. Postoperative bracing after one-and two-level ACDF: is it necessary? A prospective trial. Spine journal. 2016 to 2016-10-29;16(10):S207-S8p. doi: 10.1016/j.spinee.2016.07.120. Exclusion: E6 - conference abstract.

901. Overley SC, Merrill RK, Baird EO, et al. Is cervical bracing necessary after single and multi-level anterior cervical discectomy and fusion? a prospective randomized study. Spine. 2016:92-3. Exclusion: E6.

902. Overley SC, Merrill RK, Leven DM, et al. A matched cohort analysis comparing stand-alone cages and anterior cervical plates used for anterior cervical discectomy and fusion. Global spine j. 2017 Aug;7(5):394-9. doi: 10.1177/2192568217699211. PMID: 28811982. Exclusion: E7.

903. Oya J, Burke JF, Vogel T, et al. The accuracy of multimodality intraoperative neuromonitoring to predict postoperative neurologic deficits following cervical laminoplasty. World Neurosurg. 2017 Oct;106:17-25. doi: 10.1016/j.wneu.2017.06.026. PMID: 28619491. Exclusion: E5.

904. Ozawa H, Sato T, Hyodo H, et al. Clinical significance of intramedullary Gd-DTPA enhancement in cervical myelopathy. Spinal Cord. 2010 May;48(5):415-22. doi: 10.1038/sc.2009.152. PMID: 19901954. Exclusion: E11.

905. Ozer AF, Kaner T, Sasani M, et al. Anterior approach to disc herniation with modified anterior microforaminotomy at C7-T2: technical note. Spine. 2009 Aug 01;34(17):1879-83. doi: 10.1097/BRS.0b013e3181aa7c62. PMID: 19644341. Exclusion: E5.

906. Ozgen S, Naderi S, Ozek MM, et al. A retrospective review of cervical corpectomy: indications, complications and outcome. Acta Neurochir (Wien). 2004 Oct;146(10):1099-105; discussion 105. doi: 10.1007/s00701-004-0327-z. PMID: 15309581. Exclusion: E1.

907. Padhye K, Shultz P, Alcala C, et al. Surgical treatment of single level cervical radiculopathy: a comparison of anterior cervical decompression and fusion (ACDF) versus cervical disk arthroplasty (CDA) versus posterior cervical foraminotomy (PCF). Clin Spine Surg. 2022 05 01;35(4):149-54. doi: 10.1097/BSD.0000000000001316. PMID: 35351839. Exclusion: E11.

908. Paracino R, Fasinella MR, Mancini F, et al. Review of laminoplasty versus laminectomy in the surgical management of cervical spondylotic myelopathy. Surg Neurol Int. 2021;12:44. doi: 10.25259/SNI_788_2020. PMID: 33598360. Exclusion: E8.

909. Park CK, Ryu KS. Are controversial issues in cervical total disc replacement resolved or unresolved?: a review of literature and recent updates. Asian spine j. 2018 Feb;12(1):178-92. doi: 10.4184/asj.2018.12.1.178. PMID: 29503699. Exclusion: E6.

910. Park JH, Hyun SJ, Lee CH, et al. Efficacy of a short plate with an oblique screw trajectory for anterior cervical plating: a comparative study with a 2-year minimum follow-up. Clin Spine Surg. 2016 Feb;29(1):E43-8. doi: 10.1097/BSD.0000000000000111. PMID: 24901874. Exclusion: E11.

911. Park JH, Roh KH, Cho JY, et al. Comparative analysis of cervical arthroplasty using Mobi-c(r) and anterior cervical discectomy and fusion using the Solis(r) -cage. J. 2008;44(4):217-21. doi: 10.3340/jkns.2008.44.4.217. Exclusion: E11.

912. Park JI, Cho DC, Kim KT, et al. Anterior cervical discectomy and fusion using a stand-alone polyetheretherketone cage packed with local autobone: assessment of bone fusion and subsidence. J. 2013;54(3):189-93. doi: 10.3340/jkns.2013.54.3.189. PMID: 24278646. Exclusion: E3.

913. Park JY, Kim KH, Kuh SU, et al. What are the associative factors of adjacent segment degeneration after anterior cervical spine surgery? Comparative study between anterior cervical fusion and arthroplasty with 5-year follow-up MRI and CT. Eur Spine J. 2013 May;22(5):1078-89. doi: 10.1007/s00586-012-2613-4. PMID: 23242622. Exclusion: E11.

914. Park MS, Ju YS, Moon SH, et al. Reoperation rates after anterior cervical discectomy and fusion for cervical spondylotic radiculopathy and myelopathy: a national population-based study. Spine. 2016 Oct 15;41(20):1593-9. doi: 10.1097/BRS.0000000000001590. PMID: 27035582. Exclusion: E3.

915. Park MS, Ju YS, Moon SH, et al. Reoperation rates after surgery for degenerative cervical spine disease according to different surgical procedures: national population-based cohort study. Spine. 2016 Oct 01;41(19):1484-92. doi: 10.1097/BRS.0000000000001581. PMID: 27031768. Exclusion: E1.

916. Park S, Kim JK, Chang MC, et al. Assessment of fusion after anterior cervical discectomy and fusion using convolutional neural network algorithm. Spine (Phila Pa 1976). 2022 Dec 1;47(23):1645-50. doi: 10.1097/BRS.0000000000004439. PMID: 35905310. Exclusion: E2.

917. Park S, Lee DH, Seo J, et al. Feasibility of CaO-SiO2-P2O5-B2O3 bioactive glass ceramic cage in anterior cervical diskectomy and fusion. World Neurosurg. 2020 09;141:e358-e66. doi: 10.1016/j.wneu.2020.05.143. PMID: 32450308. Exclusion: E11.

918. Park Y, Maeda T, Cho W, et al. Comparison of anterior cervical fusion after two-level discectomy or single-level corpectomy: sagittal alignment, cervical lordosis, graft collapse, and adjacent-level ossification. Spine J. 2010 Mar;10(3):193-9. doi: 10.1016/j.spinee.2009.09.006. PMID: 19850532. Exclusion: E3.

919. Park YS, Nakase H, Kawaguchi S, et al. Predictors of outcome of surgery for cervical compressive myelopathy: retrospective analysis and prospective study. Neurol Med Chir (Tokyo). 2006 May;46(5):231-8; discussion 8-9. doi: 10.2176/nmc.46.231. PMID: 16723815. Exclusion: E9.

920. Parthiban J, Alves OL, Chandrachari KP, et al. Value of surgery and nonsurgical approaches for cervical spondylotic myelopathy: WFNS Spine Committee recommendations. Neurospine. 2019;16(3):403-7. doi: 10.14245/ns.1938238.119. PMID: 31607072. Exclusion: E6.

921. Passias PG, Gerling MC, Isaacs RE, et al. Nonoperative treatment modalities prior to cervical surgery affect patient outcomes: an analysis of 1,522 patients. Spine journal. 2015 Netherlands Elsevier Inc;Conference: 30th annual meeting of the north american spine society, NASS. Vol.15(10 Supplement 1):107Sp. doi: 10.1016/j.spinee.2015.07.065. Exclusion: E6.

922. Patel A, Fehlings MG, Sasso RC, et al. Current smoking status is an important predictor of patient response toanterior cervical fusion with instrumentation in patients with single-level degenerative disc disease: results from amulti-center randomized controlled trial. Spine. 2009. Exclusion: E3.

923. Patel V, Metz A, Schultz L, et al. Rates and reasons for reoperation within 30 and 90 days following cervical spine surgery: a retrospective cohort analysis of the Michigan Spine Surgery Improvement Collaborative (MSSIC) registry. Spine J. 2023 Jan;23(1):116-23. doi: 10.1016/j.spinee.2022.09.005. PMID: 36152774. Exclusion: E3.

924. Pechlivanis I, Thuring T, Brenke C, et al. Non-fusion rates in anterior cervical discectomy and implantation of empty polyetheretherketone cages. Spine. 2011 Jan 01;36(1):15-20. doi: 10.1097/BRS.0b013e3181cbf870. PMID: 20562731. Exclusion: E3.

925. Peng J, Li S, Lin X, et al. Anterior cervical discectomy and fusion without plate (ACDFWP) versus anterior cervical disc arthroplasty (ACDA) for cervical spondylosis: a meta-analysis and literature review. Intractable Rare Dis Res. 2022 Aug;11(3):105-12. doi: 10.5582/irdr.2022.01080. PMID: 36200026. Exclusion: E8.

926. Peng Z, Hong Y, Meng Y, et al. A meta-analysis comparing the short- and mid- to long-term outcomes of artificial cervical disc replacement(ACDR) with anterior cervical discectomy and fusion (ACDF) for the treatment of cervical degenerative disc disease. Int Orthop. 2022 Jul;46(7):1609-25. doi: 10.1007/s00264-022-05318-z. PMID: 35113188. Exclusion: E8.

927. Peolsson A, Vavruch L, Hedlund R. Long-term randomised comparison between a carbon fibre cage and the Cloward procedure in the cervical spine. Eur Spine J. 2007 Feb;16(2):173-8. doi: 10.1007/s00586-006-0067-2. PMID: 16463197. Exclusion: E3.

928. Perrini P, Cagnazzo F, Benedetto N, et al. Cage with anterior plating is advantageous over the stand-alone cage for segmental lordosis in the treatment of two-level cervical degenerative spondylopathy: a retrospective study. Clin Neurol Neurosurg. 2017 Dec;163:27-32. doi: 10.1016/j.clineuro.2017.10.014. PMID: 29055221. Exclusion: E11.

929. Pesce A, Wierzbicki V, Piccione E, et al. Adjacent segment pathology: natural history or effect of anterior cervical discectomy and fusion? A 10-year follow-up radiological multicenter study using an evaluation scale of the ageing spine. Eur. 2017 May;27(4):503-11. doi: 10.1007/s00590-017-1936-6. PMID: 28321567. Exclusion: E11.

930. Peters MJM, Bastiaenen CHG, Brans BT, et al. The diagnostic accuracy of imaging modalities to detect pseudarthrosis after spinal fusion-a systematic review and meta-analysis of the literature. Skeletal Radiol. 2019 Oct;48(10):1499-510. doi: 10.1007/s00256-019-03181-5. PMID: 30796507. Exclusion: E1.

931. Phan K, Scherman DB, Xu J, et al. Laminectomy and fusion vs laminoplasty for multi-level cervical myelopathy: a systematic review and meta-analysis. Eur Spine J. 2017 01;26(1):94-103. doi: 10.1007/s00586-016-4671-5. PMID: 27342611. Exclusion: E8.

932. Phillips DG. Surgical treatment of myelopathy with cervical spondylosis. J Neurol Neurosurg Psychiatry. 1973 Oct;36(5):879-84. doi: 10.1136/jnnp.36.5.879. PMID: 4753885. Exclusion: E11.

933. Phillips FM, Allen TR, Regan JJ, et al. Cervical disc replacement in patients with and without previous adjacent level fusion surgery: a prospective study. Spine. 2009 Mar 15;34(6):556-65. doi: 10.1097/BRS.0b013e31819b061c. PMID: 19240664. Exclusion: E1.

934. Phillips FM, Garfin SR. Cervical disc replacement. Spine. 2005 Sep 01;30(17 Suppl):S27-33. PMID: 16138062. Exclusion: E8.

935. Piazza BR, Pace GI, Knaub MA, et al. Anterior cervical discectomy and fusion pseudarthrosis. Clinical Spine Surgery. 2017;30(3):91-3. doi: 10.1097/BSD.0000000000000527. Exclusion: E6.

936. Pickett GE, Sekhon LH, Sears WR, et al. Complications with cervical arthroplasty. J Neurosurg Spine. 2006 Feb;4(2):98-105. doi: 10.3171/spi.2006.4.2.98. PMID: 16506475. Exclusion: E3.

937. Pilloni G, Ajello M, Cofano F, et al. Comparison between zero-profile spacer and cage-plate construct in anterior cervical multilevel fusion: our experience confronto tra cage con viti intra-somatiche (zero-P VA) e cage con placca nell'artrodesi cervicale anteriore: la nostra esperienza. Eur Spine J. 2018 to 2018-05-12;27(4):951-2p. doi: 10.1007/s00586-018-5531-2. Exclusion: E6.

938. Pinter ZW, Karamian B, Bou Monsef J, et al. Cervical alignment and proximal and distal junctional failure in posterior cervical fusion: a multicenter comparison of 2 surgical approaches. Clin Spine Surg. 2022 06 01;35(5):E451-E6. doi: 10.1097/BSD.0000000000001281. PMID: 34907934. Exclusion: E3.

939. Pinter ZW, Reed R, Townsley SE, et al. Titanium cervical cage subsidence: postoperative computed tomography analysis defining incidence and associated risk factors. Global spine j. 2021 Sep 24:21925682211046897. doi: 10.1177/21925682211046897. PMID: 34558320. Exclusion: E3.

940. Pirkle S, Kaskovich S, Cook DJ, et al. Cages in ACDF are associated with a higher nonunion rate than allograft: a stratified comparative analysis of 6130 patients. Spine. 2019 03 15;44(6):384-8. doi: 10.1097/BRS.0000000000002854. PMID: 30180149. Exclusion: E1.

941. Pitzen T. Loss of lordosis and loss of segmental height do not affect clinical results following ACDF: Secondary endpoint results from a multicentric, randomised, controlled study. Spine journal. 2010;Vol.Conference: 25th Annual Meeting of the North American Spine Society, NASS Miami, FL United States. Conference Start: 20101005 Conference End: 20101009. Conference Publication:(10 :(9 SUPPL. 1)):33Sp. doi: 10.1016/j.spinee.2010.07.094. Exclusion: E6.

942. Pitzen TR, Chrobok J, Stulik J, et al. Implant complications, fusion, loss of lordosis, and outcome after anterior cervical plating with dynamic or rigid plates: two-year results of a multi-centric, randomized, controlled study. Spine. 2009 Apr 01;34(7):641-6. doi: 10.1097/BRS.0b013e318198ce10. PMID: 19287352. Exclusion: E3.

943. Platt A, Fessler RG, Traynelis VC, et al. Minimally invasive posterior cervical foraminotomy versus anterior cervical fusion and arthroplasty: systematic review and meta-analysis. Global spine j. 2022 Sep;12(7):1573-82. doi: 10.1177/21925682211055094. PMID: 34879736. Exclusion: E8.

944. Ploumis A, Mehbod A, Garvey T, et al. Prospective assessment of cervical fusion status: plain radiographs versus CT-scan. Acta Orthop Belg. 2006 Jun;72(3):342-6. PMID: 16889148. Exclusion: E1.

945. Poorman GW, Moon JY, Horn SR, et al. Rates of mortality in cervical spine surgical procedures and factors associated with its occurrence over a 10-year period: a study of 342 477 patients on the nationwide inpatient sample. Int J Spine Surg. 2018 Apr;12(2):276-84. doi: 10.14444/5034. PMID: 30276085. Exclusion: E9.

946. Porchet F, Metcalf NH. Clinical outcomes with the Prestige II cervical disc: preliminary results from a prospective randomized clinical trial. Neurosurg. 2004 Sep 15;17(3):E6. doi: 10.3171/foc.2004.17.3.6. PMID: 15636562. Exclusion: E5.

947. Prokopienko M, Sobstyl M. Subjective and objective quality-of-life assessment of outcome measures in cervical spine surgery for degenerative changes. J Neurol Surg A Cent Eur Neurosurg. 2022 May;83(3):275-82. doi: 10.1055/s-0041-1739227. PMID: 34897625. Exclusion: E6.

948. Prost S, Farah K, Toquart A, et al. Contribution of dynamic cervical MRI to surgical planning for degenerative cervical myelopathy: revision rate and clinical outcomes at 5 years' postoperative. Orthop Traumatol Surg Res. 2022 Apr;109(2):103440. doi: 10.1016/j.otsr.2022.103440. PMID: 36228966. Exclusion: E4.

949. Puvanesarajah V, Hassanzadeh H, Shimer AL, et al. Readmission rates, reasons, and risk factors following anterior cervical fusion for cervical spondylosis in patients above 65 years of age. Spine. 2017 Jan 15;42(2):78-84. doi: 10.1097/BRS.0000000000001663. PMID: 27120061. Exclusion: E2.

950. Qi M, Chen H, Cao P, et al. Incidence and risk factors analysis of heterotopic ossification after cervical disc replacement. Chin Med J. 2014;127(22):3871-5. PMID: 25421183. Exclusion: E4.

951. Qiao ZG, Liu CQ, Li CP, et al. Analysis of clinical effects of anterior segmental decompression for multi-segment cervical spondylotic myelopathy. Zhongguo Gu Shang. 2018;31(8):735-9p. doi: 10.3969/j.issn.1003-0034.2018.08.010. Exclusion: E10.

952. Qin R, Chen X, Zhou P, et al. Anterior cervical corpectomy and fusion versus posterior laminoplasty for the treatment of oppressive myelopathy owing to cervical ossification of posterior longitudinal ligament: a meta-analysis. Eur Spine J. 2018 06;27(6):1375-87. doi: 10.1007/s00586-017-5451-6. PMID: 29335903. Exclusion: E8.

953. Qizhi S, Lei S, Peijia L, et al. A comparison of zero-profile devices and artificial cervical disks in patients with 2 noncontiguous levels of cervical spondylosis. Clin Spine Surg. 2016 Mar;29(2):E61-6. doi: 10.1097/BSD.0000000000000096. PMID: 26889993. Exclusion: E2.

954. Quraishi DA, Hussain I, Goldberg JL, et al. Complications of the anterior cervical approach in spine surgery. Semin Spine Surg. 2022 Mar;34(1) doi: 10.1016/j.semss.2022.100920. Exclusion: E3.

955. Rabin D, Pickett GE, Bisnaire L, et al. The kinematics of anterior cervical discectomy and fusion versus artificial cervical disc: a pilot study. Neurosurgery. 2007 Sep;61(3 Suppl):100-4; discussion 4-5. doi: 10.1227/01.neu.0000289722.12459.9e. PMID: 17876239. Exclusion: E7.

956. Radcliff K, Blumenthal SL, Davis RJ, et al. Seven-year clinical results of cervical total disc replacement compared with anterior discectomy and fusion for treatment of two-level symptomatic degenerative disc disease: a prospective, randomized, controlled, multicenter FDA clinical trial. Eur Spine J. 2016 to 2016-12-03;25(11):3796-p. doi: 10.1007/s00586-016-4801-0. Exclusion: E6.

957. Radcliff K, Zigler J, Zigler J. Costs of cervical disc replacement versus anterior cervical discectomy and fusion for treatment of single-level cervical disc disease: an analysis of the Blue Health Intelligence database for acute and long-term costs and complications. Spine. 2015 Apr 15;40(8):521-9. doi: 10.1097/BRS.0000000000000822. PMID: 25868092. Exclusion: E11.

958. Radcliff KE, Davis RJ, Hoffman GA, et al. Seven-year clinical results of cervical total disc replacement compared with anterior discectomy and fusion for treatment of two-level symptomatic degenerative disc disease: a prospective, randomized, controlled, multicenter FDA clinical trial. Spine journal. 2016 to 2016-10-29;16(10):S204-p. doi: 10.1016/j.spinee.2016.07.113. Exclusion: E6.

959. Ragab AA, Hodges FS, Hill CP, et al. Dynamic anterior cervical plating for multi-level spondylosis: Does it help? Evid. 2010 May;1(1):41-6. doi: 10.1055/s-0028-1100892. PMID: 23544023. Exclusion: E3.

960. Rajan PV, Pelle DW, Savage JW. New imaging modalities for degenerative cervical myelopathy. Clin Spine Surg. 2022 Dec 1;35(10):422-30. doi: 10.1097/BSD.0000000000001408. PMID: 36447347. Exclusion: E6.

961. Rajesh N, Moudgil-Joshi J, Kaliaperumal C. Smoking and degenerative spinal disease: a systematic review. Brain Spine. 2022 Aug 7;2:100916. doi: 10.1016/j.bas.2022.100916. PMID: 36248118. Exclusion: E4.

962. Ramzi N, Ribeiro-Vaz G, Fomekong E, et al. Long term outcome of anterior cervical discectomy and fusion using coral grafts. Acta Neurochir (Wien). 2008 Dec;150(12):1249-56; discussion 56. doi: 10.1007/s00701-008-0140-1. PMID: 19002374. Exclusion: E7.

963. Rao MJ, Nie SP, Xiao BW, et al. Cervical disc arthroplasty versus anterior cervical discectomy and fusion for treatment of symptomatic cervical disc disease: a meta-analysis of randomized controlled trials. Arch Orthop Trauma Surg. 2015 Jan;135(1):19-28. doi: 10.1007/s00402-014-2122-5. PMID: 25475930. Exclusion: E8.

964. Ravindra VM, Curran J, Mummaneni P, et al. Laminoplasty vs. laminectomy-fusion for the treatment of cervical myelopathy: preliminary data from the CSM-study comparing cervical sagittal alignment and clinical outcomes. J Neurosurg. 2017;Conference: 85th american association of neurological surgeons annual scientific meeting, AANS. Vol.126(4):A1410p. doi: 10.3171/2017.4.JNS.AANS2017abstracts. Exclusion: E6.

965. Ravshan Y, Ulug'bek K. Retrospective analysis of the results of surgical treatment of patients with discospondylogenic radiculopathy and myelopathy. International Journal of Pharmaceutical Research. 2021;13(1):3440-2. doi: 10.31838/ijpr/2021.13.01.513. Exclusion: E7.

966. Razfar A, Sadr-Hosseini SM, Rosen CA, et al. Prevention and management of dysphonia during anterior cervical spine surgery. Laryngoscope. 2012 Oct;122(10):2179-83. doi: 10.1002/lary.23284. PMID: 22898808. Exclusion: E4.

967. Ren C, Song Y, Xue Y, et al. Mid- to long-term outcomes after cervical disc arthroplasty compared with anterior discectomy and fusion: a systematic review and meta-analysis of randomized controlled trials. Eur Spine J. 2014 May;23(5):1115-23. doi: 10.1007/s00586-014-3220-3. PMID: 24515337. Exclusion: E9.

968. Resnick DK, Anderson PA, Kaiser MG, et al. Electrophysiological monitoring during surgery for cervical degenerative myelopathy and radiculopathy. J Neurosurg Spine. 2009 Aug;11(2):245-52. doi: 10.3171/2009.2.SPINE08730. PMID: 19769504. Exclusion: E2.

969. Reyes-Sanchez AA, Estrada-Gomez JA, Zarate-Kalfopulus B, et al. Comparative study between Plate-Graff, Plate-Cage and peek cage in cervical spine fusion. Acta Ortop Mex. 2018 Jul-Aug;32(4):203-8. PMID: 30549503. Exclusion: E1.

970. Rhee J, Tetreault LA, Chapman JR, et al. Nonoperative versus operative management for the treatment degenerative cervical myelopathy: an updated systematic review. Global spine j. 2017 Sep;7(3 Suppl):35S-41S. doi: 10.1177/2192568217703083. PMID: 29164031. Exclusion: E8.

971. Ricciardi L, Scerrati A, Olivi A, et al. The role of cervical collar in functional restoration and fusion after anterior cervical discectomy and fusion without plating on single or double levels: a systematic review and meta-analysis. Eur Spine J. 2020 05;29(5):955-60. doi: 10.1007/s00586-019-06270-0. PMID: 31894403. Exclusion: E8.

972. Richter H, Seule M, Hildebrandt G, et al. Dynamic cervical implant versus anterior cervical diskectomy and fusion: a prospective study of clinical and radiologic outcome. J Neurol Surg A Cent Eur Neurosurg. 2016 Jul;77(4):300-7. doi: 10.1055/s-0035-1567861. PMID: 27088592. Exclusion: E3.

973. Riederman BD, Butler BA, Lawton CD, et al. Recombinant human bone morphogenetic protein-2 versus iliac crest bone graft in anterior cervical discectomy and fusion: Dysphagia and dysphonia rates in the early postoperative period with review of the literature. J Clin Neurosci. 2017 Oct;44:180-3. doi: 10.1016/j.jocn.2017.06.034. PMID: 28716569. Exclusion: E3.

974. Riew KD, Buchowski JM, Sasso R, et al. Cervical disc arthroplasty compared with arthrodesis for the treatment of myelopathy. J Bone Joint Surg Am. 2008 Nov;90(11):2354-64. doi: 10.2106/jbjs.G.01608. PMID: 18978404. Exclusion: E5.

975. Riew KD, Ecker E, Dettori JR. Anterior cervical discectomy and fusion for the management of axial neck pain in the absence of radiculopathy or myelopathy. Evid. 2010 Dec;1(3):45-50. doi: 10.1055/s-0030-1267067. PMID: 22956927. Exclusion: E9.

976. Riew KD, Schenk-Kisser JM, Skelly AC. Adjacent segment disease and C-ADR: promises fulfilled? Evid. 2012 Feb;3(S1):39-46. doi: 10.1055/s-0031-1298607. PMID: 23236312. Exclusion: E8.

977. Riina J, Patel A, Dietz JW, et al. Comparison of single-level cervical fusion and a metal-on-metal cervical disc replacement device. Am J Orthop. 2008 Apr;37(4):E71-7. PMID: 18535684. Exclusion: E5.

978. Rindler RS, Chokshi FH, Malcolm JG, et al. Spinal diffusion tensor imaging in evaluation of preoperative and postoperative severity of cervical spondylotic myelopathy: systematic review of literature. World Neurosurg. 2017 Mar;99:150-8. doi: 10.1016/j.wneu.2016.11.141. PMID: 27939797. Exclusion: E8.

979. Robertson JT, Papadopoulos SM, Traynelis VC. Assessment of adjacent-segment disease in patients treated with cervical fusion or arthroplasty: a prospective 2-year study. J Neurosurg Spine. 2005 Dec;3(6):417-23. doi: 10.3171/spi.2005.3.6.0417. PMID: 16381202. Exclusion: E3.

980. Rodrigues MA, Hanel RA, Prevedello DM, et al. Posterior approach for soft cervical disc herniation: a neglected technique? Surg Neurol. 2001 Jan;55(1):17-22; discussion doi: 10.1016/s0090-3019(00)00349-9. PMID: 11248299. Exclusion: E5.

981. Rodriguez Dominguez V, Gandia Gonzalez ML, Garcia Feijoo P, et al. Treatment of cervical myelopathy by posterior approach: Laminoplasty vs. laminectomy with posterior fixation, are there differences from a clinical and radiological point of view? Neurocirugia. 2021 Nov 16;16:16. doi: 10.1016/j.neucie.2021.11.002. PMID: 34799283. Exclusion: E7.

982. Rodriguez-Feo JA, Leas D, Odum SM, et al. Reoperation rates following open-door cervical laminoplasty. Int J Spine Surg. 2018 Dec;12(6):751-6. doi: 10.14444/5094. PMID: 30619680. Exclusion: E5.

983. Rodway I, Gander J. Comparison of fusion rates between glycerol-preserved and frozen composite allografts in cervical fusion. int. 2014;2014:960142. doi: 10.1155/2014/960142. PMID: 27382618. Exclusion: E11.

984. Ross DA, Pollock JM, Li NP, et al. Anterior cervical arthrodesis with polyetheretherketone spacers: What is the role of the grafting material? Clin Spine Surg. 2020 12;33(10):E539-E44. doi: 10.1097/BSD.0000000000000995. PMID: 32324673. Exclusion: E3.

985. Rossi V, Adamson T. Cervical spine surgery: arthroplasty versus fusion versus posterior foraminotomy. Neurosurg Clin N Am. 2021 Oct;32(4):483-92. doi: 10.1016/j.nec.2021.05.005. PMID: 34538474. Exclusion: E6.

986. Rozankovic M, Marasanov SM, Vukic M. Cervical disk replacement with discover versus fusion in a single-level cervical disk disease: a prospective single-center randomized trial with a minimum 2-year follow-up. Clin Spine Surg; 2017. p. E515-E22. Exclusion: E2.

987. Rožanković M, Marasanov SM, Vukić M. Cervical Disk Replacement With Discover Versus Fusion in a Single-Level Cervical Disk Disease: a Prospective Single-Center Randomized Trial With a Minimum 2-Year Follow-up. Clin Spine Surg. 2017 Jun;30(5):E515-e22. doi: 10.1097/bsd.0000000000000170. PMID: 28525471. Exclusion: E2.

988. Rumalla K, Smith KA, Arnold PM. Cervical total disc replacement and anterior cervical discectomy and fusion: reoperation rates, complications, and hospital resource utilization in 72 688 patients in the United States. Neurosurgery. 2018 04 01;82(4):441-53. doi: 10.1093/neuros/nyx289. PMID: 28973385. Exclusion: E4.

989. Ryken TC, Heary RF, Matz PG, et al. Cervical laminectomy for the treatment of cervical degenerative myelopathy. J Neurosurg Spine. 2009 Aug;11(2):142-9. doi: 10.3171/2009.1.SPINE08725. PMID: 19769493. Exclusion: E6 - background.

990. Ryken TC, Heary RF, Matz PG, et al. Techniques for cervical interbody grafting. J Neurosurg Spine. 2009 Aug;11(2):203-20. doi: 10.3171/2009.2.SPINE08723. PMID: 19769500. Exclusion: E6.

991. Ryu HS, Han MS, Lee SS, et al. Influence of subsidence after stand-alone anterior cervical discectomy and fusion in patients with degenerative cervical disease: a long-term follow-up study. Medicine (Baltimore). 2022 Sep 23;101(38):e30673. doi: 10.1097/MD.0000000000030673. PMID: 36197165. Exclusion: E3.

992. Ryu SI, Mitchell M, Kim DH. A prospective randomized study comparing a cervical carbon fiber cage to the Smith-Robinson technique with allograft and plating: up to 24 months follow-up. Eur Spine J. 2006 Feb;15(2):157-64. doi: 10.1007/s00586-005-0951-1. PMID: 15980998. Exclusion: E3 - per Shelley's email on 1/17.

993. Saavedra-Pozo FM, Deusdara RA, Benzel EC. Adjacent segment disease perspective and review of the literature. Ochsner J. 2014;14(1):78-83. PMID: 24688337. Exclusion: E6.

994. Sahai N, Changoor S, Dunn CJ, et al. Minimally invasive posterior cervical foraminotomy as an alternative to anterior cervical discectomy and fusion for unilateral cervical radiculopathy: a systematic review and meta-analysis. Spine. 2019 Dec 15;44(24):1731-9. doi: 10.1097/BRS.0000000000003156. PMID: 31343619. Exclusion: E8.

995. Sakai K, Yoshii T, Arai Y, et al. Early experiences of one-level total disc replacement (prestige LP) in Japan: a comparison of short-term outcomes with anterior cervical discectomy with fusion. Spine Surg Relat Res. 2022 May 10;6(6):581-8. doi: 10.22603/ssrr.2022-0040. PMID: 36561158. Exclusion: E11.

996. Sakai K, Yoshii T, Hirai T, et al. Impact of the surgical treatment for degenerative cervical myelopathy on the preoperative cervical sagittal balance: a review of prospective comparative cohort between anterior decompression with fusion and laminoplasty. Eur Spine J. 2017 01;26(1):104-12. doi: 10.1007/s00586-016-4717-8. PMID: 27473211. Exclusion: E11.

997. Sakaki K, Kawabata S, Ukegawa D, et al. Warning thresholds on the basis of origin of amplitude changes in transcranial electrical motor-evoked potential monitoring for cervical compression myelopathy. Spine. 2012 Jul 01;37(15):E913-21. doi: 10.1097/BRS.0b013e31824caab6. PMID: 22322375. Exclusion: E3.

998. Sakaura H, Miwa T, Kuroda Y, et al. Incidence and risk factors for late neurologic deterioration after C3-C6 laminoplasty for cervical spondylotic myelopathy. Global spine j. 2016 Feb;6(1):53-9. doi: 10.1055/s-0035-1556583. PMID: 26835202. Exclusion: E11.

999. Sala V, Lisi C, Di Natali G, et al. Functional and quality of life evaluation after single level cervical discectomy and fusion or cervical artificial disc replacement. G Ital Med Lav Ergon. 2015 Oct-Dec;37(4):239-44. PMID: 26934809. Exclusion: E11.

1000. Salem HM, Salem KM, Burget F, et al. Cervical spondylotic myelopathy: the prediction of outcome following surgical intervention in 93 patients using T1- and T2-weighted MRI scans. Eur Spine J. 2015 Dec;24(12):2930-5. doi: 10.1007/s00586-015-4028-5. PMID: 26077097. Exclusion: E11.

1001. Samartzis D, Shen FH, Lyon C, et al. Does rigid instrumentation increase the fusion rate in one-level anterior cervical discectomy and fusion? Spine J. 2004 Nov-Dec;4(6):636-43. doi: 10.1016/j.spinee.2004.04.010. PMID: 15541695. Exclusion: E11.

1002. Samartzis D, Shen FH, Matthews DK, et al. Comparison of allograft to autograft in multilevel anterior cervical discectomy and fusion with rigid plate fixation. Spine J. 2003 Nov-Dec;3(6):451-9. doi: 10.1016/s1529-9430(03)00173-6. PMID: 14609689. Exclusion: E9.

1003. Samini F, Mashhadinejad H, Ehsaei M, et al. Comparison of surgical and medical treatments for cervical spondylosis: a prospective study. Neurosurgery Quarterly. 2014;24(1):18-21. doi: 10.1097/WNQ.0b013e31828c7286. Exclusion: E1.

1004. Sampath P, Bendebba M, Davis JD, et al. Outcome in patients with cervical radiculopathy. Prospective, multicenter study with independent clinical review. Spine (Phila Pa 1976). 1999 Mar 15;24(6):591-7. doi: 10.1097/00007632-199903150-00021. PMID: 10101827. Exclusion: E11.

1005. Sampath P, Bendebba M, Davis JD, et al. Outcome of patients treated for cervical myelopathy. A prospective, multicenter study with independent clinical review. Spine (Phila Pa 1976). 2000 Mar 15;25(6):670-6. doi: 10.1097/00007632-200003150-00004. PMID: 10752097. Exclusion: E11.

1006. Sangondimath G, Mallepally AR, Marathe N, et al. Degenerative cervical myelopathy: Recent updates and future directions. J. 2020 Sep-Oct;11(5):822-9. doi: 10.1016/j.jcot.2020.07.012. PMID: 32879568. Exclusion: E6.

1007. Saphier PS, Arginteanu MS, Moore FM, et al. Stress-shielding compared with load-sharing anterior cervical plate fixation: a clinical and radiographic prospective analysis of 50 patients. J Neurosurg Spine. 2007 May;6(5):391-7. doi: 10.3171/spi.2007.6.5.391. PMID: 17542503. Exclusion: E3.

1008. Sarani B, Waring S, Sonnad S, et al. Magnetic resonance imaging is a useful adjunct in the evaluation of the cervical spine of injured patients. J Trauma. 2007 Sep;63(3):637-40. doi: 10.1097/TA.0b013e31812eedb1. PMID: 18073613. Exclusion: E1.

1009. Sarkar S, Nair BR, Rajshekhar V. Complications following central corpectomy in 468 consecutive patients with degenerative cervical spine disease. Neurosurg. 2016 Jun;40(6):E10. doi: 10.3171/2016.3.FOCUS1638. PMID: 27246480. Exclusion: E3.

1010. Sarraj M, Hache P, Foroutan F, et al. Long-term survivorship of cervical spine procedures; a survivorship meta-analysis and meta-regression. Global spine j. 2022 Apr;13(3):840-54. doi: 10.1177/21925682221125766. PMID: 36069054. Exclusion: E8.

1011. Sasai K, Saito T, Akagi S, et al. Preventing C5 palsy after laminoplasty. Spine (Phila Pa 1976). 2003 Sep 1;28(17):1972-7. doi: 10.1097/01.Brs.0000083237.94535.46. PMID: 12973145. Exclusion: E2.

1012. Sasso R, Vaccaro AR, Fehlings MG, et al. Efficacy of a novel synthetic small peptide in anterior cervical arthrodesis: a randomized, controlled, multicenter study with 24-month follow-up. Spine journal. 2015 START: 2015 Oct 14 CONFERENCE END: 2015 Oct 17 30th Annual Meeting of the North American Spine Society, NASS 2015 Chicago, IL United States;15(10 SUPPL. 1):S243-S4p. doi: 10.1016/j.spinee.2015.07.365. Exclusion: E6.

1013. Sasso RC, Best NM. Cervical kinematics after fusion and bryan disc arthroplasty. J Spinal Disord Tech. 2008 Feb;21(1):19-22. doi: 10.1097/BSD.0b013e3180500778. PMID: 18418131. Exclusion: E1.

1014. Sasso RC, Best NM, Metcalf NH, et al. Motion analysis of bryan cervical disc arthroplasty versus anterior discectomy and fusion: results from a prospective, randomized, multicenter, clinical trial. J Spinal Disord Tech. 2008 Aug;21(6):393-9. doi: 10.1097/BSD.0b013e318150d121. PMID: 18679092. Exclusion: E4.

1015. Sasso RC, Smucker JD, Hacker RJ, et al. Clinical outcomes of BRYAN cervical disc arthroplasty: a prospective, randomized, controlled, multicenter trial with 24-month follow-up. J Spinal Disord Tech. 2007 Oct;20(7):481-91. doi: 10.1097/BSD.0b013e3180310534. PMID: 17912124. Exclusion: E5.

1016. Sasso RC, Smucker JD, Hacker RJ, et al. Artificial disc versus fusion: a prospective, randomized study with 2-year follow-up on 99 patients. Spine. 2007 Dec 15;32(26):2933-40; discussion 41-2. doi: 10.1097/BRS.0b013e31815d0034. PMID: 18091483. Exclusion: E5.

1017. Sasso WR, Smucker JD, Sasso MP, et al. Long-term clinical outcomes of cervical disc arthroplasty: a prospective, randomized, controlled trial. Spine. 2017 Feb 15;42(4):209-16. doi: 10.1097/BRS.0000000000001746. PMID: 28207654. Exclusion: E5.

1018. Satomi K, Ogawa J, Ishii Y, et al. Short-term complications and long-term results of expansive open-door laminoplasty for cervical stenotic myelopathy. Spine J. 2001 Jan-Feb;1(1):26-30. doi: 10.1016/s1529-9430(01)00008-0. PMID: 14588365. Exclusion: E5.

1019. Savio SD, Deslivia MF, Arimbawa IBG, et al. Thorough comparative analysis of stand-alone cage and anterior cervical plate for anterior cervical discectomy and fusion in the treatment of cervical degenerative disease: a systematic review and meta-analysis. Asian spine j. 2022 Mar 11;11:11. doi: 10.31616/asj.2021.0123. PMID: 35263831. Exclusion: E8.

1020. Savolainen S, Rinne J, Hernesniemi J. A prospective randomized study of anterior single-level cervical disc operations with long-term follow-up: surgical fusion is unnecessary. Neurosurgery. 1998 Jul;43(1):51-5. doi: 10.1097/00006123-199807000-00032. PMID: 9657188. Exclusion: E3.

1021. Sawin PD, Traynelis VC, Menezes AH. A comparative analysis of fusion rates and donor-site morbidity for autogeneic rib and iliac crest bone grafts in posterior cervical fusions. J Neurosurg. 1998 Feb;88(2):255-65. doi: 10.3171/jns.1998.88.2.0255. PMID: 9452233. Exclusion: E4.

1022. Scerrati A, Visani J, Norri N, et al. Effect of external cervical orthoses on clinical and radiological outcome of patients undergoing anterior cervical discectomy and fusion. Acta Neurochir (Wien). 2019 Oct;161(10):2195-200. doi: 10.1007/s00701-019-04046-5. PMID: 31455994. Exclusion: E11 - per Shelley's email on 12/14.

1023. Schafer E, Bazydlo M, Schultz L, et al. Rates and risk factors associated with 90-day readmission following cervical spine fusion surgery: analysis of the Michigan Spine Surgery Improvement Collaborative (MSSIC) registry. Spine J. 2020 05;20(5):708-16. doi: 10.1016/j.spinee.2020.01.003. PMID: 31958576. Exclusion: E5.

1024. Schiedo RM, Narain A, Adams S, et al. 101. Prospective evaluation of degenerative cervical myelopathy in asymptomatic patients over 60 years. Spine Journal. 2020;20(9):S50-S1. doi: 10.1016/j.spinee.2020.05.207. Exclusion: E4.

1025. Scholz M, Schelfaut S, Pingel A, et al. A cervical "zero-profile" cage with integrated angle-stable fixation: 24-months results. Acta Orthop Belg. 2014 Dec;80(4):558-66. PMID: 26280730. Exclusion: E3.

1026. Scholz M, Schleicher P, Pingel A, et al. A comparison of stand-alone locking zero-profil spacer and cage + plate for two level cervical spondylopathy: a randomized controlled single center trial. Eur Spine J. 2018 to 2018-12-08;27(11):2915-6p. doi: 10.1007/s00586-018-5770-2. Exclusion: E6.

1027. Scholz T, Geiger MF, Mainz V, et al. Anterior cervical decompression and fusion or posterior foraminotomy for cervical radiculopathy: results of a single-center series. J Neurol Surg A Cent Eur Neurosurg. 2018 May;79(3):211-7. doi: 10.1055/s-0037-1607225. PMID: 29132169. Exclusion: E11 - email from Tamara 12/9.

1028. Schroder J, Grosse-Dresselhaus F, Schul C, et al. PMMA versus titanium cage after anterior cervical discectomy - a prospective randomized trial. Zentralbl Neurochir. 2007 Feb;68(1):2-7. doi: 10.1055/s-2006-942184. PMID: 16969747. Exclusion: E3.

1029. Schroder J, Krampulz T, Bajaj S, et al. PEEK cages versus Titanium coated PEEK cages in single level anterior cervical fusion-a randomized controlled study. Eur Spine J. 2020;29:2892-3. doi: 10.1007/s00586-020-06630-1. Exclusion: E6 - conference abstract.

1030. Schroeder GD, Kepler CK, Hollern DA, et al. The effect of dynamic versus static plating systems on fusion rates and complications in 1-level and/or 2-level anterior cervical discectomy and fusion: a systematic review. Clin Spine Surg. 2017 02;30(1):20-6. doi: 10.1097/BSD.0000000000000453. PMID: 27898451. Exclusion: E8.

1031. Schroeder GD, Suleiman LI, Chioffe MA, et al. The effect of oblique magnetic resonance imaging on surgical decision making for patients undergoing an anterior cervical discectomy and fusion for cervical radiculopathy. Int J Spine Surg. 2019 Jun;13(3):302-7. doi: 10.14444/6041. PMID: 31328096. Exclusion: E1.

1032. Schuermans VNE, Smeets A, van de Kar LGC, et al. A systematic review on neurological outcomes for cervical degenerative myelopathy after anterior decompression surgery: motion preservation vs fusion. Int J Spine Surg. 2022 Dec;16(6):969-76. doi: 10.14444/8320. PMID: 35831065. Exclusion: E8.

1033. Seaman S, Kerezoudis P, Bydon M, et al. Titanium vs. polyetheretherketone (PEEK) interbody fusion: Meta-analysis and review of the literature. J Clin Neurosci. 2017 Oct;44:23-9. doi: 10.1016/j.jocn.2017.06.062. PMID: 28736113. Exclusion: E8.

1034. Segebarth B, Datta JC, Darden B, et al. Incidence of dysphagia comparing cervical arthroplasty and ACDF. Sas J. 2010;4(1):3-8. doi: 10.1016/j.esas.2009.12.001. PMID: 25802643. Exclusion: E5.

1035. Sekhon LH, Duggal N, Lynch JJ, et al. Magnetic resonance imaging clarity of the Bryan, Prodisc-C, Prestige LP, and PCM cervical arthroplasty devices. Spine. 2007 Mar 15;32(6):673-80. doi: 10.1097/01.brs.0000257547.17822.14. PMID: 17413473. Exclusion: E2.

1036. Seki S, Kawaguchi Y, Nakano M, et al. Clinical significance of high intramedullary signal on T2-weighted cervical flexion-extension magnetic resonance imaging in cervical myelopathy. J Orthop Sci. 2015 Nov;20(6):973-7. doi: 10.1007/s00776-015-0757-x. PMID: 26243328. Exclusion: E11.

1037. Selvanathan SK, Beagrie C, Thomson S, et al. Anterior cervical discectomy and fusion versus posterior cervical foraminotomy in the treatment of brachialgia: the Leeds spinal unit experience (2008-2013). Acta Neurochir (Wien). 2015 Sep;157(9):1595-600. doi: 10.1007/s00701-015-2491-8. PMID: 26144567. Exclusion: E11.

1038. Seng C, Tow BP, Siddiqui MA, et al. Surgically treated cervical myelopathy: a functional outcome comparison study between multilevel anterior cervical decompression fusion with instrumentation and posterior laminoplasty. Spine J. 2013 Jul;13(7):723-31. doi: 10.1016/j.spinee.2013.02.038. PMID: 23541452. Exclusion: E11.

1039. Severino R, Nouri A, Tessitore E. Degenerative cervical myelopathy: how to identify the best responders to surgery? J. 2020 Mar 11;9(3):11. doi: 10.3390/jcm9030759. PMID: 32168833. Exclusion: E7.

1040. Shah NV, Jain I, Moattari CR, et al. Comparing predictors of complications after anterior cervical diskectomy and fusion, total disk arthroplasty, and combined anterior cervical diskectomy and fusion-total disk arthroplasty with a minimum 2-year follow-up. J Am Acad Orthop Surg. 2020 Sep 01;28(17):e759-e65. doi: 10.5435/JAAOS-D-19-00666. PMID: 31860582. Exclusion: E12 - per Andrea email 12/23.

1041. Shaker AS, Addosooki AI, El-Deen MA. Anterior cervical corpectomy with free vascularized fibular graft versus multilevel discectomy and grafting for cervical spondylotic myelopathy. Int J Spine Surg. 2015;9:60. doi: 10.14444/2060. PMID: 26767152. Exclusion: E3.

1042. Shakya A, Sharma A, Singh V, et al. Preoperative T1 magnetic resonance imaging changes carry a poor postoperative prognosis in cervical myelopathy: a retrospective study of 182 patients. Surg Neurol Int. 2021;12:629. doi: 10.25259/SNI_1151_2021. PMID: 35350821. Exclusion: E11.

1043. Shamji MF, Cook C, Pietrobon R, et al. Impact of surgical approach on complications and resource utilization of cervical spine fusion: a nationwide perspective to the surgical treatment of diffuse cervical spondylosis. Spine J. 2009 Jan-Feb;9(1):31-8. doi: 10.1016/j.spinee.2008.07.005. PMID: 18790678. Exclusion: E12 - per Andrea email 12/23.

1044. Shamji MF, Cook C, Tackett S, et al. Impact of preoperative neurological status on perioperative morbidity associated with anterior and posterior cervical fusion. J Neurosurg Spine. 2008 Jul;9(1):10-6. doi: 10.3171/SPI/2008/9/7/010. PMID: 18590405. Exclusion: E3.

1045. Shamji MF, Massicotte EM, Traynelis VC, et al. Comparison of anterior surgical options for the treatment of multilevel cervical spondylotic myelopathy: a systematic review. Spine. 2013 Oct 15;38(22 Suppl 1):S195-209. doi: 10.1097/BRS.0b013e3182a7eb27. PMID: 23962998. Exclusion: E8.

1046. Shangguan L, Ning GZ, Tang Y, et al. Discover cervical disc arthroplasty versus anterior cervical discectomy and fusion in symptomatic cervical disc diseases: a meta-analysis. PLoS ONE. 2017;12(3):e0174822. doi: 10.1371/journal.pone.0174822. PMID: 28358860. Exclusion: E8.

1047. Shao H, Chen J, Ru B, et al. Zero-profile implant versus conventional cage-plate implant in anterior cervical discectomy and fusion for the treatment of degenerative cervical spondylosis: a meta-analysis. J. 2015 Sep 17;10:148. doi: 10.1186/s13018-015-0290-9. PMID: 26381236. Exclusion: E8.

1048. Shao HY, Zhang J, Yang D, et al. [Case-control study on Zero-profile implant for anterior cervical discectomy and fusion and conventional cage plate internal fixation for the treatment of single segmental cervical intervertebral disc herniation]. Zhongguo Gu Shang. 2016 Jun;29(6):530-7. PMID: 27534085. Exclusion: E10.

1049. Shao MH, Zhang F, Yin J, et al. Titanium cages versus autogenous iliac crest bone grafts in anterior cervical discectomy and fusion treatment of patients with cervical degenerative diseases: a systematic review and meta-analysis. Curr Med Res Opin. 2017 May;33(5):803-11. doi: 10.1080/03007995.2017.1284050. PMID: 28097889. Exclusion: E8.

1050. Shao MM, Chen CH, Lin ZK, et al. Comparison of the more than 5-year clinical outcomes of cervical disc arthroplasty versus anterior cervical discectomy and fusion: a protocol for a systematic review and meta-analysis of prospective randomized controlled trials. Medicine (Baltimore). 2016 Dec;95(51):e5733. doi: 10.1097/MD.0000000000005733. PMID: 28002345. Exclusion: E6.

1051. Sharma A. 230. Does elevated mean arterial pressure lead to better outcomes in degenerative cervical myelopathy: a prospective, pilot randomized control trial. Spine journal. 2021 to 2021-10-02;21(9):S118-p. doi: 10.1016/j.spinee.2021.05.437. Exclusion: E6.

1052. Sharma A. 229. Prospective randomized control pilot study to compare the role of injection cerebrolysin in operated cases of degenerative cervical myelopathy. Spine journal. 2021 to 2021-10-02;21(9):S117-S8p. doi: 10.1016/j.spinee.2021.05.436. Exclusion: E6.

1053. Sharma A, Agrawal H, Naseem A, et al. Prospective randomized control trial to compare the role of injection cerebrolysin for 10 days duration against placebo in operated cases of degenerative cervical myelopathy. Spine (Phila Pa 1976). 2023 Mar 1;48(5):295-300. doi: 10.1097/BRS.0000000000004542. PMID: 36730671. Exclusion: E2.

1054. Sharma A, Marathe N, Aggarwal R, et al. Prospective randomized control pilot study to compare the role of injection cerebrolysin in operated cases of degenerative cervical myelopathy. Spine. 2022 Jan 15;47(2):E58-E63. doi: 10.1097/BRS.0000000000004131. PMID: 34889883. Exclusion: E4.

1055. Sharma N, Alugolu R, Gangapatnam D, et al. Role of diffuse tensor imaging in predicting outcomes of decompressive surgery in degenerative cervical myelopathy-a prospective analysis. Indian Journal of Neurosurgery. 2021 doi: 10.1055/s-0041-1727421. Exclusion: E7.

1056. Shau DN, Bible JE, Samade R, et al. Utility of postoperative radiographs for cervical spine fusion: a comprehensive evaluation of operative technique, surgical indication, and duration since surgery. Spine. 2012 Nov 15;37(24):1994-2000. doi: 10.1097/BRS.0b013e31825c0130. PMID: 22565389. Exclusion: E1.

1057. Shen HX, Li L, Yang ZG, et al. Position of increased signal intensity in the spinal cord on MR images: does it predict the outcome of cervical spondylotic myelopathy? Chin Med J. 2009 Jun 20;122(12):1418-22. PMID: 19567164. Exclusion: E11.

1058. Shen Q, Ding H, Zhu ZH, et al. Anterior cervical discectomy and fusion versus anterior cervical corpectomy and fusion for treating two-level contiguous cervical spondylotic myelopathy. Chinese journal of tissue engineering research. 2016 China Journal of Clinical Rehabilitative Tissue Engineering Research (E-mail: lei0415@hotmail;20(48):7175-84p. doi: 10.3969/j.issn.2095-4344.2016.48.005. Exclusion: E3.

1059. Shen Y, Du W, Wang LF, et al. Comparison of zero-profile device versus plate-and-cage implant in the treatment of symptomatic adjacent segment disease after anterior cervical discectomy and fusion: a minimum 2-year follow-up study. World Neurosurg. 2018 Jul;115:e226-e32. doi: 10.1016/j.wneu.2018.04.019. PMID: 29654956. Exclusion: E11.

1060. Sheth JH, Patankar AP, Shah R. Anterior cervical microdiscectomy: is bone grafting and in-situ fusion with instrumentation required? Br J Neurosurg. 2012 Feb;26(1):12-5. doi: 10.3109/02688697.2011.591854. PMID: 21767123. Exclusion: E5.

1061. Shi R, Li J, Liu H, et al. Clinical comparison of 2 implantation systems for single-level cervical disk replacement. Orthopedics. 2014 Feb;37(2):e161-8. doi: 10.3928/01477447-20140124-20. PMID: 24679203. Exclusion: E3.

1062. Shi S, Li XF, Zhao QT, et al. Risk factors for dysphagia after single-level anterior cervical decompression with arthroplasty or fusion: a prospective study comparing 2 zero-profile implants. World Neurosurg. 2016 Nov;95:148-55. doi: 10.1016/j.wneu.2016.07.100. PMID: 27506403. Exclusion: E2.

1063. Shi S, Zheng S, Li XF, et al. Comparison of a stand-alone anchored spacer versus plate-cage construct in the treatment of two noncontiguous levels of cervical spondylosis: a preliminary investigation. World Neurosurg. 2016 05;89:285-92. doi: 10.1016/j.wneu.2016.02.009. PMID: 26868426. Exclusion: E11.

1064. Shi S, Zheng S, Li XF, et al. Comparison of 2 Zero-Profile Implants in the Treatment of Single-Level Cervical Spondylotic Myelopathy: a Preliminary Clinical Study of Cervical Disc Arthroplasty versus Fusion. PLoS ONE. 2016;11(7):e0159761. doi: 10.1371/journal.pone.0159761. PMID: 27441736. Exclusion: E11.

1065. Shibuya S, Komatsubara S, Oka S, et al. Differences between subtotal corpectomy and laminoplasty for cervical spondylotic myelopathy. Spinal Cord. 2010 Mar;48(3):214-20. doi: 10.1038/sc.2009.114. PMID: 19752872. Exclusion: E4.

1066. Shichang L, Yueming S, Limin L, et al. Clinical and radiologic comparison of dynamic cervical implant arthroplasty and cervical total disc replacement for single-level cervical degenerative disc disease. J Clin Neurosci. 2016 May;27:102-9. doi: 10.1016/j.jocn.2015.05.072. PMID: 26928156. Exclusion: E3.

1067. Shields LB, Raque GH, Glassman SD, et al. Adverse effects associated with high-dose recombinant human bone morphogenetic protein-2 use in anterior cervical spine fusion. Spine (Phila Pa 1976). 2006 Mar 1;31(5):542-7. doi: 10.1097/01.brs.0000201424.27509.72. PMID: 16508549. Exclusion: E3.

1068. Shim HK, Lee JM, Kim DH, et al. Successful motor evoked potential monitoring in cervical myelopathy : related factors and the effect of increased stimulation intensity. J. 2021 Jan;64(1):78-87. doi: 10.3340/jkns.2020.0111. PMID: 33355842. Exclusion: E2.

1069. Shimer A, Lee JY, Tannoury C. Laminoplasty. Operative Techniques in Orthopaedics. 2007;17(3):169-73. doi: 10.1053/j.oto.2007.04.003. Exclusion: E6.

1070. Shin DA, Yi S, Yoon DH, et al. Artificial disc replacement combined with fusion versus two-level fusion in cervical two-level disc disease. Spine. 2009 May 15;34(11):1153-9; discussion 60-1. doi: 10.1097/BRS.0b013e31819c9d39. PMID: 19444062. Exclusion: E3.

1071. Shin HJ, Kim P, Ju CI, et al. Anterior approaches for two-level cervical degenerative disease: a comparative study of at least 6-year follow-up. Korean j. 2021;17(2):118-25. doi: 10.13004/kjnt.2021.17.e27. PMID: 34760822. Exclusion: E3.

1072. Shin JJ, Jin BH, Kim KS, et al. Intramedullary high signal intensity and neurological status as prognostic factors in cervical spondylotic myelopathy. Acta Neurochir (Wien). 2010 Oct;152(10):1687-94. doi: 10.1007/s00701-010-0692-8. PMID: 20512384. Exclusion: E9.

1073. Shin SH, Lee WJ, Eun JP, et al. Clinical and radiologic assessment for anterior cervical interbody fusion with synthetic cages. Daehan singyeong oegwa haghoeji. 2007;41(2):105-10p. Exclusion: E7.

1074. Shou F, Li Z, Wang H, et al. Prevalence of C5 nerve root palsy after cervical decompressive surgery: a meta-analysis. Eur Spine J. 2015 Dec;24(12):2724-34. doi: 10.1007/s00586-015-4186-5. PMID: 26281981. Exclusion: E1.

1075. Shousha M, Alhashash M, Allouch H, et al. Reoperation rate after anterior cervical discectomy and fusion using standalone cages in degenerative disease: a study of 2,078 cases. Spine J. 2019 12;19(12):2007-12. doi: 10.1016/j.spinee.2019.08.003. PMID: 31404654. Exclusion: E3.

1076. Shriver MF, Lewis DJ, Kshettry VR, et al. Pseudoarthrosis rates in anterior cervical discectomy and fusion: a meta-analysis. Spine J. 2015 Sep 01;15(9):2016-27. doi: 10.1016/j.spinee.2015.05.010. PMID: 25982430. Exclusion: E8.

1077. Shriver MF, Lewis DJ, Kshettry VR, et al. Dysphagia rates after anterior cervical diskectomy and fusion: a systematic review and meta-analysis. Global spine j. 2017 Feb;7(1):95-103. doi: 10.1055/s-0036-1583944. PMID: 28451514. Exclusion: E4.

1078. Shriver MF, Lubelski D, Sharma AM, et al. Adjacent segment degeneration and disease following cervical arthroplasty: a systematic review and meta-analysis. Spine J. 2016 Feb;16(2):168-81. doi: 10.1016/j.spinee.2015.10.032. PMID: 26515401. Exclusion: E8.

1079. Siemionow K, Monsef JB, Janusz P. Preliminary analysis of adjacent segment degeneration in patients treated with posterior cervical cages: 2-year follow-up. World Neurosurg. 2016 May;89:730.e1-7. doi: 10.1016/j.wneu.2016.01.053. PMID: 26836696. Exclusion: E5.

1080. Siemionow KB, Glowka P, Blok RJ, et al. Perioperative complications in patients treated with posterior cervical fusion and bilateral cages. J Craniovertebr Junction Spine. 2017 Oct-Dec;8(4):342-9. doi: 10.4103/jcvjs.JCVJS_61_17. PMID: 29403247. Exclusion: E3.

1081. Signorelli F, Trevisi G, Bianchi F, et al. Clinical and radiological outcomes following open door laminoplasty: a single center evolution of the technique. J Neurosurg Sci. 2022 Apr;66(2):117-24. doi: 10.23736/S0390-5616.18.04555-1. PMID: 30356036. Exclusion: E3.

1082. Silvestre C, Mac-Thiong JM, Hilmi R, et al. Complications and morbidities of mini-open anterior retroperitoneal lumbar interbody fusion: oblique lumbar interbody fusion in 179 patients. Asian spine j. 2012 Jun;6(2):89-97. doi: 10.4184/asj.2012.6.2.89. PMID: 22708012. Exclusion: E1.

1083. Sing DC, Vora M, Yue JK, et al. Half of unplanned readmissions following one or two-level anterior cervical decompression and fusion are unrelated to surgical site. Spine. 2020 May 01;45(9):573-9. doi: 10.1097/BRS.0000000000003330. PMID: 31770318. Exclusion: E4.

1084. Singh A, Crockard HA. Comparison of seven different scales used to quantify severity of cervical spondylotic myelopathy and post-operative improvement. J Outcome Meas. 2001;5(1):798-818. PMID: 16320550. Exclusion: E2.

1085. Singh A, Crockard HA, Platts A, et al. Clinical and radiological correlates of severity and surgery-related outcome in cervical spondylosis. J Neurosurg. 2001 Apr;94(2 Suppl):189-98. doi: 10.3171/spi.2001.94.2.0189. PMID: 11302619. Exclusion: E11.

1086. Singh H, Kukowski NR, Lunati MP, et al. Porous 3D printed titanium cages in anterior cervical discectomy and fusion are associated with less subsidence, improved maintenance of segmental lordotic correction, and similar clinical outcomes as allograft. Global spine j. 2022 Sep 3:21925682221124527. doi: 10.1177/21925682221124527. PMID: 36062347. Exclusion: E3.

1087. Singh K, Ahmadinia K, Park DK, et al. Complications of spinal fusion with utilization of bone morphogenetic protein: a systematic review of the literature. Spine. 2014 Jan 01;39(1):91-101. doi: 10.1097/BRS.0000000000000004. PMID: 24026158. Exclusion: E9.

1088. Singh K, Phillips F, Park D, et al. Factors affecting reoperations after anterior cervical discectomy and fusion within and outside of a Federal Drug Administration investigational device exemption cervical disc replacement trial. Spine J. 2012 May;12(5):372-8. doi: 10.1016/j.spinee.2012.02.005. PMID: 22425784. Exclusion: E3.

1089. Singh P, Kumar A, Shekhawat V. Comparative analysis of interbody cages versus tricortical graft with anterior plate fixation for anterior cervical discectomy and fusion in degenerative cervical disc disease. J Clin Diagn Res. 2016 Mar;10(3):RC05-8. doi: 10.7860/JCDR/2016/16520.7340. PMID: 27134955. Exclusion: E3.

1090. Singhatanadgige W, Limthongkul W, Valone Fr, et al. Outcomes following laminoplasty or laminectomy and fusion in patients with myelopathy caused by ossification of the posterior longitudinal ligament: a systematic review. Global spine j. 2016 Nov;6(7):702-9. doi: 10.1055/s-0036-1578805. PMID: 27781191. Exclusion: E1.

1091. Singhatanadgige W, Tanavalee C, Yingsakmongkol W, et al. Minimal invasive posterior cervical laminoforaminotomy for treatment of degenerative cervical radiculopathy: a technical report and review of the literatures. J Med Assoc Thai. 2018;101(8):1133-7. Exclusion: E6.

1092. Singrakhia MD, Malewar NR, Deshmukh S, et al. Prospective analysis of functional outcome of single-stage surgical treatment for symptomatic tandem spinal stenosis. Indian j. 2019 Mar-Apr;53(2):315-23. doi: 10.4103/ortho.IJOrtho_316_17. PMID: 30967703. Exclusion: E1.

1093. Sivaraman A, Bhadra AK, Altaf F, et al. Skip laminectomy and laminoplasty for cervical spondylotic myelopathy: a prospective study of clinical and radiologic outcomes. J Spinal Disord Tech. 2010 Apr;23(2):96-100. doi: 10.1097/BSD.0b013e318198c92a. PMID: 20084024. Exclusion: E11.

1094. Skeppholm M, Henriques T, Tullberg T. Higher reoperation rate following cervical disc replacement in a retrospective, long-term comparative study of 715 patients. Eur Spine J. 2017 09;26(9):2434-40. doi: 10.1007/s00586-017-5218-0. PMID: 28718168. Exclusion: E11.

1095. Skeppholm M, Lindgren L, Henriques T, et al. The Discover artificial disc replacement versus fusion in cervical radiculopathy--a randomized controlled outcome trial with 2-year follow-up. Spine J. 2015 Jun 01;15(6):1284-94. doi: 10.1016/j.spinee.2015.02.039. PMID: 25733022. Exclusion: E2.

1096. Skeppholm M, Olerud C. Comparison of dysphagia between cervical artificial disc replacement and fusion: data from a randomized controlled study with two years of follow-up. Spine (Phila Pa 1976). 2013 Nov 15;38(24):E1507-10. doi: 10.1097/BRS.0b013e3182a516ef. PMID: 23883828. Exclusion: E2.

1097. Skovrlj B, Gologorsky Y, Haque R, et al. Complications, outcomes, and need for fusion after minimally invasive posterior cervical foraminotomy and microdiscectomy. Spine J. 2014 Oct 01;14(10):2405-11. doi: 10.1016/j.spinee.2014.01.048. PMID: 24486472. Exclusion: E3.

1098. Smith MW, Romano DR, McEntire BJ, et al. A single center retrospective clinical evaluation of anterior cervical discectomy and fusion comparing allograft spacers to silicon nitride cages. J. 2018 Jun;4(2):349-60. doi: 10.21037/jss.2018.06.02. PMID: 30069528. Exclusion: E11.

1099. Smith PN, Balzer JR, Khan MH, et al. Intraoperative somatosensory evoked potential monitoring during anterior cervical discectomy and fusion in nonmyelopathic patients--a review of 1,039 cases. Spine J. 2007 Jan-Feb;7(1):83-7. doi: 10.1016/j.spinee.2006.04.008. PMID: 17197338. Exclusion: E1.

1100. Smucker JD, Sasso WR, Sasso RC, et al. Long-term clinical outcomes of cervical disc arthroplasty: a prospective, randomized, controlled trial. Spine. 2016(104):2016-12. Exclusion: E1.

1101. Soliman HM. Cervical microendoscopic discectomy and fusion: does it affect the postoperative course and the complication rate? A blinded randomized controlled trial. Spine. 2013 Nov 15;38(24):2064-70. doi: 10.1097/01.brs.0000435030.96058.bf. PMID: 24026156. Exclusion: E3.

1102. Soliman ME, Raslan MS, Fattah Eissa SA, et al. Evaluation of surgical outcome In anterior versus posterior surgical approaches in management of cervical spondylotic myelopathy. Journal of Pharmaceutical Negative Results. 2022 Dec 31;13(09):8316-25. doi: 10.47750/pnr.2022.13.S09.976. Exclusion: E11.

1103. Sommaruga S, Camara-Quintana J, Patel K, et al. Clinical outcomes between stand-alone zero-profile spacers and cervical plate with cage fixation for anterior cervical discectomy and fusion: a retrospective analysis of 166 patients. J. 2021 Jul 12;10(14):12. doi: 10.3390/jcm10143076. PMID: 34300241. Exclusion: E12.

1104. Son S, Kim WK, Lee SG, et al. Long-term outcomes after microscopic anterior cervical foraminotomy with a minimum 10-year follow-up. World Neurosurg. 2019 Feb;122:e67-e80. doi: 10.1016/j.wneu.2018.09.049. PMID: 30240855. Exclusion: E3.

1105. Song KJ, Choi BW, Jeon TS, et al. Adjacent segment degenerative disease: is it due to disease progression or a fusion-associated phenomenon? Comparison between segments adjacent to the fused and non-fused segments. Eur Spine J. 2011 Nov;20(11):1940-5. doi: 10.1007/s00586-011-1864-9. PMID: 21656051. Exclusion: E3.

1106. Song KJ, Choi BW, Kim GH, et al. Clinical usefulness of CT-myelogram comparing with the MRI in degenerative cervical spinal disorders: is CTM still useful for primary diagnostic tool? J Spinal Disord Tech. 2009 Jul;22(5):353-7. doi: 10.1097/BSD.0b013e31817df78e. PMID: 19525791. Exclusion: E4.

1107. Song KJ, Choi BW, Kim JK. Adjacent segment pathology following anterior decompression and fusion using cage and plate for the treatment of degenerative cervical spinal diseases. Asian spine j. 2014 Dec;8(6):720-8. doi: 10.4184/asj.2014.8.6.720. PMID: 25558313. Exclusion: E3.

1108. Song KJ, Johnson JS, Choi BR, et al. Anterior fusion alone compared with combined anterior and posterior fusion for the treatment of degenerative cervical kyphosis. J Bone Joint Surg Br. 2010 Nov;92(11):1548-52. doi: 10.1302/0301-620X.92B11.24995. PMID: 21037350. Exclusion: E7.

1109. Song KJ, Kim GH, Choi BW, et al. Does plate construct improve the result of 1- or 2-level anterior cervical fusion? Neurosurgery quarterly. 2008;18(3):172-7p. doi: 10.1097/WNQ.0b013e3181820780. Exclusion: E11.

1110. Song KJ, Song JS, Kim DY, et al. Efficacy of combined anteroposterior fusion with no plate versus anterior fusion alone with cage and plate for multilevel degenerative cervical disease. Spine J. 2014 Apr;14(4):598-603. doi: 10.1016/j.spinee.2013.06.082. PMID: 24144691. Exclusion: E3.

1111. Song KJ, Taghavi CE, Lee KB, et al. The efficacy of plate construct augmentation versus cage alone in anterior cervical fusion. Spine. 2009 Dec 15;34(26):2886-92. doi: 10.1097/BRS.0b013e3181b64f2c. PMID: 19949367. Exclusion: E11.

1112. Song KJ, Yoon SJ, Lee KB. Three- and four-level anterior cervical discectomy and fusion with a PEEK cage and plate construct. Eur Spine J. 2012 Dec;21(12):2492-7. doi: 10.1007/s00586-012-2447-0. PMID: 22842956. Exclusion: E3.

1113. Song KS, Lee J, Ham DW, et al. Postoperative segmental motion up to 1 year following single-level anterior cervical discectomy and fusion: plate versus non-plate. Asian spine j. 2023 Jun;17:492-9. doi: 10.31616/asj.2022.0192. PMID: 36775832. Exclusion: E12.

1114. Soufi KH, Perez TM, Umoye AO, et al. How is spinal cord function measured in degenerative cervical myelopathy? A systematic review. J. 2022;11(5):1441. doi: 10.3390/jcm11051441. PMID: 35268533. Exclusion: E4.

1115. Spallone A, Marchione P, Li Voti P, et al. Anterior cervical discectomy and fusion with "mini-invasive" harvesting of iliac crest graft versus polyetheretherketone (PEEK) cages: a retrospective outcome analysis. Int J Surg. 2014 Dec;12(12):1328-32. doi: 10.1016/j.ijsu.2014.11.003. PMID: 25448654. Exclusion: E11.

1116. Spanu G, Marchionni M, Adinolfi D, et al. Complications following anterior cervical spine surgery for disc diseases: an analysis of ten years experience. Chir Organi Mov. 2005 Jul-Sep;90(3):229-40. PMID: 16681101. Exclusion: E11.

1117. Spivak JM, Zigler JE, Philipp T, et al. Segmental motion of cervical arthroplasty leads to decreased adjacent-level degeneration: analysis of the 7-year postoperative results of a multicenter randomized controlled trial. Int J Spine Surg. 2022 Feb;16(1):186-93. doi: 10.14444/8187. PMID: 35177528. Exclusion: E4.

1118. Stancic M, Stancic I, Barl P, et al. Scarcity of implants has partially replaced cervical spondylotic myelopathy decompression and instrumented fusion with implant-less expansile cervical laminoplasty: poverty teaches all the arts. World Neurosurg. 2017 Jan;97:267-78. doi: 10.1016/j.wneu.2016.09.103. PMID: 27725298. Exclusion: E7.

1119. Stark JR, Hsieh J, Waller D. Bone graft substitutes in single- or double-level anterior cervical discectomy and fusion: a systematic review. Spine. 2019 May 15;44(10):E618-E28. doi: 10.1097/BRS.0000000000002925. PMID: 30395088. Exclusion: E8.

1120. Staub LP, Ryser C, Roder C, et al. Total disc arthroplasty versus anterior cervical interbody fusion: use of the Spine Tango registry to supplement the evidence from randomized control trials. Spine J. 2016 Feb;16(2):136-45. doi: 10.1016/j.spinee.2015.11.056. PMID: 26674445. Exclusion: E12.

1121. Steib JP, Davis R. Total disc replacement versus ACDF: results from a two-level prospective, randomized, clinical trial with 48 months follow-up. Eur Spine J. 2014;23(1):S507. doi: 10.1007/s00586-014-3516-3. Exclusion: E6 - conference abstract, PDF not available.

1122. Steib JP, Hisey MS. FDA IDE clinical trial results through 48 months: one-level TDR versus ACDF. Eur Spine J. 2014;23(1):S473-S4. doi: 10.1007/s00586-014-3515-4. Exclusion: E6.

1123. Steinberg JA, German JW. The effect of minimally invasive posterior cervical approaches versus open anterior approaches on neck pain and disability. Int J Spine Surg. 2012;6:55-61. doi: 10.1016/j.ijsp.2011.11.003. PMID: 25694872. Exclusion: E11.

1124. Stephens BF, Rhee JM, Neustein TM, et al. Laminoplasty does not lead to worsening axial neck pain in the properly selected patient with cervical myelopathy: a comparison with laminectomy and fusion. Spine. 2017 Dec 15;42(24):1844-50. doi: 10.1097/BRS.0000000000002308. PMID: 28658033. Exclusion: E11.

1125. Stulik J, Pitzen TR, Chrobok J, et al. Fusion and failure following anterior cervical plating with dynamic or rigid plates: 6-months results of a multi-centric, prospective, randomized, controlled study. Eur Spine J. 2007 Oct;16(10):1689-94. doi: 10.1007/s00586-007-0451-6. PMID: 17684777. Exclusion: E3.

1126. Stulik J, Ronai M, Rudinsky B, et al. Quality of Life Following Prestige LP Cervical Disc Arthroplasty in a Prospective Multicountry Study. Int J Spine Surg. 2019 Jun;13(3):221-9. doi: 10.14444/6030. PMID: 31328085. Exclusion: E5.

1127. Su Q, Zhao R, Wang S, et al. Identification and therapeutic outcome prediction of cervical spondylotic myelopathy based on the functional connectivity from resting-state functional MRI data: a preliminary machine learning study. Front Neurol. 2021;12:711880. doi: 10.3389/fneur.2021.711880. PMID: 34690912. Exclusion: E2.

1128. Suchomel P, Barsa P, Buchvald P, et al. Autologous versus allogenic bone grafts in instrumented anterior cervical discectomy and fusion: a prospective study with respect to bone union pattern. Eur Spine J. 2004 Oct;13(6):510-5. doi: 10.1007/s00586-003-0667-z. PMID: 15042453. Exclusion: E11.

1129. Sugawara T, Itoh Y, Hirano Y, et al. beta-Tricalcium phosphate promotes bony fusion after anterior cervical discectomy and fusion using titanium cages. Spine. 2011 Nov 01;36(23):E1509-14. doi: 10.1097/BRS.0b013e31820e60d9. PMID: 21221053. Exclusion: E11.

1130. Suk KS, Jimenez KA, Jo JH, et al. Anterior plate-screws and lower postoperative T1 slope affect cervical allospacer failures in multi-level ACDF surgery: anterior versus posterior fixation. Global spine j. 2021 Mar 02:2192568221991515. doi: 10.1177/2192568221991515. PMID: 33648356. Exclusion: E11.

1131. Suleiman LI, Bhatt SA, Parrish TB, et al. Imaging modalities and tests for cervical myelopathy. Seminars in Spine Surgery. 2014;26(2):68-72. doi: 10.1053/j.semss.2014.05.003. Exclusion: E2.

1132. Sumiya S, Kawabata S, Ushio S, et al. Cervical spinal cord injury associated with neck flexion in posterior cervical decompression. Clin Spine Surg. 2019 06;32(5):E221-E7. doi: 10.1097/BSD.0000000000000764. PMID: 30608235. Exclusion: E3.

1133. Sun B, Shi C, Wu H, et al. Application of zero-profile spacer in the treatment of three-level cervical spondylotic myelopathy: 5-year follow-up results. Spine. 2020 Apr 15;45(8):504-11. doi: 10.1097/BRS.0000000000003312. PMID: 32224806. Exclusion: E11.

1134. Sun LQ, Li M, Li YM. Predictors for surgical outcome of laminoplasty for cervical spondylotic myelopathy. World Neurosurg. 2016 Oct;94:89-96. doi: 10.1016/j.wneu.2016.06.092. PMID: 27368503. Exclusion: E3.

1135. Sun LQ, Li YM, Wang X, et al. Quantitative magnetic resonance imaging analysis correlates with surgical outcome of cervical spondylotic myelopathy. Spinal Cord. 2015 Jun;53(6):488-93. doi: 10.1038/sc.2014.204. PMID: 25403500. Exclusion: E7.

1136. Sun Y, Li L, Zhao J, et al. Comparison between anterior approaches and posterior approaches for the treatment of multilevel cervical spondylotic myelopathy: a meta-analysis. Clin Neurol Neurosurg. 2015 Jul;134:28-36. doi: 10.1016/j.clineuro.2015.04.011. PMID: 25935128. Exclusion: E1.

1137. Sun Z, Liu Z, Hu W, et al. Zero-profile versus cage and plate in anterior cervical discectomy and fusion with a minimum 2 years of follow-up: a meta-analysis. World Neurosurg. 2018 Dec;120:e551-e61. doi: 10.1016/j.wneu.2018.08.128. PMID: 30172062. Exclusion: E3.

1138. Sundseth J, Fredriksli OA, Kolstad F, et al. The Norwegian Cervical Arthroplasty Trial (NORCAT): 2-year clinical outcome after single-level cervical arthroplasty versus fusion-a prospective, single-blinded, randomized, controlled multicenter study. Eur Spine J. 2017 04;26(4):1225-35. doi: 10.1007/s00586-016-4922-5. PMID: 28012081. Exclusion: E2.

1139. Szollosi B, Kiss L, Lazary A, et al. Hybrid constructs versus ACDF in the surgical treatment of multisegmental degenerative cervical disc disease. Global spine j. 2018;Vol.Conference: 7th Annual Global Spine Congress, GSC 2018. Singapore. 8(1 Supplement 1):240Sp. Exclusion: E3/E6 - conference abstract.

1140. Tabaraee E, Ahn J, Bohl DD, et al. Comparison of surgical outcomes, narcotics utilization, and costs after an anterior cervical discectomy and fusion: stand-alone cage versus anterior plating. Clin Spine Surg. 2017 Nov;30(9):E1201-E5. doi: 10.1097/BSD.0000000000000341. PMID: 29049131. Exclusion: E11.

1141. Takahashi M, Yamashita Y, Sakamoto Y, et al. Chronic cervical cord compression: clinical significance of increased signal intensity on MR images. Radiology. 1989 Oct;173(1):219-24. doi: 10.1148/radiology.173.1.2781011. PMID: 2781011. Exclusion: E9.

1142. Takeda M, Yamaguchi S, Mitsuhara T, et al. Intraoperative neurophysiologic monitoring for degenerative cervical myelopathy. Neurosurg Clin N Am. 2018 Jan;29(1):159-67. doi: 10.1016/j.nec.2017.09.012. PMID: 29173429. Exclusion: E6.

1143. Takenaka S, Nagamoto Y, Aono H, et al. Differences in the time of onset of postoperative upper limb palsy among surgical procedures: a meta-analysis. Spine J. 2016 12;16(12):1486-99. doi: 10.1016/j.spinee.2016.09.014. PMID: 27725308. Exclusion: E8.

1144. Takeuchi K, Yokoyama T, Aburakawa S, et al. Axial symptoms after cervical laminoplasty with C3 laminectomy compared with conventional C3-C7 laminoplasty: a modified laminoplasty preserving the semispinalis cervicis inserted into axis. Spine (Phila Pa 1976). 2005 Nov 15;30(22):2544-9. doi: 10.1097/01.brs.0000186332.66490.ba. PMID: 16284593. Exclusion: E11.

1145. Takeuchi M, Yasuda M, Niwa A, et al. Plasmapore-coated titanium cervical cages induce more rapid and complete bone fusion after anterior cervical discectomy and fusion as compared to noncoated titanium cages. World Neurosurg. 2014 Sep-Oct;82(3-4):519-22. doi: 10.1016/j.wneu.2013.04.001. PMID: 23624365. Exclusion: E11.

1146. Tan B, Wang H, Dong J, et al. Comparison of rhBMP-2 versus autogenous iliac crest bone graft for 2-level anterior cervical discectomy and fusion for cervical spondylotic myelopathy. Med Sci Monit. 2015 Oct 19;21:3159-65. doi: 10.12659/msm.894656. PMID: 26479708. Exclusion: E12 - per Shelley's email 1/17.

1147. Tanaka N, Nakanishi K, Fujimoto Y, et al. Expansive laminoplasty for cervical myelopathy with interconnected porous calcium hydroxyapatite ceramic spacers: comparison with autogenous bone spacers. J Spinal Disord Tech. 2008;21(8):547-52p. doi: 10.1097/BSD.0b013e31815c85bd. Exclusion: E3.

1148. Tanaka N, Nakanishi K, Fujiwara Y, et al. Postoperative segmental C5 palsy after cervical laminoplasty may occur without intraoperative nerve injury: a prospective study with transcranial electric motor-evoked potentials. Spine. 2006 Dec 15;31(26):3013-7. doi: 10.1097/01.brs.0000250303.17840.96. PMID: 17172998. Exclusion: E5.

1149. Tang SL, Huang QH, Cao HM, et al. [Comparison of short term curative effects of open door laminoplasty with different plate density for the treatment of multi segment cervical spondylotic myelopathy]. Zhongguo Gu Shang. 2016 Oct 25;29(10):916-22. doi: 10.3969/j.issn.1003-0034.2016.10.009. PMID: 29285910. Exclusion: E10.

1150. Tarawneh A, Alawi S, Janbek O. Cervical disc arthroplasty versus anterior cervical discectomy and fusion (short and long term follow up): a systematic review of randomized controlled trials. Global spine j. 2017 to 2017-06-05;7(2):171S-p. doi: 10.1177/2192568217708577. Exclusion: E6.

1151. Tasiou A, Giannis T, Brotis AG, et al. Anterior cervical spine surgery-associated complications in a retrospective case-control study. J. 2017 Sep;3(3):444-59. doi: 10.21037/jss.2017.08.03. PMID: 29057356. Exclusion: E3.

1152. Taylor AJ, Combs K, Kay RD, et al. Combined motor and sensory intraoperative neuromonitoring for cervical spondylotic myelopathy surgery causes confusion: a level-1 diagnostic study. Spine. 2021 Nov 15;46(22):E1185-E91. doi: 10.1097/BRS.0000000000004070. PMID: 34417419. Exclusion: E3.

1153. Tederko P, Krasuski M, Tarnacka B. Effectiveness of rehabilitation after cervical disk surgery: a systematic review of controlled studies. Clin Rehabil. 2019 Mar;33(3):370-80. doi: 10.1177/0269215518810777. PMID: 30458634. Exclusion: E8.

1154. Tetreault L, Garwood P, Gharooni AA, et al. Improving assessment of disease severity and strategies for monitoring progression in degenerative cervical myelopathy Global spine j. 2022 Feb;12(1_suppl):64S-77S. doi: 10.1177/21925682211063854. PMID: 34971524. Exclusion: E2.

1155. Tetreault L, Ibrahim A, Cote P, et al. A systematic review of clinical and surgical predictors of complications following surgery for degenerative cervical myelopathy. J Neurosurg Spine. 2016 Jan;24(1):77-99. doi: 10.3171/2015.3.SPINE14971. PMID: 26407090. Exclusion: E8.

1156. Tetreault L, Kalsi-Ryan S, Benjamin D, et al. Degenerative cervical myelopathy: a practical approach to diagnosis. Global spine j. 2022;12(8):1881-93. doi: 10.1177/21925682211072847. PMID: 35043715. Exclusion: E2.

1157. Tetreault L, Lange SF, Chotai S, et al. A systematic review of definitions for neurological complications and disease progression in patients treated surgically for degenerative cervical myelopathy. Spine. 2019 Sep;44(18):1318-31. doi: 10.1097/BRS.0000000000003066. PMID: 31261274. Exclusion: E8.

1158. Tetreault L, Le D, Côté P, et al. The practical application of clinical prediction rules: a commentary using case examples in surgical patients with degenerative cervical myelopathy. Global spine j. 2015;5(6):457-65. doi: 10.1055/s-0035-1567838. PMID: 26682095 Exclusion: E6.

1159. Tetreault L, Nouri A, Kopjar B, et al. The minimum clinically important difference of the modified japanese orthopaedic association scale in patients with degenerative cervical myelopathy. Spine. 2015 Nov;40(21):1653-9. doi: 10.1097/BRS.0000000000001127. PMID: 26502097. Exclusion: E5.

1160. Tetreault L, Wilson JR, Kotter MRN, et al. Is preoperative duration of symptoms a significant predictor of functional outcomes in patients undergoing surgery for the treatment of degenerative cervical myelopathy? Neurosurgery. 2019 11 01;85(5):642-7. doi: 10.1093/neuros/nyy474. PMID: 30445506. Exclusion: E6.

1161. Thalgott JS, Fritts K, Giuffre JM, et al. Anterior interbody fusion of the cervical spine with coralline hydroxyapatite. Spine. 1999 Jul 01;24(13):1295-9. doi: 10.1097/00007632-199907010-00005. PMID: 10404570. Exclusion: E9.

1162. Thind H, Aura AB, Lee P, et al. 2-Level anterior cervical arthrodesis with integrated spacer and plate vs traditional anterior spacer and plate system. Int J Spine Surg. 2022;16(2):215-21. doi: 10.14444/8206. PMID: 35273112. Exclusion: E11.

1163. Thirumala PD, Muralidharan A, Loke YK, et al. Value of intraoperative neurophysiological monitoring to reduce neurological complications in patients undergoing anterior cervical spine procedures for cervical spondylotic myelopathy. J Clin Neurosci. 2016 Mar;25:27-35. doi: 10.1016/j.jocn.2015.06.027. PMID: 26677786. Exclusion: E8.

1164. Thome C, Leheta O, Krauss JK, et al. A prospective randomized comparison of rectangular titanium cage fusion and iliac crest autograft fusion in patients undergoing anterior cervical discectomy. J Neurosurg Spine. 2006 Jan;4(1):1-9. doi: 10.3171/spi.2006.4.1.1. PMID: 16506459. Exclusion: E3.

1165. Tian P, Fu X, Li ZJ, et al. Hybrid surgery versus anterior cervical discectomy and fusion for multilevel cervical degenerative disc diseases: a meta-analysis. Sci. 2015 Aug 26;5:13454. doi: 10.1038/srep13454. PMID: 26307360. Exclusion: E8.

1166. Tian W, Han X, Liu B, et al. Clinical and radiographic results of cervical artificial disc arthroplasty: over three years follow-up cohort study. Chin Med J (Engl). 2010 Nov;123(21):2969-73. PMID: 21162939. Exclusion: E3.

1167. Tian W, Yan K, Han X, et al. Comparison of the clinical and radiographic results between cervical artificial disk replacement and anterior cervical fusion: a 6-year prospective nonrandomized comparative study. Clin Spine Surg. 2017 Jun;30(5):E578-E86. doi: 10.1097/BSD.0000000000000206. PMID: 28525481. Exclusion: E11.

1168. Tian W, Yu J. The role of C2-C7 angle in the development of dysphagia after anterior and posterior cervical spine surgery. Clin Spine Surg. 2017 Nov;30(9):E1306-E14. doi: 10.1097/BSD.0000000000000493. PMID: 27930391. Exclusion: E11.

1169. Toci GR, Canseco JA, Patel PD, et al. The incidence of adjacent segment pathology after cervical disc arthroplasty compared with anterior cervical discectomy and fusion: a systematic review and meta-analysis of randomized clinical trials. World Neurosurg. 2022 Apr;160:e537-e48. doi: 10.1016/j.wneu.2022.01.072. PMID: 35085804. Exclusion: E8.

1170. Tome-Bermejo F, Alvarez-Galovich L, Pinera-Parrilla AR, et al. Anterior 1-2 level cervical corpectomy and fusion for degenerative cervical disease: a retrospective study with lordotic porous tantalum cages. Long-term changes in sagittal alignment and their clinical and radiological implications after cage subsidence. Int J Spine Surg. 2022 Apr;16(2):222-32. doi: 10.14444/8207. PMID: 35273111. Exclusion: E3.

1171. Tong MJ, Xiang GH, He ZL, et al. Zero-profile spacer versus cage-plate construct in anterior cervical diskectomy and fusion for multilevel cervical spondylotic myelopathy: Systematic review and meta-analysis. World Neurosurg. 2017 Aug;104:545-53. doi: 10.1016/j.wneu.2017.05.045. PMID: 28526640. Exclusion: E8.

1172. Toop N, Gifford CS, McGahan BG, et al. Influence of clinical and radiological parameters on the likelihood of neurological improvement after surgery for degenerative cervical myelopathy. J Neurosurg Spine. 2023 Aug 19;38(1):14-23. doi: 10.3171/2022.6.SPINE2234. PMID: 35986727. Exclusion: E3.

1173. Torres A, Fernandez-Fairen M, Acebal G, et al. Anterior cervical fusion with tantalum implant: prospective randomized controlled study, five years follow up results. Eur Spine J. 2013 to 2013-10-04;22(5):S694-p. doi: 10.1007/s00586-013-2945-8. Exclusion: E6.

1174. Towner JE, Li YI, Pieters TA, et al. Descriptive analysis of 1972 cervical corpectomy patients and 30-day postoperative outcomes. Int J Spine Surg. 2020 Jun;14(3):412-7. doi: 10.14444/7054. PMID: 32699765. Exclusion: E3.

1175. Tracey RW, Kang DG, Cody JP, et al. Outcomes of single-level cervical disc arthroplasty versus anterior cervical discectomy and fusion. J Clin Neurosci. 2014 Nov;21(11):1905-8. doi: 10.1016/j.jocn.2014.05.007. PMID: 24986154. Exclusion: E11.

1176. Traynelis VC. The Prestige cervical disc replacement. Spine J. 2004 Nov-Dec;4(6 Suppl):310S-4S. doi: 10.1016/j.spinee.2004.07.025. PMID: 15541682. Exclusion: E6.

1177. Traynelis VC, Arnold PM, Fourney DR, et al. Alternative procedures for the treatment of cervical spondylotic myelopathy: arthroplasty, oblique corpectomy, skip laminectomy: evaluation of comparative effectiveness and safety. Spine. 2013 Oct 15;38(22 Suppl 1):S210-31. doi: 10.1097/BRS.0000000000000009. PMID: 24113359. Exclusion: E8.

1178. Traynelis VC, Leigh BC, Skelly AC. Return to work rates and activity profiles: are there differences between those receiving C-ADR and ACDF? Evid. 2012 Feb;3(S1):47-52. doi: 10.1055/s-0031-1298608. PMID: 23236313. Exclusion: E8.

1179. Troyanovich SJ, Stroink AR, Kattner KA, et al. Does anterior plating maintain cervical lordosis versus conventional fusion techniques? A retrospective analysis of patients receiving single-level fusions. J Spinal Disord Tech. 2002 Feb;15(1):69-74. doi: 10.1097/00024720-200202000-00013. PMID: 11891456. Exclusion: E7.

1180. Truumees E, Singh D, Ennis D, et al. Bridging the cervicothoracic junction during multi-level posterior cervical decompression and fusion: a systematic review and meta-analysis. Global spine j. 2022 Apr 11:21925682221090925. doi: 10.1177/21925682221090925. PMID: 35410499. Exclusion: E8.

1181. Truumees E, Singh D, Lavelle W, et al. Is it safe to stop at C7 during multilevel posterior cervical decompression and fusion? - multicenter analysis. Spine J. 2021 01;21(1):90-5. doi: 10.1016/j.spinee.2020.08.018. PMID: 32890781. Exclusion: E2.

1182. Tu PH, Chen CT, Chen CC, et al. Symptomatic cord compression by paraspinal musculature following cervical laminectomy: rare complication. Eur Spine J. 2018 08;27(8):1815-23. doi: 10.1007/s00586-018-5685-y. PMID: 29968163. Exclusion: E4.

1183. Tu TH, Kuo CH, Huang WC, et al. Effects of smoking on cervical disc arthroplasty. J Neurosurg Spine. 2019 02 01;30(2):168-74. doi: 10.3171/2018.7.SPINE18634. PMID: 31066538. Exclusion: E5.

1184. Tuchman A, Brodke DS, Youssef JA, et al. Autograft versus allograft for cervical spinal fusion. Global spine j. 2017;7(1):59-70. doi: 10.1055/s-0036-1580610. Exclusion: E8.

1185. Tuli SK, Chen P, Eichler ME, et al. Reliability of radiologic assessment of fusion: cervical fibular allograft model. Spine (Phila Pa 1976). 2004 Apr 15;29(8):856-60. doi: 10.1097/00007632-200404150-00007. PMID: 15082984. Exclusion: E2.

1186. Tumialan LM, Pan J, Rodts GE, et al. The safety and efficacy of anterior cervical discectomy and fusion with polyetheretherketone spacer and recombinant human bone morphogenetic protein-2: a review of 200 patients. J Neurosurg Spine. 2008 Jun;8(6):529-35. doi: 10.3171/SPI/2008/8/6/529. PMID: 18518673. Exclusion: E5.

1187. Uematsu Y, Tokuhashi Y, Matsuzaki H. Radiculopathy after laminoplasty of the cervical spine. Spine (Phila Pa 1976). 1998 Oct 1;23(19):2057-62. doi: 10.1097/00007632-199810010-00004. PMID: 9794049. Exclusion: E5.

1188. Ukegawa D, Kawabata S, Sakaki K, et al. Efficacy of biphasic transcranial electric stimulation in intraoperative motor evoked potential monitoring for cervical compression myelopathy. Spine. 2014 Feb 01;39(3):E159-65. doi: 10.1097/BRS.0000000000000082. PMID: 24153163. Exclusion: E3.

1189. Upadhyaya CD, Wu JC, Trost G, et al. Analysis of the three United States Food and Drug Administration investigational device exemption cervical arthroplasty trials. J Neurosurg Spine. 2012 Mar;16(3):216-28. doi: 10.3171/2011.6.SPINE10623. PMID: 22195608. Exclusion: E8.

1190. Upadhyayula PS, Yue JK, Curtis EI, et al. A matched cohort comparison of cervical disc arthroplasty versus anterior cervical discectomy and fusion: Evaluating perioperative outcomes. J Clin Neurosci. 2017 Sep;43:235-9. doi: 10.1016/j.jocn.2017.04.027. PMID: 28511972. Exclusion: E12.

1191. Uribe JS, Sangala JR, Duckworth EA, et al. Comparison between anterior cervical discectomy fusion and cervical corpectomy fusion using titanium cages for reconstruction: analysis of outcome and long-term follow-up. Eur Spine J. 2009 May;18(5):654-62. doi: 10.1007/s00586-009-0897-9. PMID: 19214597. Exclusion: E3.

1192. Vaidya R, Carp J, Sethi A, et al. Complications of anterior cervical discectomy and fusion using recombinant human bone morphogenetic protein-2. Eur Spine J. 2007 Aug;16(8):1257-65. doi: 10.1007/s00586-007-0351-9. PMID: 17387522. Exclusion: E1.

1193. Vaishnav AS, Saville P, McAnany S, et al. Is the likelihood of dysphagia different in patients undergoing one-level versus two-level anterior cervical discectomy and fusion? Spine J. 2020 05;20(5):737-44. doi: 10.1016/j.spinee.2020.01.011. PMID: 32006711. Exclusion: E3.

1194. Vaishnav AS, Saville P, McAnany S, et al. Predictive factors of postoperative dysphagia in single-level anterior cervical discectomy and fusion. Spine. 2019 04 01;44(7):E400-E7. doi: 10.1097/BRS.0000000000002865. PMID: 30889144. Exclusion: E12.

1195. Vakharia RM, Vakharia AM, Ameri B, et al. Hypothyroidism increases 90-day postoperative complications in patients undergoing primary single level anterior cervical disectomy and fusion: a matched control analysis. J. 2018 Jun;4(2):274-80. doi: 10.21037/jss.2018.05.26. PMID: 30069518. Exclusion: E2.

1196. Van de Kelft E, van Vyve M. Diagnostic imaging algorithm for cervical soft disc herniation. J Neurol Neurosurg Psychiatry. 1994 Jun;57(6):724-8. doi: 10.1136/jnnp.57.6.724. PMID: 8006654. Exclusion: E4.

1197. van den Bent MJ, Oosting J, Wouda EJ, et al. Anterior cervical discectomy with or without fusion with acrylate. A randomized trial. Spine (Phila Pa 1976). 1996 Apr 1;21(7):834-9; discussion 40. doi: 10.1097/00007632-199604010-00011. PMID: 8779014. Exclusion: E3 - per email from Shelley 1/10.

1198. van Eck CF, Regan C, Donaldson WF, et al. The revision rate and occurrence of adjacent segment disease after anterior cervical discectomy and fusion: a study of 672 consecutive patients. Spine. 2014 Dec 15;39(26):2143-7. doi: 10.1097/BRS.0000000000000636. PMID: 25271512. Exclusion: E3.

1199. van Geest S, de Vormer AM, Arts MP, et al. Long-term follow-up of clinical and radiological outcome after cervical laminectomy. Eur Spine J. 2015 Apr;24 Suppl 2:229-35. doi: 10.1007/s00586-013-3089-6. PMID: 24221920. Exclusion: E2.

1200. van Geest S, Kuijper B, Oterdoom M, et al. CASINO: surgical or nonsurgical treatment for cervical radiculopathy, a randomised controlled trial. BMC Musculoskelet Disord. 2014 Apr 14;15:129. doi: 10.1186/1471-2474-15-129. PMID: 24731301. Exclusion: E6.

1201. Vanek P, Bradac O, Delacy P, et al. Anterior interbody fusion of the cervical spine with Zero-P spacer: prospective comparative study-clinical and radiological results at a minimum 2 years after surgery. Spine. 2013 Jun 01;38(13):E792-7. doi: 10.1097/BRS.0b013e3182913400. PMID: 23524869. Exclusion: E2.

1202. Vanek P, Bradac O, DeLacy P, et al. Comparison of 3 fusion techniques in the treatment of the degenerative cervical spine disease. Is stand-alone autograft really the "gold standard?": prospective study with 2-year follow-up. Spine. 2012 Sep 01;37(19):1645-51. doi: 10.1097/BRS.0b013e31825413fe. PMID: 22433506. Exclusion: E11.

1203. Vavruch L, Hedlund R, Javid D, et al. A prospective randomized comparison between the cloward procedure and a carbon fiber cage in the cervical spine: a clinical and radiologic study. Spine (Phila Pa 1976). 2002 Aug 15;27(16):1694-701. doi: 10.1097/00007632-200208150-00003. PMID: 12195057. Exclusion: E3.

1204. Vedantam A, Jonathan A, Rajshekhar V. Association of magnetic resonance imaging signal changes and outcome prediction after surgery for cervical spondylotic myelopathy. J Neurosurg Spine. 2011 Dec;15(6):660-6. doi: 10.3171/2011.8.SPINE11452. PMID: 21923236. Exclusion: E9.

1205. Veeravagu A, Cole T, Jiang B, et al. Revision rates and complication incidence in single- and multilevel anterior cervical discectomy and fusion procedures: an administrative database study. Spine J. 2014 Jul 01;14(7):1125-31. doi: 10.1016/j.spinee.2013.07.474. PMID: 24126076. Exclusion: E3.

1206. Villavicencio AT, Babuska JM, Ashton A, et al. Prospective, randomized, double-blind clinical study evaluating the correlation of clinical outcomes and cervical sagittal alignment. Neurosurgery. 2011 May;68(5):1309-16; discussion 16. doi: 10.1227/NEU.0b013e31820b51f3. PMID: 21792113. Exclusion: E3.

1207. Villavicencio AT, Nelson EL, Rajpal S, et al. Local retropharyngeal space anesthetic for dysphagia reduction after anterior cervical discectomy and fusion surgery: a single-center, prospective, randomized, double-blinded, placebo-controlled clinical trial. Clin Neurosurg. 2020 to 2020-09-16;67(SUPPL 1):244-p. doi: 10.1093/neuros/nyaa447708. Exclusion: E6.

1208. Villavicencio AT, Nelson EL, Rajpal S, et al. Prospective, randomized, blinded clinical trial comparing PEEK and allograft spacers in patients undergoing anterior cervical discectomy and fusion surgeries. Spine (Phila Pa 1976). 2022 Aug 1;47(15):1043-54. doi: 10.1097/BRS.0000000000004361. PMID: 35881014. Exclusion: E2.

1209. Villavicencio AT, Rajpal S, Nelson EL, et al. Local retropharyngeal space anesthetic for dysphagia reduction after anterior cervical discectomy and fusion surgery: a single-center, prospective, randomized, double-blinded, placebo-controlled clinical trial. World Neurosurg. 2021 02;146:e1377-e83. doi: 10.1016/j.wneu.2020.12.016. PMID: 33309893. Exclusion: E2.

1210. Virkar N, Bhilare P, Hadgaonkar S, et al. Standalone cage versus anchored cage for anterior cervical discectomy and fusion: a comparative analysis of clinical and radiological outcomes. Int Orthop. 2022 10;46(10):2339-45. doi: 10.1007/s00264-022-05493-z. PMID: 35790547. Exclusion: E3.

1211. Viswanathan VK, Shetty AP, Sindhiya N, et al. Prospective study to identify the clinical and radiologic factors predictive of pseudarthrosis development in patients with osteoporotic vertebral fractures. World Neurosurg. 2022 Nov;167:e350-e9. doi: 10.1016/j.wneu.2022.08.011. PMID: 35961591. Exclusion: E1.

1212. Vleggeert-Lankamp CLA, Janssen TMH, van Zwet E, et al. The NECK trial: Effectiveness of anterior cervical discectomy with or without interbody fusion and arthroplasty in the treatment of cervical disc herniation; a double-blinded randomized controlled trial. Spine J. 2019 06;19(6):965-75. doi: 10.1016/j.spinee.2018.12.013. PMID: 30583108. Exclusion: E2.

1213. Vonck C, Tanenbaum J, Bomberger T, et al. Short-term outcomes following posterior cervical fusion among octogenarians with cervical spondylotic myelopathy: a NSQIP database analysis. Spine J. 2018 Sep;18(9):1603-11. doi: 10.1016/j.spinee.2018.02.012. PMID: 29454135. Exclusion: E5.

1214. Vorsic M, Bunc G. ProDisc-C versus fusion with Cervios chronOS prosthesis in cervical degenerative disc disease: Is there a difference at 12 months? Evid. 2010 May;1(1):51-6. doi: 10.1055/s-0028-1100894. PMID: 23544025. Exclusion: E11.

1215. Wada E, Ohmura M, Yonenobu K. Intramedullary changes of the spinal cord in cervical spondylotic myelopathy. Spine (Phila Pa 1976). 1995 Oct 15;20(20):2226-32. doi: 10.1097/00007632-199510001-00009. PMID: 8545717. Exclusion: E9.

1216. Wada E, Yonenobu K, Suzuki S, et al. Can intramedullary signal change on magnetic resonance imaging predict surgical outcome in cervical spondylotic myelopathy? Spine (Phila Pa 1976). 1999 Mar 1;24(5):455-61; discussion 62. doi: 10.1097/00007632-199903010-00009. PMID: 10084183. Exclusion: E9.

1217. Wada K, Imagama S, Matsuyama Y, et al. Comparison of intraoperative neuromonitoring accuracies and procedures associated with alarms in anterior versus posterior fusion for cervical spinal disorders: a prospective multi-institutional cohort study. Medicine (Baltimore). 2022 Dec 9;101(49):e31846. doi: 10.1097/MD.0000000000031846. PMID: 36626536. Exclusion: E1.

1218. Wahdan M, Taema R, Elawady M. Dynamic cervical implant (DCI) versus anterior cervical discectomy and fusion(ACDF) for the treatment of single-level cervical degenerative disc disease (DDD): an RCT. Egyptian Spine Journal. 2022. Exclusion: E6.

1219. Wahood W, Yolcu YU, Kerezoudis P, et al. Artificial discs in cervical disc replacement: a meta-analysis for comparison of long-term outcomes. World Neurosurg. 2020 Feb;134:598-613.e5. doi: 10.1016/j.wneu.2019.10.032. PMID: 31627001. Exclusion: E3.

1220. Wan J, Xu TT, Shen QF, et al. Influence of hinge position on the effectiveness of open-door expansive laminoplasty for cervical spondylotic myelopathy. Chinese journal of traumatology - english edition. 2011;14(1):36-41p. doi: 10.3760/cma.j.issn.1008-1275.2011.01.007. Exclusion: E3.

1221. Wang B, Lu G, Kuang L. Anterior cervical discectomy and fusion with stand-alone anchored cages versus posterior laminectomy and fusion for four-level cervical spondylotic myelopathy: a retrospective study with 2-year follow-up. BMC Musculoskelet Disord. 2018 Jul 12;19(1):216. doi: 10.1186/s12891-018-2136-1. PMID: 30001719. Exclusion: E11 - email from Tamara 12/9.

1222. Wang C, Zhang Y, Yuan W. Early clinical outcomes and radiographic features after treatment of cervical degenerative disk disease with the new zero-profile implant: a 1-year follow-up retrospective study. Clin Spine Surg. 2016 Mar;29(2):E73-E9. doi: 10.1097/BSD.0000000000000101. PMID: 26889995. Exclusion: E3.

1223. Wang F, Wang P, Miao DC, et al. Different surgical approaches for the treatment of adjacent segment diseases after anterior cervical fusion: a retrospective study of 49 patients. Medicine (Baltimore). 2017 Jun;96(23):e7042. doi: 10.1097/MD.0000000000007042. PMID: 28591037. Exclusion: E7.

1224. Wang H, Meng Y, Liu H, et al. A comparison of 2 anterior hybrid techniques for 3-level cervical degenerative disc disease. Med Sci Monit. 2020 Nov 06;26:e927972. doi: 10.12659/MSM.927972. PMID: 33154343. Exclusion: E3.

1225. Wang J, Li H, Yang B. Predictive nomogram for clinical prognosis in cervical spondylotic myelopathy with intramedullary T2-weighted increased signal intensity: a novel digital tool for patient prognosis education. Frontiers in Public Health. 2022;10:898242. doi: 10.3389/fpubh.2022.898242. PMID: 35712279. Exclusion: E2.

1226. Wang J, Wo J, Wen J, et al. Laminoplasty versus laminectomy with fusion for treatment of multilevel cervical compressive myelopathy: an updated meta-analysis. Postgrad Med J. 2021 Jun 02;2:02. doi: 10.1136/postgradmedj-2020-139667. PMID: 34083368. Exclusion: E8.

1227. Wang JC, McDonough PW, Endow K, et al. The effect of cervical plating on single-level anterior cervical discectomy and fusion. J Spinal Disord. 1999 Dec;12(6):467-71. PMID: 10598986. Exclusion: E11.

1228. Wang JC, McDonough PW, Endow KK, et al. A comparison of fusion rates between single-level cervical corpectomy and two-level discectomy and fusion. J Spinal Disord. 2001 Jun;14(3):222-5. doi: 10.1097/00002517-200106000-00006. PMID: 11389372. Exclusion: E3.

1229. Wang JY, Zhang CL, Zhai FY, et al. Minimally invasive cervical laminoplasty versus single-door laminoplasty for treatment of cervical spondylotic myelopathy. Chinese journal of tissue engineering research. 2014;18(9):1380-5p. doi: 10.3969/j.issn.2095-4344.2014.09.012. Exclusion: E10.

1230. Wang KF, Duan S, Zhu ZQ, et al. Clinical and radiologic features of 3 reconstructive procedures for the surgical management of patients with bilevel cervical degenerative disc disease at a minimum follow-up period of 5 years: a comparative study. World Neurosurg. 2018 May;113:e70-e6. doi: 10.1016/j.wneu.2018.01.157. PMID: 29408574. Exclusion: E11.

1231. Wang KY, Idowu O, Thompson CB, et al. Tract-specific diffusion tensor imaging in cervical spondylotic myelopathy before and after decompressive spinal surgery: Preliminary results. Clin Neuroradiol. 2017 2017/03/01;27(1):61-9. doi: 10.1007/s00062-015-0418-7. Exclusion: E7 - per Shelley's email on 12/15.

1232. Wang M, Chou D, Chang CC, et al. Anterior cervical discectomy and fusion performed using structural allograft or polyetheretherketone: pseudarthrosis and revision surgery rates with minimum 2-year follow-up. J Neurosurg Spine. 2019 Dec 13;32(4):1-8. doi: 10.3171/2019.9.SPINE19879. PMID: 31835252. Exclusion: E3 harms.

1233. Wang MC, Chan L, Maiman DJ, et al. Complications and mortality associated with cervical spine surgery for degenerative disease in the United States. Spine. 2007 Feb 01;32(3):342-7. doi: 10.1097/01.brs.0000254120.25411.ae. PMID: 17268266. Exclusion: E3.

1234. Wang MY, Shah S, Green BA. Clinical outcomes following cervical laminoplasty for 204 patients with cervical spondylotic myelopathy. Surg Neurol. 2004 Dec;62(6):487-92; discussion 92-3. doi: 10.1016/j.surneu.2004.02.040. PMID: 15576110. Exclusion: E5.

1235. Wang Q, Cai J, Tao Y, et al. Comparison of clinical outcomes of anterior versus posterior surgery in treating multi-segmental cervical degeneration. Cell Biochem Biophys. 2015 Mar;71(2):1077-82. doi: 10.1007/s12013-014-0311-z. PMID: 25331673. Exclusion: E11.

1236. Wang QL, Tu ZM, Hu P, et al. Long-term results comparing cervical disc arthroplasty to anterior cervical discectomy and fusion: a systematic review and meta-analysis of randomized controlled trials. Orthop Surg. 2020 Feb;12(1):16-30. doi: 10.1111/os.12585. PMID: 31863642. Exclusion: E8.

1237. Wang S, Jiang S, Jiang L, et al. Axial pain after posterior cervical spine surgery: a systematic review. Eur Spine J. 2011 Feb;20(2):185-94. doi: 10.1007/s00586-010-1600-x. PMID: 20941514. Exclusion: E8.

1238. Wang S, Tian Y. Exploration of the Intraoperative Motor Evoked Potential. Spine. 2016 Mar;41(6):470-5. doi: 10.1097/BRS.0000000000001240. PMID: 26966972. Exclusion: E2.

1239. Wang S, Tian Y, Lin X, et al. Comparison of intraoperative neurophysiologic monitoring outcomes between cervical and thoracic spine surgery. Eur Spine J. 2017 09;26(9):2404-9. doi: 10.1007/s00586-017-5194-4. PMID: 28620788. Exclusion: E2.

1240. Wang S, Tian Y, Wang C, et al. Prognostic value of intraoperative MEP signal improvement during surgical treatment of cervical compressive myelopathy. Eur Spine J. 2016 06;25(6):1875-80. doi: 10.1007/s00586-016-4477-5. PMID: 26951171. Exclusion: E3.

1241. Wang T, Tian XM, Liu SK, et al. Prevalence of complications after surgery in treatment for cervical compressive myelopathy: a meta-analysis for last decade. Medicine (Baltimore). 2017 Mar;96(12):e6421. doi: 10.1097/MD.0000000000006421. PMID: 28328846. Exclusion: E8.

1242. Wang T, Wang H, Liu S, et al. Anterior cervical discectomy and fusion versus anterior cervical corpectomy and fusion in multilevel cervical spondylotic myelopathy: a meta-analysis. Medicine (Baltimore). 2016 Dec;95(49):e5437. doi: 10.1097/MD.0000000000005437. PMID: 27930523. Exclusion: E3.

1243. Wang T, Wang H, Liu S, et al. Incidence of C5 nerve root palsy after cervical surgery: a meta-analysis for last decade. Medicine (Baltimore). 2017 Nov;96(45):e8560. doi: 10.1097/MD.0000000000008560. PMID: 29137073. Exclusion: E3.

1244. Wang T, Yang SD, Huang WZ, et al. Factors predicting venous thromboembolism after spine surgery. Medicine (Baltimore). 2016 Dec;95(52):e5776. doi: 10.1097/MD.0000000000005776. PMID: 28033299. Exclusion: E1.

1245. Wang TY, Lubelski D, Abdullah KG, et al. Rates of anterior cervical discectomy and fusion after initial posterior cervical foraminotomy. Spine J. 2015 May 01;15(5):971-6. doi: 10.1016/j.spinee.2013.05.042. PMID: 23871122. Exclusion: E3.

1246. Wang W, Wang LM, Wang WD, et al. Single level artificial disc replacement versus anterior cervical fusion: range of motion and stability of cervical vertebra. Chinese journal of tissue engineering research. 2014;18(44):7083-7p. doi: 10.3969/j.issn.2095-4344.2014.44.006. Exclusion: E6.

1247. Wang X, Chen Y, Chen D, et al. Removal of posterior longitudinal ligament in anterior decompression for cervical spondylotic myelopathy. J Spinal Disord Tech. 2009;22(6):404-7p. doi: 10.1097/BSD.0b013e318187039f. Exclusion: E2.

1248. Wang Y, Cai B, Zhang XS, et al. [Clinical outcomes of single level Bryan cervical disc arthroplasty: a prospective controlled study]. Chung Hua Wai Ko Tsa Chih. 2008 Mar 01;46(5):328-32. PMID: 18785525. Exclusion: E2.

1249. Wang Y, Wei R, Subedi D, et al. Tantalum fusion device in anterior cervical discectomy and fusion for treatment of cervical degeneration disease: a systematic review and meta-analysis. Clin Spine Surg. 2020 04;33(3):111-9. doi: 10.1097/BSD.0000000000000875. PMID: 31634174. Exclusion: E8.

1250. Wang YP, Zhang W, An JL, et al. A comparative study for the usage of Fidji cervical cages after multilevel anterior cervical discectomy and fusion. Injury. 2019 Apr;50(4):908-12. doi: 10.1016/j.injury.2019.03.029. PMID: 30952496. Exclusion: E11.

1251. Wang Z, Jiang W, Li X, et al. The application of zero-profile anchored spacer in anterior cervical discectomy and fusion. Eur Spine J. 2015 Jan;24(1):148-54. doi: 10.1007/s00586-014-3628-9. PMID: 25337859. Exclusion: E11.

1252. Wang Z, Jiang W, Zhang Z, et al. [Comparison of ROI-C and traditional cage with anterior plating for anterior cervical discectomy and fusion]. Chung Hua Wai Ko Tsa Chih. 2014 Jun;52(6):425-30. PMID: 25219557. Exclusion: E10.

1253. Wang Z, Zhou L, Lin B, et al. Risk factors for non-fusion segment disease after anterior cervical spondylosis surgery: a retrospective study with long-term follow-up of 171 patients. J. 2018 Feb 02;13(1):27. doi: 10.1186/s13018-018-0717-1. PMID: 29394936. Exclusion: E3.

1254. Wang Z, Zhu R, Yang H, et al. Zero-profile implant (Zero-p) versus plate cage benezech implant (PCB) in the treatment of single-level cervical spondylotic myelopathy. BMC Musculoskelet Disord. 2015 Oct 12;16:290. doi: 10.1186/s12891-015-0746-4. PMID: 26459625. Exclusion: E11.

1255. Warren D, Andres T, Hoelscher C, et al. Cost-utility analysis modeling at 2-year follow-up for cervical disc arthroplasty versus anterior cervical discectomy and fusion: a single-center contribution to the randomized controlled trial. Int J Spine Surg. 2013;7:e58-66. doi: 10.1016/j.ijsp.2013.05.001. PMID: 25694905. Exclusion: E5.

1256. Watters WC, 3rd, Levinthal R. Anterior cervical discectomy with and without fusion. Results, complications, and long-term follow-up. Spine (Phila Pa 1976). 1994 Oct 15;19(20):2343-7. doi: 10.1097/00007632-199410150-00016. PMID: 7846581. Exclusion: E3 - per Shelley's email on 12/14.

1257. Wei L, Cao P, Xu C, et al. Comparison of the prognostic value of different quantitative measurements of increased signal intensity on T2-weighted MRI in cervical spondylotic myelopathy. World Neurosurg. 2018 Oct;118:e505-e12. doi: 10.1016/j.wneu.2018.06.224. PMID: 30257303. Exclusion: E4.

1258. Wei L, Wei Y, Tian Y, et al. Does three-grade classification of T2-weighted increased signal intensity reflect the severity of myelopathy and surgical outcomes in patients with cervical compressive myelopathy? A systematic review and meta-analysis. Neurosurg Rev. 2020 Jun;43(3):967-76. doi: 10.1007/s10143-019-01106-3. PMID: 31053986. Exclusion: E4.

1259. Wei L, Xu C, Dong M, et al. Application of a new integrated low-profile anterior plate and cage system in single-level cervical spondylosis: a preliminary retrospective study. J. 2022 Jan 15;17(1):26. doi: 10.1186/s13018-022-02917-9. PMID: 35033153. Exclusion: E11.

1260. Wei Z, Zhang Y, Yang S, et al. Retrospective analysis of sagittal balance parameters and clinical efficacy after short-segment anterior cervical spine surgery with different fusion devices. Int J Gen Med. 2022;15:3237-46. doi: 10.2147/IJGM.S340877. PMID: 35345776. Exclusion: E11.

1261. Wei-bing X, Wun-Jer S, Gang L, et al. Reconstructive techniques study after anterior decompression of multilevel cervical spondylotic myelopathy. J Spinal Disord Tech. 2009 Oct;22(7):511-5. doi: 10.1097/BSD.0b013e3181a6a1fa. PMID: 20075815. Exclusion: E3.

1262. Wen YD, Jiang WM, Yang HL, et al. Exploratory meta-analysis on dose-related efficacy and complications of rhBMP-2 in anterior cervical discectomy and fusion: 1,539,021 cases from 2003 to 2017 studies. J Orthop Translat. 2020 Sep;24:166-74. doi: 10.1016/j.jot.2020.01.002. PMID: 33101967. Exclusion: E3.

1263. Westermaier T, Doerr C, Stetter C, et al. Influence of myelography and postmyelographic CT on therapeutic decisions in degenerative diseases of the cervical spine. Clin Spine Surg. 2017 Jun;30(5):E656-E61. doi: 10.1097/BSD.0000000000000344. PMID: 28525493. Exclusion: E4.

1264. Wewel JT, Brahimaj BC, Kasliwal MK, et al. Perioperative complications with multilevel anterior and posterior cervical decompression and fusion. J Neurosurg Spine. 2019 Sep 20;32(1):1-6. doi: 10.3171/2019.6.SPINE198. PMID: 31710423. Exclusion: E2.

1265. Wewel JT, Kasliwal MK, Adogwa O, et al. Fusion rate following three- and four-level ACDF using allograft and segmental instrumentation: a radiographic study. J Clin Neurosci. 2019 Apr;62:142-6. doi: 10.1016/j.jocn.2018.11.040. PMID: 30692036. Exclusion: E3.

1266. White BD, Fitzgerald JJ. To graft or not to graft: rationalizing choice in anterior cervical discectomy. Br J Neurosurg. 2005 Apr;19(2):148-54. doi: 10.1080/02688690500145605. PMID: 16120518. Exclusion: E11.

1267. Whitmore RG, Ghogawala Z, Petrov D, et al. Functional outcome instruments used for cervical spondylotic myelopathy: interscale correlation and prediction of preference-based quality of life. Spine J. 2013 Aug;13(8):902-7. doi: 10.1016/j.spinee.2012.11.058. PMID: 23523443. Exclusion: E2.

1268. Wigfield C, Gill S, Nelson R, et al. Influence of an artificial cervical joint compared with fusion on adjacent-level motion in the treatment of degenerative cervical disc disease. J Neurosurg. 2002 Jan;96(1 Suppl):17-21. doi: 10.3171/spi.2002.96.1.0017. PMID: 11795709. Exclusion: E9.

1269. Wigfield CC, Nelson RJ. Nonautologous interbody fusion materials in cervical spine surgery: how strong is the evidence to justify their use? Spine (Phila Pa 1976). 2001 Mar 15;26(6):687-94. doi: 10.1097/00007632-200103150-00027. PMID: 11246387. Exclusion: E8.

1270. Wilkinson BG, Chang JT, Glass NA, et al. Intraoperative spinal cord monitoring does not decrease new postoperative neurological deficits in patients with cervical radiculopathy or spondylotic myelopathy undergoing one or two level anterior cervical discectomy and fusion. Iowa Orthop J. 2021;41(1):95-102. PMID: 34552410. Exclusion: E11.

1271. Wilson JRF, Badhiwala JH, Jiang F, et al. The impact of older age on functional recovery and quality of life outcomes after surgical decompression for degenerative cervical myelopathy: results from an ambispective, propensity-matched analysis from the csm-na and csm-i international, multi-center studies. J. 2019 Oct 17;8(10):17. doi: 10.3390/jcm8101708. PMID: 31627303. Exclusion: E3.

1272. Witzmann A, Hejazi N, Krasznai L. Posterior cervical foraminotomy. A follow-up study of 67 surgically treated patients with compressive radiculopathy. Neurosurg Rev. 2000 Dec;23(4):213-7. doi: 10.1007/pl00011957. PMID: 11153550. Exclusion: E5 - per Shelley's email on 12/14.

1273. Woiciechowsky C. Distractable vertebral cages for reconstruction after cervical corpectomy. Spine. 2005 Aug 01;30(15):1736-41. doi: 10.1097/01.brs.0000172158.31437.ce. PMID: 16094275. Exclusion: E2.

1274. Woo JB, Son DW, Lee SH, et al. Risk factors of allogenous bone graft collapse in two-level anterior cervical discectomy and fusion. J. 2019;62(4):450-7. doi: 10.3340/jkns.2019.0008. Exclusion: E7.

1275. Wu AM, Xu H, Mullinix KP, et al. Minimum 4-year outcomes of cervical total disc arthroplasty versus fusion: a meta-analysis based on prospective randomized controlled trials. Medicine (Baltimore). 2015 Apr;94(15):e665. doi: 10.1097/MD.0000000000000665. PMID: 25881841. Exclusion: E8.

1276. Wu JC, Chen YC, Huang WC. Ossification of the posterior longitudinal ligament in cervical spine: prevalence, management, and prognosis. Neurospine. 2018 Mar;15(1):33-41. doi: 10.14245/ns.1836084.042. PMID: 29656627. Exclusion: E6.

1277. Wu JC, Huang WC, Tsai HW, et al. Differences between 1- and 2-level cervical arthroplasty: more heterotopic ossification in 2-level disc replacement: Clinical article. J Neurosurg Spine. 2012 Jun;16(6):594-600. doi: 10.3171/2012.2.SPINE111066. PMID: 22443547. Exclusion: E3.

1278. Wu JC, Liu L, Chen YC, et al. Ossification of the posterior longitudinal ligament in the cervical spine: an 11-year comprehensive national epidemiology study. Neurosurg. 2011 Mar;30(3):E5. doi: 10.3171/2010.12.FOCUS10268. PMID: 21434821. Exclusion: E5.

1279. Wu JC, Meyer SA, Gandhoke G, et al. PRESTIGE Cervical Arthroplasty: Past, Present, and Future. Seminars in Spine Surgery. 2012;24(1):14-9. doi: 10.1053/j.semss.2011.11.004. Exclusion: E3.

1280. Wu TK, Wang BY, Deng MD, et al. A comparison of anterior cervical discectomy and fusion combined with cervical disc arthroplasty and cervical disc arthroplasty for the treatment of skip-level cervical degenerative disc disease: a retrospective study. Medicine (Baltimore). 2017 Oct;96(41):e8112. doi: 10.1097/MD.0000000000008112. PMID: 29019878. Exclusion: E11.

1281. Wu TK, Wang BY, Meng Y, et al. Multilevel cervical disc replacement versus multilevel anterior discectomy and fusion: a meta-analysis. Medicine (Baltimore). 2017 Apr;96(16):e6503. doi: 10.1097/MD.0000000000006503. PMID: 28422837. Exclusion: E8.

1282. Wu W, Thuomas KA, Hedlund R, et al. Degenerative changes following anterior cervical discectomy and fusion evaluated by fast spin-echo MR imaging. Acta Radiol. 1996 Sep;37(5):614-7. doi: 10.1177/02841851960373P239. PMID: 8915262. Exclusion: E3.

1283. Wu W, Yang Y, Liu H, et al. New dynamic plate system combined with titanium mesh cage and bone graft in the treatment of cervical spondylosis. Turk. 2016;26(5):750-7. doi: 10.5137/1019-5149.JTN.13141-14.2. PMID: 27438620. Exclusion: E3.

1284. Wu WJ, Jiang LS, Liang Y, et al. Cage subsidence does not, but cervical lordosis improvement does affect the long-term results of anterior cervical fusion with stand-alone cage for degenerative cervical disc disease: a retrospective study. Eur Spine J. 2012 Jul;21(7):1374-82. doi: 10.1007/s00586-011-2131-9. PMID: 22205113. Exclusion: E3.

1285. Xia B, Xie Y, Hu S, et al. Effect of auricular point acupressure on axial neck pain after anterior cervical discectomy and fusion: a randomized controlled trial. Pain Med. 2018 01 01;19(1):193-201. doi: 10.1093/pm/pnx112. PMID: 28505292. Exclusion: E2.

1286. Xia XP, Chen HL, Cheng HB. Prevalence of adjacent segment degeneration after spine surgery: a systematic review and meta-analysis. Spine. 2013 Apr 01;38(7):597-608. doi: 10.1097/BRS.0b013e318273a2ea. PMID: 22986837. Exclusion: E1.

1287. Xia Y, Xu R, Kosztowski TA, et al. Reoperation for proximal adjacent segment pathology in posterior cervical fusion constructs that fuse to C2 vs C3. Neurosurgery. 2019 09 01;85(3):E520-E6. doi: 10.1093/neuros/nyz019. PMID: 30860261. Exclusion: E3.

1288. Xia YP, Zhang XL, Li HN, et al. Clinical validity of hinge position to expansive semi open-door laminoplasty. Zhonghua wai ke za zhi [Chinese journal of surgery]. 2010;48(16):1229-33p. Exclusion: E10.

1289. Xiao B, Wu B, Rong T, et al. Clinical impact of 3-level anterior cervical decompression and fusion (ACDF) on the occipito-atlantoaxial complex: a retrospective study of patients who received a zero-profile anchored spacer versus cage-plate construct. Eur Spine J. 2021 12;30(12):3656-65. doi: 10.1007/s00586-021-06974-2. PMID: 34453599. Exclusion: E3.

1290. Xiao S, Liang Z, Wei W, et al. Zero-profile anchored cage reduces risk of postoperative dysphagia compared with cage with plate fixation after anterior cervical discectomy and fusion. Eur Spine J. 2017 04;26(4):975-84. doi: 10.1007/s00586-016-4914-5. PMID: 28004243. Exclusion: E8.

1291. Xiao SW, Jiang H, Yang LJ, et al. Anterior cervical discectomy versus corpectomy for multilevel cervical spondylotic myelopathy: a meta-analysis. Eur Spine J. 2015 Jan;24(1):31-9. doi: 10.1007/s00586-014-3607-1. PMID: 25326181. Exclusion: E3.

1292. Xiao Y, Shi Y, Li Ha, et al. Application of Zero-P on anterior cervical decompression and bone fusion. Int J Clin Exp Med. 2017;10(4):7077-83. Exclusion: E3.

1293. Xie JC, Hurlbert RJ. Discectomy versus discectomy with fusion versus discectomy with fusion and instrumentation: a prospective randomized study. Neurosurgery. 2007 Jul;61(1):107-16; discussion 16-7. doi: 10.1227/01.neu.0000279730.44016.da. PMID: 17621025. Exclusion: E3.

1294. Xie L, Liu M, Ding F, et al. Cervical disc arthroplasty (CDA) versus anterior cervical discectomy and fusion (ACDF) in symptomatic cervical degenerative disc diseases (CDDDs): an updated meta-analysis of prospective randomized controlled trials (RCTs). Springerplus. 2016;5(1):1188. doi: 10.1186/s40064-016-2851-8. PMID: 27516926. Exclusion: E8.

1295. Xie S, Sun T, Tian R, et al. [Analysis of risk factors of axial symptoms after single door laminoplasty for cervical myelopathy]. Chinese journal of reparative and reconstructive surgery. 2014 May;28(5):620-4. PMID: 25073285. Exclusion: E10.

1296. Xing D, Ma XL, Ma JX, et al. A meta-analysis of cervical arthroplasty compared to anterior cervical discectomy and fusion for single-level cervical disc disease. J Clin Neurosci. 2013 Jul;20(7):970-8. doi: 10.1016/j.jocn.2012.03.046. PMID: 23375397. Exclusion: E8.

1297. Xiong Y, Yang YD, Yu X, et al. Comparison of 2-year follow-up results of the hybrid surgery using Mobi-C combined with ROI-C and anterior cervical discectomy and fusion for the treatment of contiguous two-level cervical degenerative disc diseases. J Clin Neurosci. 2020 Mar;73:42-7. doi: 10.1016/j.jocn.2020.01.090. PMID: 32029368. Exclusion: E11.

1298. Xu B, Ma JX, Tian JH, et al. Indirect meta-analysis comparing clinical outcomes of total cervical disc replacements with fusions for cervical degenerative disc disease. Sci. 2017 05 11;7(1):1740. doi: 10.1038/s41598-017-01865-3. PMID: 28496111. Exclusion: E8.

1299. Xu C, Wang R, Li J, et al. Intervertebral-spreader-assisted anterior cervical discectomy and fusion prevents postoperative axial pain by alleviating facet joint pressure. J. 2022 Feb 15;17(1):91. doi: 10.1186/s13018-022-02983-z. PMID: 35168657. Exclusion: E3.

1300. Xu J, He Y, Li Y, et al. Incidence of subsidence of seven intervertebral devices in anterior cervical discectomy and fusion: a network meta-analysis. World Neurosurg. 2020 09;141:479-89.e4. doi: 10.1016/j.wneu.2020.03.130. PMID: 32251812. Exclusion: E8.

1301. Xu R, Bydon M, Macki M, et al. Adjacent segment disease after anterior cervical discectomy and fusion: clinical outcomes after first repeat surgery versus second repeat surgery. Spine. 2014 Jan 15;39(2):120-6. doi: 10.1097/BRS.0000000000000074. PMID: 24150434. Exclusion: E3.

1302. Xu R, Ritzl EK, Sait M, et al. A role for motor and somatosensory evoked potentials during anterior cervical discectomy and fusion for patients without myelopathy: analysis of 57 consecutive cases. Surg Neurol Int. 2011;2:133. doi: 10.4103/2152-7806.85606. PMID: 22059128. Exclusion: E1.

1303. Xu S, Liang Y, Zhu Z, et al. Adjacent segment degeneration or disease after cervical total disc replacement: a meta-analysis of randomized controlled trials. J. 2018 Oct 03;13(1):244. doi: 10.1186/s13018-018-0940-9. PMID: 30285807. Exclusion: E8.

1304. Xu Z, Rao H, Zhang L, et al. Anterior cervical discectomy and fusion versus hybrid decompression and fusion for the treatment of 3-level cervical spondylotic myelopathy: a comparative analysis of cervical sagittal balance and outcomes. World Neurosurg. 2019 Dec;132:e752-e8. doi: 10.1016/j.wneu.2019.08.022. PMID: 31415890. Exclusion: E3.

1305. Yadav YR, Parihar V, Ratre S, et al. Endoscopic anterior decompression in cervical disc disease. Neurol India. 2014 Jul-Aug;62(4):417-22. doi: 10.4103/0028-3886.141287. PMID: 25237949. Exclusion: E3.

1306. Yagi M, Ninomiya K, Kihara M, et al. Long-term surgical outcome and risk factors in patients with cervical myelopathy and a change in signal intensity of intramedullary spinal cord on Magnetic Resonance imaging. J Neurosurg Spine. 2010 Jan;12(1):59-65. doi: 10.3171/2009.5.Spine08940. PMID: 20043766. Exclusion: E11.

1307. Yahanda AT, Pennicooke B, Ray WZ, et al. Pharyngoesophageal damage from hardware extrusion at an average of 7.5 years after anterior cervical diskectomy and fusion: a Case series, discussion of risk factors, and guide for management. World Neurosurg. 2022 Apr;160:e189-e98. doi: 10.1016/j.wneu.2021.12.110. PMID: 34990840. Exclusion: E7.

1308. Yamagata T, Naito K, Arima H, et al. A minimum 2-year comparative study of autologous cancellous bone grafting versus beta-tricalcium phosphate in anterior cervical discectomy and fusion using a rectangular titanium stand-alone cage. Neurosurg Rev. 2016 Jul;39(3):475-82. doi: 10.1007/s10143-016-0714-y. PMID: 27098659. Exclusion: E11.

1309. Yamagata T, Naito K, Yoshimura M, et al. Influence of prevertebral soft tissue swelling on dysphagia after anterior cervical discectomy and fusion using a rectangular titanium stand-alone cage. J Craniovertebr Junction Spine. 2017 Jul-Sep;8(3):179-86. doi: 10.4103/jcvjs.JCVJS_57_17. PMID: 29021668. Exclusion: E3.

1310. Yan B, Nie L. Clinical comparison of Zero-profile interbody fusion device and anterior cervical plate interbody fusion in treating cervical spondylosis. Int J Clin Exp Med. 2015;8(8):13854-8. PMID: 26550337. Exclusion: E3.

1311. Yan SZ, Di J, Shen Y. Adjacent segment degeneration following anterior cervical discectomy and fusion versus the bryan cervical disc arthroplasty. Med Sci Monit. 2017 Jun 02;23:2692-700. doi: 10.12659/msm.905178. PMID: 28574978. Exclusion: E11.

1312. Yang B, Li H, Zhang T, et al. The incidence of adjacent segment degeneration after cervical disc arthroplasty (CDA): a meta analysis of randomized controlled trials. PLoS ONE. 2012;7(4):e35032. doi: 10.1371/journal.pone.0035032. PMID: 22558112. Exclusion: E8.

1313. Yang DS, Patel SA, DiSilvestro KJ, et al. Postoperative complication rates and hazards-model survival analysis of revision surgery following occipitocervical and atlanto-axial fusion. N Am Spine Soc J. 2020 Oct;3:100017. doi: 10.1016/j.xnsj.2020.100017. PMID: 35141587. Exclusion: E1.

1314. Yang F, Tan MS, Yi P, et al. [Clinical study on spinal cord decompression combined with traditional Chinese medicine for the treatment of cervical spondylotic myelopathy]. Zhongguo Gu Shang. 2018 Jan 25;31(1):30-6. doi: 10.3969/j.issn.1003-0034.2018.01.006. PMID: 29533034. Exclusion: E10.

1315. Yang H, Chen D, Wang X, et al. Zero-profile integrated plate and spacer device reduces rate of adjacent-level ossification development and dysphagia compared to ACDF with plating and cage system. Arch Orthop Trauma Surg. 2015 Jun;135(6):781-7. doi: 10.1007/s00402-015-2212-z. PMID: 25851405. Exclusion: E11.

1316. Yang H, Gao C, Lu X, et al. Exclusion of ossified ligaments behind C2 vertebra combined with anterior controllable antedisplacement and fusion for cervical ossification of the posterior longitudinal ligament extending to C2 segment. World Neurosurg. 2021 02;146:e1351-e9. doi: 10.1016/j.wneu.2020.12.015. PMID: 33307264. Exclusion: E3.

1317. Yang H, Sun J, Shi J, et al. In situ decompression to spinal cord during anterior controllable antedisplacement fusion treating degenerative kyphosis with stenosis: Surgical outcomes and analysis of c5 nerve palsy based on 49 patients. World Neurosurg. 2018 Jul;115:e501-e8. doi: 10.1016/j.wneu.2018.04.078. PMID: 29689396. Exclusion: E7.

1318. Yang H, Yang Y, Shi J, et al. Anterior controllable antedisplacement fusion as a choice for degenerative cervical kyphosis with stenosis: preliminary clinical and radiologic results. World Neurosurg. 2018 Oct;118:e562-e9. doi: 10.1016/j.wneu.2018.06.239. PMID: 30257309. Exclusion: E7.

1319. Yang HY, Zhang YG, Zhao D, et al. A new posterior extensor attachment-point reconstruction technique for cervical spondylotic myelopathy involving C2 segment: clinical outcome and safety. J Neurol Surg A Cent Eur Neurosurg. 2021 Mar;82(2):169-75. doi: 10.1055/s-0040-1719102. PMID: 33352613. Exclusion: E11.

1320. Yang JS, Chu L, Chen L, et al. Anterior or posterior approach of full-endoscopic cervical discectomy for cervical intervertebral disc herniation? A comparative cohort study. Spine. 2014 Oct 01;39(21):1743-50. doi: 10.1097/BRS.0000000000000508. PMID: 25010095. Exclusion: E11.

1321. Yang L, Gu Y, Liang L, et al. Stand-alone anchored spacer versus anterior plate for multilevel anterior cervical diskectomy and fusion. Orthopedics. 2012 Oct;35(10):e1503-10. doi: 10.3928/01477447-20120919-20. PMID: 23027488. Exclusion: E11.

1322. Yang L, Gu Y, Shi J, et al. Modified plate-only open-door laminoplasty versus laminectomy and fusion for the treatment of cervical stenotic myelopathy. Orthopedics. 2013 Jan;36(1):e79-87. doi: 10.3928/01477447-20121217-23. PMID: 23276358. Exclusion: E11.

1323. Yang S, Wu X, Hu Y, et al. Early and intermediate follow-up results after treatment of degenerative disc disease with the Bryan cervical disc prosthesis: single- and multiple-level. Spine. 2008 May 20;33(12):E371-E7. doi: 10.1097/BRS.0b013e31817343a6. PMID: 18496332. Exclusion: E5.

1324. Yang S, Yu Y, Liu X, et al. Clinical and radiological results comparison of allograft and polyetheretherketone cage for one to two-level anterior cervical discectomy and fusion: a CONSORT-compliant article. Medicine (Baltimore). 2019 Nov;98(45):e17935. doi: 10.1097/MD.0000000000017935. PMID: 31702680. Exclusion: E11.

1325. Yang SD, Zhu YB, Yan SZ, et al. Anterior cervical discectomy and fusion surgery versus total disc replacement: a comparative study with minimum of 10-year follow-up. Sci. 2017 11 27;7(1):16443. doi: 10.1038/s41598-017-16670-1. PMID: 29180636. Exclusion: E11.

1326. Yang X, Bartels R, Donk R, et al. Does heterotopic ossification in cervical arthroplasty affect clinical outcome? World Neurosurg. 2019;131:e408-e14. doi: 10.1016/j.wneu.2019.07.187. Exclusion: E2.

1327. Yang X, Chen Q, Liu L, et al. Comparison of anterior cervical fusion by titanium mesh cage versus nano-hydroxyapatite/polyamide cage following single-level corpectomy. Int Orthop. 2013 Dec;37(12):2421-7. doi: 10.1007/s00264-013-2101-4. PMID: 24057657. Exclusion: E11.

1328. Yang X, Donk R, Arts MP, et al. Maintaining range of motion after cervical discectomy does not prevent adjacent segment degeneration. Spine J. 2019 11;19(11):1816-23. doi: 10.1016/j.spinee.2019.07.011. PMID: 31326630. Exclusion: E3.

1329. Yang X, Donk R, Arts MP, et al. Prosthesis in anterior cervical herniated disc approach does not prevent radiologic adjacent segment degeneration. Spine. 2020 Aug 01;45(15):1024-9. doi: 10.1097/BRS.0000000000003453. PMID: 32675601. Exclusion: E12.

1330. Yang X, Donk R, Arts MP, et al. Are modic vertebral end-plate signal changes associated with degeneration or clinical outcomes in the cervical spine? World Neurosurg. 2019 Sep;129:e881-e9. doi: 10.1016/j.wneu.2019.06.067. PMID: 31226457. Exclusion: E1.

1331. Yang X, Donk R, Bartels R, et al. Comparing heterotopic ossification in two cervical disc prostheses. Spine. 2020 Oct 01;45(19):1329-34. doi: 10.1097/BRS.0000000000003537. PMID: 32576776. Exclusion: E3.

1332. Yang X, Gharooni AA, Dhillon RS, et al. The relative merits of posterior surgical treatments for multi-level degenerative cervical myelopathy remain uncertain: Findings from a systematic review. J. 2021 Aug 18;10(16):18. doi: 10.3390/jcm10163653. PMID: 34441949. Exclusion: E8.

1333. Yang Y, Ma L, Hong Y, et al. The application of zero-profile implant in two-level and single level anterior cervical discectomy and fusion for the treatment of cervical spondylosis: a comparative study. Int J Clin Exp Med. 2016;9(8):15667-77. Exclusion: E3.

1334. Yang Y, Ma L, Liu H, et al. Comparison of the incidence of patient-reported post-operative dysphagia between ACDF with a traditional anterior plate and artificial cervical disc replacement. Clin Neurol Neurosurg. 2016 Sep;148:72-8. doi: 10.1016/j.clineuro.2016.07.020. PMID: 27428486. Exclusion: E4.

1335. Yang Y, Ma L, Zeng J, et al. Comparison of anterior cervical discectomy and fusion with the zero-profile implant and cage-plate implant in treating two-level degenerative cervical spondylosis. Int J Clin Exp Med. 2016;9(11):21772-9p. Exclusion: E11.

1336. Yang YD, Zhao H, Chai Y, et al. A comparison study between hybrid surgery and anterior cervical discectomy and fusion for the treatment of multilevel cervical spondylosis. Bone Joint J. 2020 Aug;102-B(8):981-96. doi: 10.1302/0301-620X.102B8.BJJ-2019-1666.R1. PMID: 32731832. Exclusion: E2.

1337. Yang Z, Zhao Y, Luo J. Incidence of dysphagia of zero-profile spacer versus cage-plate after anterior cervical discectomy and fusion: a meta-analysis. Medicine (Baltimore). 2019 Jun;98(25):e15767. doi: 10.1097/MD.0000000000015767. PMID: 31232918. Exclusion: E8.

1338. Yao Q, Liang F, Xia Y, et al. A meta-analysis comparing total disc arthroplasty with anterior cervical discectomy and fusion for the treatment of cervical degenerative diseases. Arch Orthop Trauma Surg. 2016 Mar;136(3):297-304. doi: 10.1007/s00402-015-2337-0. PMID: 26411552. Exclusion: E9.

1339. Yao X, Peng J, Xu Y, et al. Variable-angle zero-notch anterior interbody fusion system in the treatment of cervical spondylotic myelopathy: 30-month follow-up. Chinese journal of tissue engineering research. 2022;26(9):1377-82p. doi: 10.12307/2022.432. Exclusion: E10.

1340. Yee TJ, Swong K, Park P. Complications of anterior cervical spine surgery: a systematic review of the literature. J. 2020 Mar;6(1):302-22. doi: 10.21037/jss.2020.01.14. PMID: 32309668. Exclusion: E8.

1341. Yeh KT, Lee RP, Chen IH, et al. Laminoplasty instead of laminectomy as a decompression method in posterior instrumented fusion for degenerative cervical kyphosis with stenosis. J. 2015 Sep 04;10:138. doi: 10.1186/s13018-015-0280-y. PMID: 26338009. Exclusion: E3.

1342. Yi S, Lee DY, Ahn PG, et al. Radiologically documented adjacent-segment degeneration after cervical arthroplasty: characteristics and review of cases. Surg Neurol. 2009 Oct;72(4):325-9; discussion 9. doi: 10.1016/j.surneu.2009.02.013. PMID: 19665192. Exclusion: E5.

1343. Yi S, Shin DA, Kim KN, et al. The predisposing factors for the heterotopic ossification after cervical artificial disc replacement. Spine J. 2013 Sep;13(9):1048-54. doi: 10.1016/j.spinee.2013.02.036. PMID: 23541453. Exclusion: E3.

1344. Yi YY, Xu HW, Zhang SB, et al. Does the C3/4 disc play a role in cervical spondylosis with dizziness? A retrospective study. Int Orthop. 2020 06;44(6):1159-68. doi: 10.1007/s00264-020-04531-y. PMID: 32193610. Exclusion: E3.

1345. Yin S, Yu X, Zhou S, et al. Is cervical disc arthroplasty superior to fusion for treatment of symptomatic cervical disc disease? A meta-analysis. Clin Orthop. 2013 Jun;471(6):1904-19. doi: 10.1007/s11999-013-2830-0. PMID: 23389804. Exclusion: E8.

1346. Ying Z, Xinwei W, Jing Z, et al. Cervical corpectomy with preserved posterior vertebral wall for cervical spondylotic myelopathy: a randomized control clinical study. Spine. 2007 Jun 15;32(14):1482-7. doi: 10.1097/BRS.0b013e318068b30a. PMID: 17572615. Exclusion: E3.

1347. Ylinen JJ, Savolainen S, Airaksinen O, et al. Decreased strength and mobility in patients after anterior cervical diskectomy compared with healthy subjects. Arch Phys Med Rehabil. 2003 Jul;84(7):1043-7. doi: 10.1016/s0003-9993(03)00039-x. PMID: 12881832. Exclusion: E3.

1348. Yone K, Sakou T, Yanase M, et al. Preoperative and postoperative magnetic resonance image evaluations of the spinal cord in cervical myelopathy. Spine (Phila Pa 1976). 1992 Oct;17(10 Suppl):S388-92. doi: 10.1097/00007632-199210001-00008. PMID: 1440032. Exclusion: E3.

1349. Yonenobu K, Fuji T, Ono K, et al. Choice of surgical treatment for multisegmental cervical spondylotic myelopathy. Spine (Phila Pa 1976). 1985 Oct;10(8):710-6. doi: 10.1097/00007632-198510000-00004. PMID: 4081877. Exclusion: E11.

1350. Yonenobu K, Hosono N, Iwasaki M, et al. Laminoplasty versus subtotal corpectomy. A comparative study of results in multisegmental cervical spondylotic myelopathy. Spine (Phila Pa 1976). 1992 Nov;17(11):1281-4. PMID: 1462201. Exclusion: E11.

1351. Yoo M, Kim WH, Hyun SJ, et al. Comparison between two different cervical interbody fusion cages in one level stand-alone ACDF: carbon fiber composite frame cage versus polyetheretherketone cage. Korean J. 2014 Sep;11(3):127-35. doi: 10.14245/kjs.2014.11.3.127. PMID: 25346758. Exclusion: E11.

1352. Yoo S, Ryu D, Choi HJ, et al. Ossification foci act as stabilizers in continuous-type ossification of the posterior longitudinal ligament: a comparative study between laminectomy and laminoplasty. Acta Neurochir (Wien). 2017 Sep;159(9):1783-90. doi: 10.1007/s00701-017-3233-x. PMID: 28589467. Exclusion: E11.

1353. Yoon ST, Hashimoto RE, Raich A, et al. Outcomes after laminoplasty compared with laminectomy and fusion in patients with cervical myelopathy: a systematic review. Spine. 2013 Oct 15;38(22 Suppl 1):S183-94. doi: 10.1097/BRS.0b013e3182a7eb7c. PMID: 23963000. Exclusion: E8.

1354. Yoshihara H, Margalit A, Yoneoka D. Incidence of C5 palsy: meta-analysis and potential etiology. World Neurosurg. 2019 Feb;122:e828-e37. doi: 10.1016/j.wneu.2018.10.159. PMID: 30391764. Exclusion: E3 - per email from Andrea 12/23.

1355. Yoshii T, Egawa S, Chikuda H, et al. Comparison of anterior decompression with fusion and posterior decompression with fusion for cervical spondylotic myelopathy-A systematic review and meta-analysis. J Orthop Sci. 2020 Nov;25(6):938-45. doi: 10.1016/j.jos.2019.12.010. PMID: 32008876. Exclusion: E8.

1356. Yoshii T, Tomizawa S, Hirai T, et al. Surgical outcomes in selective laminectomy and conventional double-door laminoplasty for cervical spondylotic myelopathy. Orthopedics. 2020 Jul 01;43(4):e311-e5. doi: 10.3928/01477447-20200521-06. PMID: 32501516. Exclusion: E11.

1357. Yoshii T, Yuasa M, Sotome S, et al. Porous/dense composite hydroxyapatite for anterior cervical discectomy and fusion. Spine. 2013 May 01;38(10):833-40. doi: 10.1097/BRS.0b013e3182801390. PMID: 23211531. Exclusion: E11.

1358. Yoshizawa A, Nakagawa K, Yoshimi K, et al. Analysis of swallowing function after anterior/posterior surgery for cervical degenerative disorders and factors related to the occurrence of postoperative dysphagia. Spine J. 2022 Apr;23(4):513-22. doi: 10.1016/j.spinee.2022.12.010. PMID: 36539039. Exclusion: E4.

1359. You J, Tang X, Gao W, et al. Factors predicting adjacent segment disease after anterior cervical discectomy and fusion treating cervical spondylotic myelopathy: a retrospective study with 5-year follow-up. Medicine (Baltimore). 2018 Oct;97(43):e12893. doi: 10.1097/MD.0000000000012893. PMID: 30412087. Exclusion: E3.

1360. Young RM, Leiphart JW, Shields DC, et al. Anterior cervical fusion versus minimally invasive posterior keyhole decompression for cervical radiculopathy. Interdisciplinary Neurosurgery: advanced Techniques and Case Management. 2015;2(4):169-76. doi: 10.1016/j.inat.2015.08.002. Exclusion: E11 - email from Tamara 12/9.

1361. Youssef JA, Heiner AD, Montgomery JR, et al. Outcomes of posterior cervical fusion and decompression: a systematic review and meta-analysis. Spine J. 2019 10;19(10):1714-29. doi: 10.1016/j.spinee.2019.04.019. PMID: 31075361. Exclusion: E3/E8

1362. Yson SC, Sembrano JN, Santos ER. Comparison of allograft and polyetheretherketone (PEEK) cage subsidence rates in anterior cervical discectomy and fusion (ACDF). J Clin Neurosci. 2017 Apr;38:118-21. doi: 10.1016/j.jocn.2016.12.037. PMID: 28153602. Exclusion: E11.

1363. Yu Z, Pan W, Chen J, et al. Application of electrophysiological measures in degenerative cervical myelopathy. Front Cell Dev Biol. 2022 Aug 9;10 doi: 10.3389/fcell.2022.834668. PMID: 36016659. Exclusion: E8.

1364. Yu Z, Shi X, Yin J, et al. Comparison of complications between anterior cervical diskectomy and fusion versus anterior cervical corpectomy and fusion in two- and three-level cervical spondylotic myelopathy: a meta-analysis. J Neurol Surg A Cent Eur Neurosurg. 2022 Jul;84(4):343-54. doi: 10.1055/s-0042-1747926. PMID: 35777419. Exclusion: E3.

1365. Yuan W, Zhu Y, Liu X, et al. Laminoplasty versus skip laminectomy for the treatment of multilevel cervical spondylotic myelopathy: a systematic review. Arch Orthop Trauma Surg. 2014 Jan;134(1):1-7. doi: 10.1007/s00402-013-1881-8. PMID: 24202410. Exclusion: E2.

1366. Yuan X, Wei C, Xu W, et al. Comparison of laminectomy and fusion vs laminoplasty in the treatment of multilevel cervical spondylotic myelopathy: a meta-analysis. Medicine (Baltimore). 2019 Mar;98(13):e14971. doi: 10.1097/MD.0000000000014971. PMID: 30921202. Exclusion: E8.

1367. Yudoyono F, Cho PG, Park SH, et al. Factors associated with surgical outcomes of cervical ossification of the posterior longitudinal ligament. Medicine (Baltimore). 2018 Jul;97(29):e11342. doi: 10.1097/MD.0000000000011342. PMID: 30024507. Exclusion: E4.

1368. Yue JK, Upadhyayula PS, Deng H, et al. Risk factors for 30-day outcomes in elective anterior versus posterior cervical fusion: a matched cohort analysis. J Craniovertebr Junction Spine. 2017 Jul-Sep;8(3):222-30. doi: 10.4103/jcvjs.JCVJS_88_17. PMID: 29021673. Exclusion: E1.

1369. Yukawa Y, Kato F, Ito K, et al. Laminoplasty and skip laminectomy for cervical compressive myelopathy: range of motion, postoperative neck pain, and surgical outcomes in a randomized prospective study. Spine. 2007 Aug 15;32(18):1980-5. PMID: 17700444. Exclusion: E7.

1370. Yukawa Y, Kato F, Ito K, et al. Postoperative changes in spinal cord signal intensity in patients with cervical compression myelopathy: comparison between preoperative and postoperative magnetic resonance images. J Neurosurg Spine. 2008 Jun;8(6):524-8. doi: 10.3171/SPI/2008/8/6/524. PMID: 18518672. Exclusion: E11.

1371. Yukawa Y, Kato F, Yoshihara H, et al. MR T2 image classification in cervical compression myelopathy: predictor of surgical outcomes. Spine. 2007 Jul 01;32(15):1675-8; discussion 9. doi: 10.1097/BRS.0b013e318074d62e. PMID: 17621217. Exclusion: E11.

1372. Yun DJ, Lee SJ, Park SJ, et al. Use of a zero-profile device for contiguous 2-level anterior cervical diskectomy and fusion: comparison with cage with plate construct. World Neurosurg. 2017 Jan;97:189-98. doi: 10.1016/j.wneu.2016.09.065. PMID: 27671883. Exclusion: E11.

1373. Zadegan SA, Abedi A, Jazayeri SB, et al. Clinical application of ceramics in anterior cervical discectomy and fusion: a review and update. Global spine j. 2017 Jun;7(4):343-9. doi: 10.1177/2192568217699201. PMID: 28815162. Exclusion: E6.

1374. Zadegan SA, Abedi A, Jazayeri SB, et al. Demineralized bone matrix in anterior cervical discectomy and fusion: a systematic review. Eur Spine J. 2017 04;26(4):958-74. doi: 10.1007/s00586-016-4858-9. PMID: 27832365. Exclusion: E8.

1375. Zaki O, Jain N, Yu EM, et al. 30- and 90-day unplanned readmission rates, causes, and risk factors after cervical fusion: a single-institution analysis. Spine. 2019 Jun 01;44(11):762-9. doi: 10.1097/BRS.0000000000002937. PMID: 30475339. Exclusion: E11.

1376. Zarate-Kalfopulos B, Araos-Silva W, Reyes-Sanchez A, et al. Hybrid decompression and fixation technique for the treatment of multisegmental cervical spondylotic myelopathy. Int J Spine Surg. 2016;10:30. doi: 10.14444/3030. PMID: 27909651. Exclusion: E3.

1377. Zavras A, Siyaji Z, Piracha A, et al. 232. Standalone cages vs cage and plate constructs for primary one- and two-level anterior cervical discectomy and fusion: a prospective randomized controlled trial. Spine journal. 2021 to 2021-10-02;21(9):S119-p. doi: 10.1016/j.spinee.2021.05.439. Exclusion: E6.

1378. Zavras AG, Sullivan TB, Singh K, et al. Failure in cervical total disc arthroplasty: single institution experience, systematic review of the literature, and proposal of the RUSH TDA failure classification system. Spine J. 2022 03;22(3):353-69. doi: 10.1016/j.spinee.2021.08.006. PMID: 34419625. Exclusion: E3.

1379. Zdeblick TA, Ducker TB. The use of freeze-dried allograft bone for anterior cervical fusions. Spine (Phila Pa 1976). 1991 Jul;16(7):726-9. doi: 10.1097/00007632-199107000-00006. PMID: 1925745. Exclusion: E11.

1380. Zechmeister I, Winkler R, Mad P. Artificial total disc replacement versus fusion for the cervical spine: a systematic review. Eur Spine J. 2011 Feb;20(2):177-84. doi: 10.1007/s00586-010-1583-7. PMID: 20936484. Exclusion: E8.

1381. Zeidman SM, Ducker TB. Posterior cervical laminoforaminotomy for radiculopathy: review of 172 cases. Neurosurgery. 1993 Sep;33(3):356-62. PMID: 8413864. Exclusion: E5.

1382. Zelenty WD, Paek S, Dodo Y, et al. Utilization trends of intraoperative neuromonitoring for anterior cervical discectomy and fusion in New York state. Spine (Phila Pa 1976). 2022 Apr 1;48(7):492-500. doi: 10.1097/BRS.0000000000004569. PMID: 36576864. Exclusion: E4.

1383. Zeng J, Duan Y, Liu H, et al. Dynamic cervical implant in treating cervical degenerative disc disease: a systematic review and meta-analysis. Int J Clin Exp Med. 2017;10(6):8700-8. Exclusion: E8.

1384. Zhai S, Li A, Li X, et al. Total disc replacement compared with fusion for cervical degenerative disc disease: a systematic review of overlapping meta-analyses. Medicine (Baltimore). 2020 May;99(19):e20143. doi: 10.1097/MD.0000000000020143. PMID: 32384498. Exclusion: E8.

1385. Zhang C, Das SK, Yang DJ, et al. Application of magnetic resonance imaging in cervical spondylotic myelopathy. World J Radiol. 2014 Oct 28;6(10):826-32. doi: 10.4329/wjr.v6.i10.826. PMID: 25349665. Exclusion: E6.

1386. Zhang D, Liu B, Zhu J, et al. Comparison of clinical and radiologic outcomes between self-locking stand-alone cage and cage with anterior plate for multilevel anterior cervical discectomy and fusion: a meta-analysis. World Neurosurg. 2019 05;125:e117-e31. doi: 10.1016/j.wneu.2018.12.218. PMID: 30677575. Exclusion: E8.

1387. Zhang H, Sun T, Lu S, et al. [Comparison of effectiveness between laminoplasty and laminectomy decompression and fusion with internal fixation for cervical spondylotic myelopathy]. Chung Kuo Hsiu Fu Chung Chien Wai Ko Tsa Chih. 2012 Oct;26(10):1191-6. PMID: 23167101. Exclusion: E10.

1388. Zhang J, Hirabayashi S, Saiki K, et al. Effectiveness of multiple-level decompression in laminoplasty and simultaneous C1 laminectomy for patients with cervical myelopathy. Eur Spine J. 2006 Sep;15(9):1367-74. PMID: 16369832. Exclusion: E8.

1389. Zhang J, Liu H, Bou EH, et al. Comparative study between anterior cervical discectomy and fusion with roi-c cage and laminoplasty for multilevel cervical spondylotic myelopathy without spinal stenosis. World Neurosurg. 2019 Jan;121:e917-e24. doi: 10.1016/j.wneu.2018.10.016. PMID: 30321683. Exclusion: E11.

1390. Zhang J, Meng F, Ding Y, et al. Hybrid surgery versus anterior cervical discectomy and fusion in multilevel cervical disc diseases: a meta-analysis. Medicine (Baltimore). 2016 05;95(21):e3621. doi: 10.1097/MD.0000000000003621. PMID: 27227922. Exclusion: E9.

1391. Zhang J, Meng F, Ding Y, et al. Comprehensive analysis of hybrid surgery and anterior cervical discectomy and fusion in cervical diseases: a meta-analysis. Medicine (Baltimore). 2020 Jan;99(5):e19055. doi: 10.1097/MD.0000000000019055. PMID: 32000453. Exclusion: E8.

1392. Zhang J, Wang S, Tang X, et al. Clinical and radiological comparison of the zero-profile anchored cage and traditional cage-plate fixation in single-level anterior cervical discectomy and fusion. Eur J Med Res. 2022 Sep 30;27(1):189. doi: 10.1186/s40001-022-00813-w. PMID: 36175990. Exclusion: E11.

1393. Zhang KZ, Tu HH, Liu ZL, et al. [Correlation between increased spinal cord signal intensity on T2-weighted MRI and clinical prognosis of compressive cervical myelopathy]. Nan Fang Yi Ke Da Xue Xue Bao. 2009 Oct;29(10):2018-20. PMID: 19861254. Exclusion: E10.

1394. Zhang L, Wang J, Tao Y, et al. Outcome evaluation of zero-profile implant compared with an anterior plate and cage used in anterior cervical discectomy and fusion: a two-year follow-up study. Turk. 2016;26(3):416-22. doi: 10.5137/1019-5149.JTN.12017-14.1. PMID: 27161470. Exclusion: E11.

1395. Zhang MZ, Ou-Yang HQ, Jiang L, et al. Optimal machine learning methods for radiomic prediction models: Clinical application for preoperative T2 -weighted images of cervical spondylotic myelopathy. JOR Spine. 2021 Dec;4(4):e1178. doi: 10.1002/jsp2.1178. PMID: 35005444. Exclusion: E2.

1396. Zhang MZ, Ou-Yang HQ, Liu JF, et al. Predicting postoperative recovery in cervical spondylotic myelopathy: construction and interpretation of T2 -weighted radiomic-based extra trees models. Eur Radiol. 2022 May;32(5):3565-75. doi: 10.1007/s00330-021-08383-x. PMID: 35024949. Exclusion: E11.

1397. Zhang MZ, Ou-Yang HQ, Liu JF, et al. Utility of advanced DWI in the detection of spinal cord microstructural alterations and assessment of neurologic function in cervical spondylotic myelopathy patients. J Magn Reson Imaging. 2022 03;55(3):930-40. doi: 10.1002/jmri.27894. PMID: 34425037. Exclusion: E7.

1398. Zhang T, Guo N, Gao G, et al. Comparison of outcomes between Zero-p implant and anterior cervical plate interbody fusion systems for anterior cervical decompression and fusion: a systematic review and meta-analysis of randomized controlled trials. J. 2022 Jan 25;17(1):47. doi: 10.1186/s13018-022-02940-w. PMID: 35078496. Exclusion: E8.

1399. Zhang Y, Liang C, Tao Y, et al. Cervical total disc replacement is superior to anterior cervical decompression and fusion: a meta-analysis of prospective randomized controlled trials. PLoS ONE. 2015;10(3):e0117826. doi: 10.1371/journal.pone.0117826. PMID: 25822465. Exclusion: E8.

1400. Zhang Y, Lv N, He F, et al. Comparison of cervical disc arthroplasty and anterior cervical discectomy and fusion for the treatment of cervical disc degenerative diseases on the basis of more than 60 months of follow-up: a systematic review and meta-analysis. BMC Neurol. 2020 Apr 20;20(1):143. doi: 10.1186/s12883-020-01717-0. PMID: 32312321. Exclusion: E8.

1401. Zhang Y, Ouyang Z, Wang W. Percutaneous endoscopic cervical foraminotomy as a new treatment for cervical radiculopathy: a systematic review and meta-analysis. Medicine (Baltimore). 2020 Nov 06;99(45):e22744. doi: 10.1097/MD.0000000000022744. PMID: 33157922. Exclusion: E8.

1402. Zhang Y, Yang G, Zhou T, et al. Efficacy and safety of anterior cervical discectomy and fusion (ACDF) through mini-incision and posterior laminoplasty (LAMP) for treatment of long-level cervical spondylosis: a retrospective cohort study. BMC surg. 2022 Mar 25;22(1):115. doi: 10.1186/s12893-022-01567-2. PMID: 35337311. Exclusion: E11.

1403. Zhang YZ, Shen Y, Wang LF, et al. Magnetic resonance T2 image signal intensity ratio and clinical manifestation predict prognosis after surgical intervention for cervical spondylotic myelopathy. Spine. 2010 May 01;35(10):E396-9. doi: 10.1097/BRS.0b013e3181c6dbc4. PMID: 20393392. Exclusion: E9.

1404. Zhang Z, Jiao L, Zhu W, et al. Comparison of Bryan versus ProDisc-C total disk replacement as treatment for single-level cervical symptomatic degenerative disk disease. Arch Orthop Trauma Surg. 2015 Mar;135(3):305-11. doi: 10.1007/s00402-014-2149-7. PMID: 25555380. Exclusion: E11.

1405. Zhang Z, Li Y, Jiang W. A comparison of zero-profile anchored spacer (ROI-C) and plate fixation in 2-level noncontiguous anterior cervical discectomy and fusion- a retrospective study. BMC Musculoskelet Disord. 2018 Apr 17;19(1):119. doi: 10.1186/s12891-018-2033-7. PMID: 29665815. Exclusion: E7.

1406. Zhao CM, Chen Q, Zhang Y, et al. Anterior cervical discectomy and fusion versus hybrid surgery in multilevel cervical spondylotic myelopathy: a meta-analysis. Medicine (Baltimore). 2018 Aug;97(34):e11973. doi: 10.1097/MD.0000000000011973. PMID: 30142827. Exclusion: E8.

1407. Zhao H, Cheng L, Hou Y, et al. Multi-level cervical disc arthroplasty (CDA) versus single-level CDA for the treatment of cervical disc diseases: a meta-analysis. Eur Spine J. 2015 Jan;24(1):101-12. doi: 10.1007/s00586-014-3429-1. PMID: 24961223. Exclusion: E3.

1408. Zhao H, Duan L, Gao Y, et al. What is the superior surgical strategy for bi-level cervical spondylosis-anterior cervical disc replacement or anterior cervical decompression and fusion? A meta-analysis from 11 studies. Medicine (Baltimore). 2018 Mar;97(13):e0005. doi: 10.1097/MD.0000000000010005. PMID: 29595628. Exclusion: E8.

1409. Zhao H, Duan LJ, Gao YS, et al. Comparison of the adverse events of anterior cervical disc replacement versus anterior cervical discectomy and fusion: a protocol for a systematic review and meta-analysis of prospective randomized controlled trials. Medicine (Baltimore). 2018 Apr;97(16):e0015. doi: 10.1097/MD.0000000000010015. PMID: 29668575. Exclusion: E6.

1410. Zhao H, Ren R, Ma W, et al. Comparison of Laminoplasty vs. Laminectomy for Cervical Spondylotic Myelopathy: a Systematic Review and Meta-Analysis. Frontiers in Surgery. 2021;8:790593. doi: 10.3389/fsurg.2021.790593. PMID: 35111804. Exclusion: E2.

1411. Zhao JG, Xia Q, Wang J, et al. Artificial cervical disc replacement versus anterior cervical discectomy and fusion for single level disc egenerative disease: a systematic review. Eur Spine J. START: 2011 Oct 19 CONFERENCE END: 2011 Oct 21 EuroSpine 2011 Milan Italy;20(4):S539-S40p. doi: 10.1007/s00586-011-1952-x. Exclusion: E6.

1412. Zhao Y, Sun Y, Zhou F, et al. Adjacent segment disease after anterior cervical decompression and fusion: analysis of risk factors on X-ray and magnetic resonance imaging. Chin Med J. 2014;127(22):3867-70. PMID: 25421182. Exclusion: E4.

1413. Zhao Y, Yang S, Huo Y, et al. Locking stand-alone cage versus anterior plate construct in anterior cervical discectomy and fusion: a systematic review and meta-analysis based on randomized controlled trials. Eur Spine J. 2020 11;29(11):2734-44. doi: 10.1007/s00586-020-06561-x. PMID: 32770359. Exclusion: E8.

1414. Zheng B, Hao D, Guo H, et al. ACDF vs TDR for patients with cervical spondylosis - an 8 year follow up study. BMC surg. 2017 Nov 28;17(1):113. doi: 10.1186/s12893-017-0316-9. PMID: 29183306. Exclusion: E11.

1415. Zheng W, Chen H, Wang N, et al. Application of diffusion tensor imaging cutoff value to evaluate the severity and postoperative neurologic recovery of cervical spondylotic myelopathy. World Neurosurg. 2018 Oct;118:e849-e55. doi: 10.1016/j.wneu.2018.07.067. PMID: 30026160. Exclusion: E2.

1416. Zheng Y, Liew SM, Simmons ED. Value of magnetic resonance imaging and discography in determining the level of cervical discectomy and fusion. Spine. 2004 Oct 01;29(19):2140-5; discussion 6. doi: 10.1097/01.brs.0000141172.99530.e0. PMID: 15454705. Exclusion: E2.

1417. Zhong ZM, Zhu SY, Zhuang JS, et al. Reoperation after cervical disc arthroplasty versus anterior cervical discectomy and fusion: a meta-analysis. Clin Orthop. 2016 May;474(5):1307-16. doi: 10.1007/s11999-016-4707-5. PMID: 26831475. Exclusion: E8.

1418. Zhou F, Li S, Zhao Y, et al. Quantitative analysis of the correlation between preoperative cervical degeneration and postoperative heterotopic ossification after cervical disc replacement: minimum 10-year follow-up data. J Neurosurg Spine. 2020 Jul 17;33(5):1-6. doi: 10.3171/2020.4.SPINE191303. PMID: 32679563. Exclusion: E4.

1419. Zhou J, Li J, Lin H, et al. A comparison of a self-locking stand-alone cage and anterior cervical plate for ACDF: Minimum 3-year assessment of radiographic and clinical outcomes. Clin Neurol Neurosurg. 2018 07;170:73-8. doi: 10.1016/j.clineuro.2018.04.033. PMID: 29734112. Exclusion: E12.

1420. Zhou J, Xia Q, Dong J, et al. Comparison of stand-alone polyetheretherketone cages and iliac crest autografts for the treatment of cervical degenerative disc diseases. Acta Neurochir (Wien). 2011 Jan;153(1):115-22. doi: 10.1007/s00701-010-0821-4. PMID: 20924769. Exclusion: E11.

1421. Zhou X, Cai P, Li Y, et al. Posterior or single-stage combined anterior and posterior approach decompression for treating complex cervical spondylotic myelopathy coincident multilevel anterior and posterior compression. Clin Spine Surg. 2017 Dec;30(10):E1343-E51. doi: 10.1097/BSD.0000000000000437. PMID: 27681535. Exclusion: E3 - email from Tamara 12/9.

1422. Zhu B, Xu Y, Liu X, et al. Anterior approach versus posterior approach for the treatment of multilevel cervical spondylotic myelopathy: a systemic review and meta-analysis. Eur Spine J. 2013 Jul;22(7):1583-93. doi: 10.1007/s00586-013-2817-2. PMID: 23657624. Exclusion: E8.

1423. Zhu C, Yang X, Wang L, et al. Comparison of dynamic cervical implant versus anterior cervical discectomy and fusion for the treatment of single-level cervical degenerative disc disease: a five-year follow-up. Clin Neurol Neurosurg. 2018 01;164:103-7. doi: 10.1016/j.clineuro.2017.12.001. PMID: 29220729. Exclusion: E2.

1424. Zhu D, Zhang D, Liu B, et al. Can self-locking cages offer the same clinical outcomes as anterior cage-with-plate fixation for 3-level anterior cervical discectomy and fusion (ACDF) in mid-term follow-up? Med Sci Monit. 2019 Jan 19;25:547-57. doi: 10.12659/MSM.911234. PMID: 30659165. Exclusion: E11.

1425. Zhu R, Yang H, Wang Z, et al. Comparisons of three anterior cervical surgeries in treating cervical spondylotic myelopathy. BMC Musculoskelet Disord. 2014 Jul 10;15:233. doi: 10.1186/1471-2474-15-233. PMID: 25012927. Exclusion: E11.

1426. Zhu RS, Kan SL, Cao ZG, et al. Secondary surgery after cervical disc arthroplasty versus fusion for cervical degenerative disc disease: a meta-analysis with trial sequential analysis. Orthop Surg. 2018 Aug;10(3):181-91. doi: 10.1111/os.12401. PMID: 30152612. Exclusion: E8.

1427. Zhu Y, Tian Z, Zhu B, et al. Bryan cervical disc arthroplasty versus anterior cervical discectomy and fusion for treatment of cervical disc diseases: a meta-analysis of prospective, randomized controlled trials. Spine. 2016 Jun;41(12):E733-E41. doi: 10.1097/BRS.0000000000001367. PMID: 26656038. Exclusion: E8.

1428. Zigler JE, Guyer RD, Blumenthal SL, et al. Analysis of re-operations after cervical total disc replacement in a consecutive series of 535 patients receiving the ProDisc-C device. Eur Spine J. 2020 11;29(11):2683-7. doi: 10.1007/s00586-020-06399-3. PMID: 32277335. Exclusion: E3.

1429. Zigler JE, Liu ZJ, Niu CC, et al. Asia-pacific multicenter, prospective, randomized, clinical trial comparing arthroplasty vs. anterior cervical discectomy and fusion in the treatment of symptomatic cervical disc degeneration. Spine. 2016:311-2. Exclusion: E6.

1430. Zigler JE, Rogers RW, Ohnmeiss DD. Comparison of 1-Level Versus 2-Level Anterior Cervical Discectomy and Fusion: Clinical and Radiographic Follow-Up at 60 Months. Spine. 2016 Mar;41(6):463-9. doi: 10.1097/BRS.0000000000001263. PMID: 26966971. Exclusion: E3.

1431. Zoega B, Karrholm J, Lind B. One-level cervical spine fusion. A randomized study, with or without plate fixation, using radiostereometry in 27 patients. Acta Orthop Scand. 1998 Aug;69(4):363-8. doi: 10.3109/17453679808999048. PMID: 9798443. Exclusion: E7.

1432. Zoega B, Lind BI, Brisby H. A prospective randomized study of patients undergoinganterior cervical surgery for disc herniation: More than 12-year follow-up. Spine. 2009(20091205). Exclusion: E6 - conference abstract.

1433. Zoëga B, Rosén H, Lind B. Anterior cervical discectomy and fusion with or without plate fixation. A prospective and randomized study. Neuro-Orthopedics. 2000;28(1):39-51. Exclusion: E3.

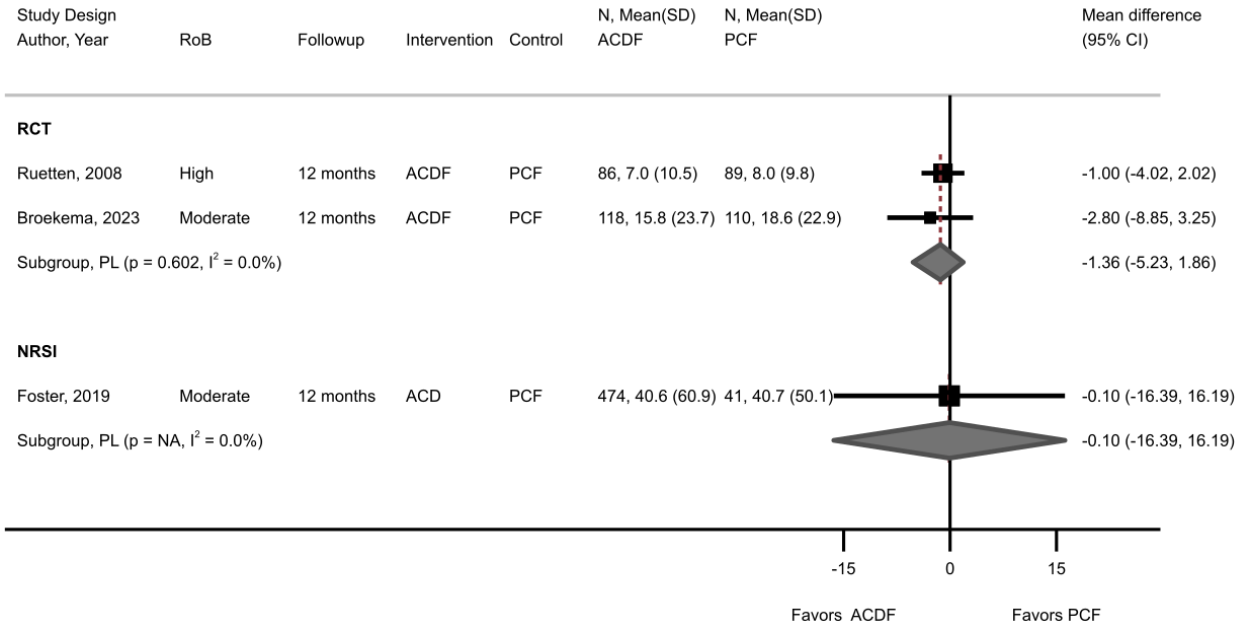
1434. Zou P, Zhang R, Yang JS, et al. Anterior and posterior approaches for 4-level degenerative cervical myelopathy: low-profile cage versus cervical pedicle screws fixation. J. 2023 Jan 10;12(2):564. doi: 10.3390/jcm12020564. PMID: 36675493. Exclusion: E11.

1435. Zou S, Gao J, Xu B, et al. Anterior cervical discectomy and fusion (ACDF) versus cervical disc arthroplasty (CDA) for two contiguous levels cervical disc degenerative disease: a meta-analysis of randomized controlled trials. Eur Spine J. 2017 04;26(4):985-97. doi: 10.1007/s00586-016-4655-5. PMID: 27314663. Exclusion: E8.

1436. Zou T, Wang PC, Chen H, et al. Minimally invasive posterior cervical foraminotomy versus anterior cervical discectomy and fusion for cervical radiculopathy: a meta-analysis. Neurosurg Rev. 2022 Dec;45(6):3609-18. doi: 10.1007/s10143-022-01882-5. PMID: 36255547. Exclusion: E8.

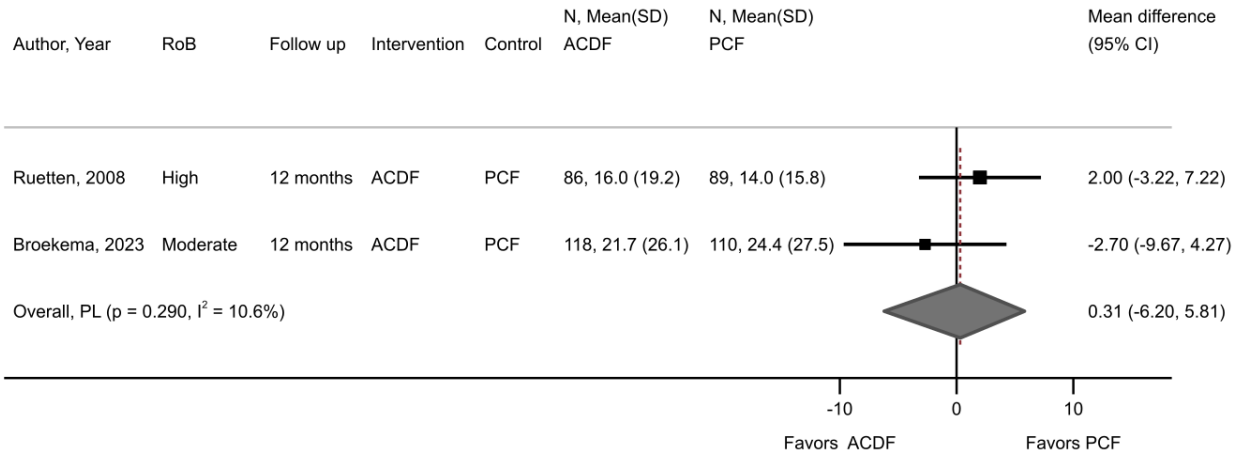
Appendix F. Meta-Analysis

Figure F-1. Effects of ACD or ACDF vs. PCF on VAS scores, arm pain



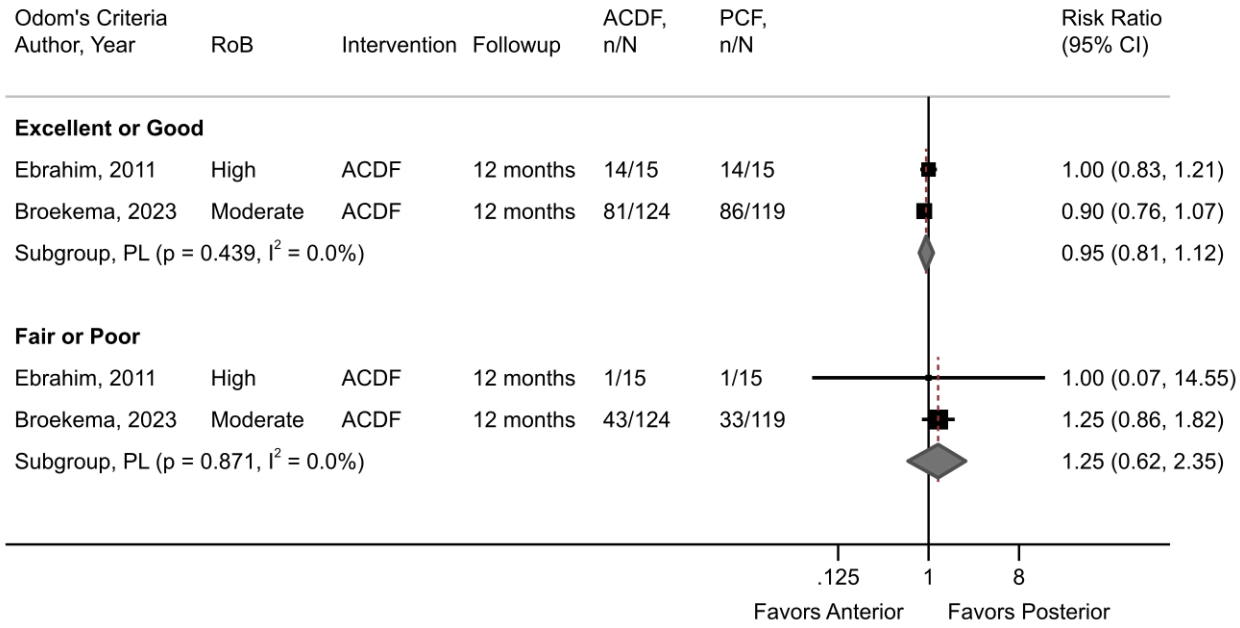
ACD = anterior cervical discectomy; ACDF = anterior cervical discectomy and fusion; CI = confidence interval; PCF = posterior cervical fusion; PL = profile likelihood; RoB = risk of bias; SD = standard deviation; VAS = visual analogue scale

Figure F-2. Effects of ACDF vs. PCF on VAS scores, neck pain



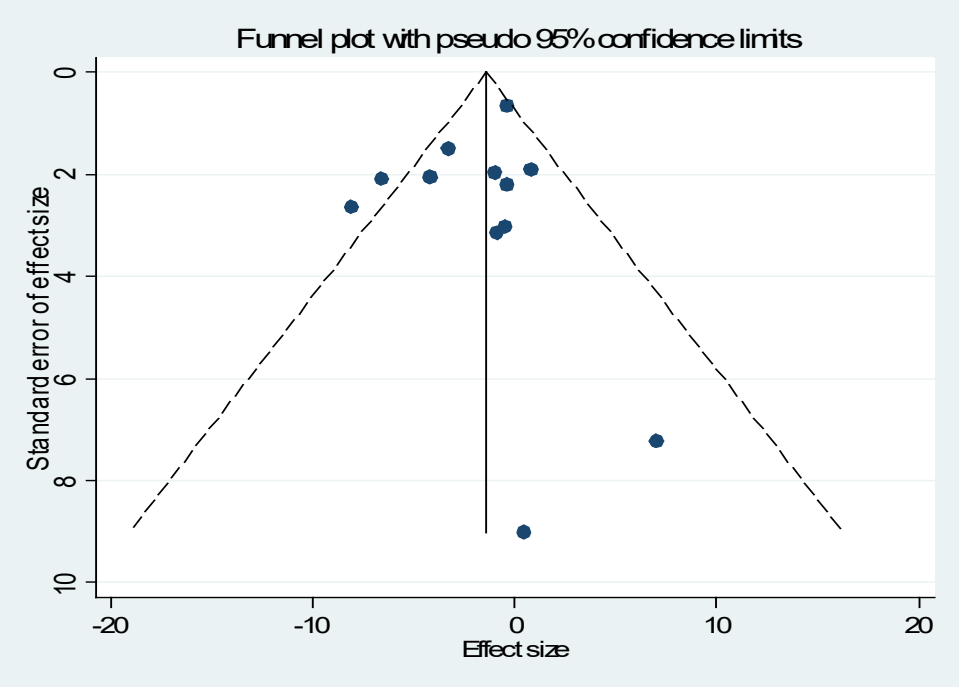
ACDF = anterior cervical discectomy and fusion; CI = confidence interval; PCF = posterior cervical fusion; PL = profile likelihood; RoB = risk of bias; SD = standard deviation; VAS = visual analogue scale

Figure F-3. Odom's criteria: anterior versus posterior approaches



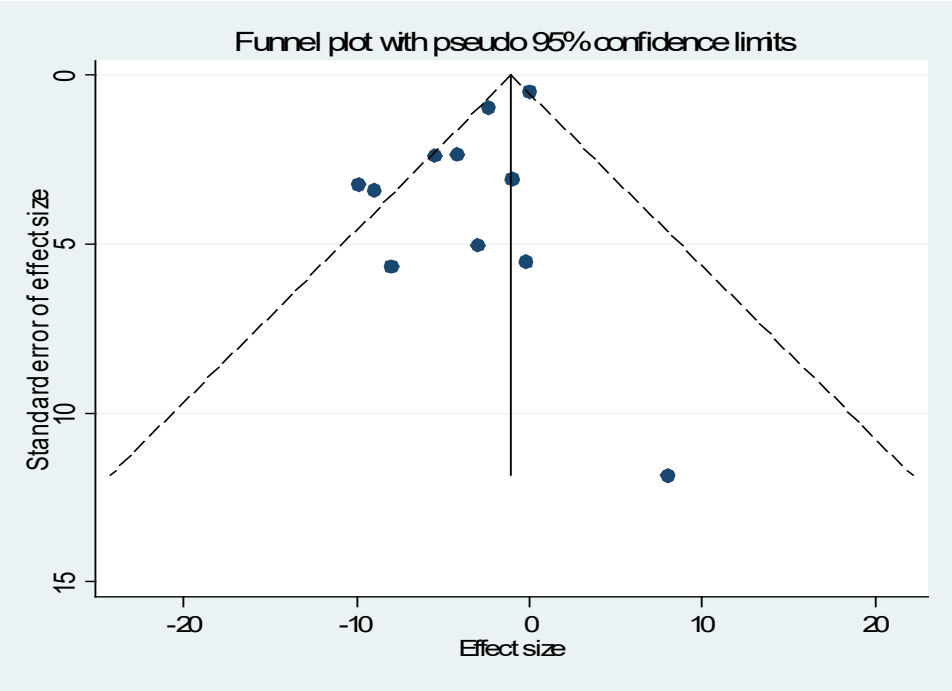
ACDF = anterior cervical discectomy and fusion; CI = confidence interval; PCF = posterior cervical fusion; PL = profile likelihood; RoB = risk of bias

Figure F-4. Funnel plot for intermediate term NDI scores after 1-level ACDF



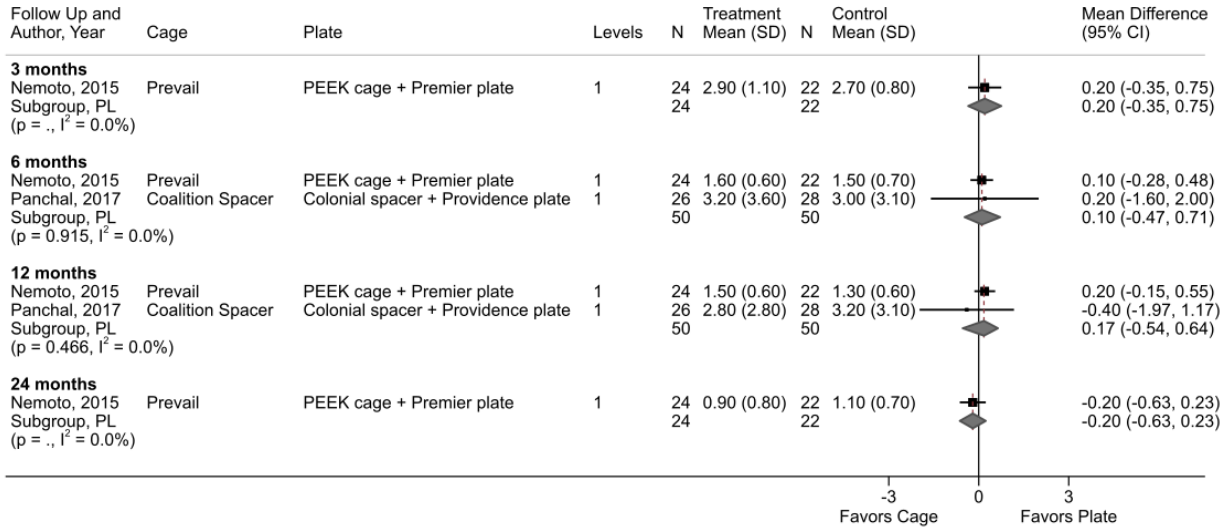
ACDF = anterior cervical discectomy and fusion; NDI = Neck Disability Index

Figure F-5. Funnel plot for intermediate term neck pain scores after 1-level ACDF



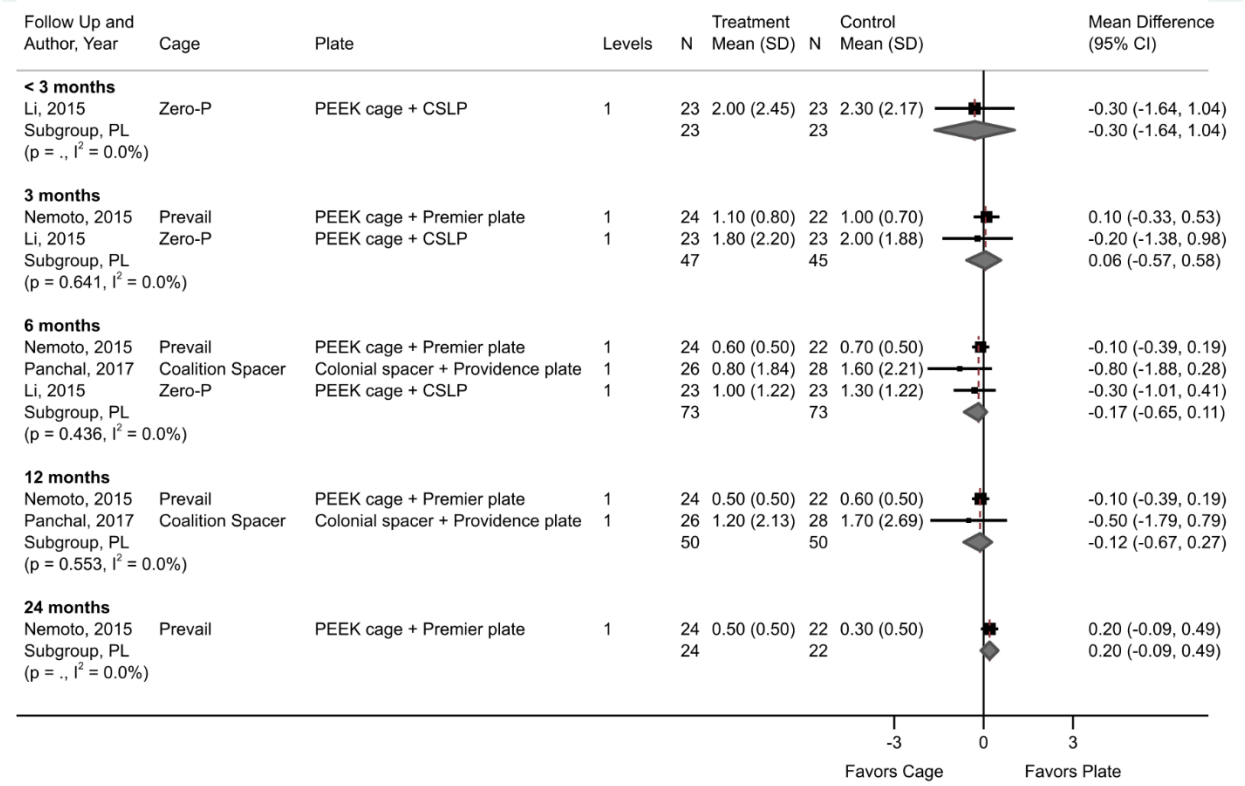
ACDF = anterior cervical discectomy and fusion

Figure F-6. Effects of cage versus plate, unspecified neck pain, 1-level ACDF



ACDF = anterior cervical discectomy and fusion; CI = confidence interval; PEEK = polyetheretherketone; PL = profile likelihood; SD = standard deviation

Figure F-7. Effects of cage versus plate, arm pain, 1-level ACDF



ACDF = anterior cervical discectomy and fusion; CI = confidence interval; PEEK = polyetheretherketone; PL = profile likelihood; SD = standard deviation.

Appendix G. Strength of Evidence

G1.1 Strength of Evidence Assessment

The EPC strength of evidence (SOE) rating for each body of evidence was assessed as high, moderate, low, or insufficient, using the approach described in the AHRQ Methods Guide,[2] based on study limitations, consistency, directness, precision, and reporting bias.

- Study Limitations (low, moderate, or high)
- Directness (Direct or Indirect)
- Consistency (Consistent, Inconsistent, or Unknown)
- Precision (Precise or Imprecise)
- Reporting Bias (Suspected or Undetected)

These criteria were applied regardless of whether evidence was synthesized quantitatively or qualitatively. The I^2 statistic was used to help assist consistency in pooled analyses; The confidence intervals surrounding effect estimates were reviewed for clear benefit, no effect, and clear harms to aid in assessing precision. We considered evidence from both randomized trials and nonrandomized studies in determining strength of evidence with greater weight given to randomized studies. Strength of evidence ratings reflected our confidence or certainty in the findings. Strength of evidence was considered insufficient when evidence was lacking, sparse, or too conflicting such that we were unable to draw conclusions. SOE was initially assessed by one researcher and confirmed by a second. Based on the assessments for each domain, an overall strength of evidence grade was assigned to each outcome, as defined in the AHRQ Methods Guide.[2]

Table G-1. Strength of evidence definitions

Grade	Definition
High	**We are very confident that the estimate of effect lies close to the true effect for this outcome.** The body of evidence has few or no deficiencies. We believe that the findings are stable, i.e., another study would not change the conclusions.
Moderate	**We are moderately confident that the estimate of effect lies close to the true effect for this outcome.** The body of evidence has some deficiencies. We believe that the findings are likely to be stable, but some doubt remains.
Low	**We have limited confidence that the estimate of effect lies close to the true effect for this outcome.** The body of evidence has major or numerous deficiencies (or both). We believe that additional evidence is needed before concluding either that the findings are stable or that the estimate of effect is close to the true effect.
Insufficient	**We have no evidence, we are unable to estimate an effect, or we have no confidence in the estimate of effect for this outcome.** No evidence is available or the body of evidence has unacceptable deficiencies, precluding reaching a conclusion.

Table G-1 taken from page 18 of the AHRQ Methods Guide.[2]

G2.1 Strength of Evidence Tables

Key Questions 1 and 10 had no eligible studies to assess.

Table G-2. Key Question 2: surgery versus conservative treatment

Outcome	Studies (n)	Limitations	Consistency	Directness	Precision	Reporting Bias	Summary of Findings	Strength of Evidence
Neurologic Function **mJOA response** **mJOA scores**	1 RCT (N=68)[8-10] 1 NRSI (N=80)[11]	High	Inconsistent	Direct	Imprecise	Undetected	1 RCT (N=66), mJOA response at 36 months: 61% vs. 73%, RR 0.83, 95% CI 0.59 to 1.18 1 RCT (N=47), mJOA scores at 10 years: 14 vs. 15, p=0.114 1 NRSI (N=40), Mild to moderate myelopathy at 12 months, mJOA scores: 15.4 vs. 14.2, p=0.03; at 36 months: 16.1 vs. 15.2, p=0.013 1 NRSI (N=40), Severe myelopathy at 12 months, mJOA: 11.5 vs. 8.6 p=0.001; at 36 months: 12.45 vs. 8.65, p<0.001	Insufficient
Adverse Events: Neurological worsening on mJOA	1 NRSI (N=80)[11]	High	Unknown	Direct	Imprecise	Undetected	0% vs. 5%, p=0.294	Insufficient

Outcome	Studies (n)	Limitations	Consistency	Directness	Precision	Reporting Bias	Summary of Findings	Strength of Evidence
General Function **10-meter Walk Test** **ADL improvement** **Self-reported improved disease course** **SF-12**	1 RCT (N=68)[8-10] 1 NRSI (N=80)[11]	High	Consistent	Direct	Imprecise	Undetected	1 RCT (N=66), 10-meter walk test, Surgery (baseline: 7.9 seconds; 6 months: 8.7 sec; 12 months: 9.9 sec; 24 months: 11.7 sec; 36 months: 9.4 sec) vs. Conservative treatment (baseline: 7.4 sec; 6 months: 7.2 sec; 12 months: 7.4 sec; 24 and 36 months: 7.5 sec) 1 NRSI (N=40), 10-meter walk test, Mild to moderate myelopathy: no differences between treatments 1 NRSI (N=40), 10-meter walk test, Severe myelopathy at 12 months: 11.4 seconds vs. 14.4 seconds, p=0.005; 36 months 10.3 seconds vs. 14.1 seconds, p=0.002) 1 RCT (N=66) improvement in ADLs at 6 months: 20% vs. 5.9%; worsening in ADLs: 20% vs. 8.8%, no differences at 12, 24, or 36 months 1 RCT (N=66) at 6 months, improvement in disease course: 61% vs. 20%, p=0.001 1 NRSI (N=40), SF-12 PCS and MCS, Mild and moderate myelopathy: PCS: 37.4 vs. 37.95, p=0.75; MCS: 47.5 vs. 46.7, p=0.78 1 NRSI (N=40), SF-12 PCS and MCS, Severe myelopathy: PCS: 53.3 vs. 26.85, p<0.001; MCS: 61.2 vs. 31.4, p<0.001	Insufficient

ADL = activities of daily living; MCS=Mental Component Score; mJOA=modified Japanese Orthopaedic Association score; NRSI = nonrandomized studies of interventions; PCS=Physical Component Score; RCT=randomized controlled trial; SF-36/12=Short-form 36 or 12 questionnaire

Table G-3. Key Question 3: surgery versus physiotherapy versus collar

Outcome	Studies (n)	Limitations	Consistency	Directness	Precision	Reporting Bias	Summary of Findings	Strength of Evidence
Pain **VAS**	1 RCT (N=81)[12,13]	Moderate	Unknown	Direct	Imprecise	Undetected	N=54, 0-100 VAS current pain, surgery vs. collar 14-16 weeks: 27 vs. 48, p<0.01 N=81, current pain, surgery vs. physiotherapy vs. collar, 16 months: 30 vs. 39 vs. 35, p>0.05 N=54, 0-100 VAS worst pain, surgery vs. collar 14-16 weeks: 43 vs. 64, p<0.01 N=81, worst pain, surgery vs. physiotherapy vs. collar, 16 months: 42 vs. 53 vs. 52, p>0.05	Insufficient
Neurologic Function **Muscle strength** **Parathesias** **Improvement in sensory loss**	1 RCT (N=81)[12,13]	Moderate	Unknown	Direct	Imprecise	Undetected	N=54, at 14-16 weeks, muscle strength, surgery better than physiotherapy in: pinch grip, elbow extension, shoulder internal rotation vs. physiotherapy; surgery better than collar in wrist and elbow flexion; at 16 months surgery better than physiotherapy in wrist and elbow extension, shoulder abduction, and shoulder internal rotation; no differences between surgery and collar or between physiotherapy and collar At 14-16 weeks, no difference in improvement in paresthesias (52% vs. 45% vs. 37%, p>0.05; at 16 months, remained no difference (51% vs. 67% vs. 66%, p>0.05) At 14-16 weeks, greater improvement in sensory loss with surgery vs. physiotherapy or collar (41% vs. 15% vs. 15%, p<0.05); no difference between treatments at 16 months (27% vs. 14% vs. 15%, p>0.05)	Insufficient

Outcome	Studies (n)	Limitations	Consistency	Directness	Precision	Reporting Bias	Summary of Findings	Strength of Evidence
General Function **Disability Rating Index**	1 RCT (N=81)[12,13]	Moderate	Unknown	Direct	Imprecise	Undetected	DRI 0-100, 14-16 weeks: surgery better than collar on dressing and completing heavy work (p<0.05); Physiotherapy better than collar on ability to walk, sit for a long time, and complete heavy work (P<0.05) At 16 months: Surgery better than physiotherapy or collar on ability to complete heavy work (p<0.05)	Insufficient
Adverse Events	No studies	NA	NA	NA	NA	NA	NA	NA

DRI = disability rating index; NA = not applicable; RCT = randomized controlled trial; VAS = visual analogue scale

Table G-4. Key Question 4: surgery (laminoplasty) plus add-on therapy versus surgery alone

Outcome	Studies (n)	Limitations	Consistency	Directness	Precision	Reporting Bias	Summary of Findings	Strength of Evidence
Add-on Therapy: Pain (Collar) Laminoplasty	2 RCTs (N=125)[14,15]	Moderate	Consistent	Direct	Imprecise	Undetected	Similar VAS scores (0-10) when adding a collar at 6 months (1.3 vs. 1.3; data NR in one trial), and 12 months (mean score 1.7 vs. 1.7 in one trial; mean change from baseline 0.19 vs. -0.04 in another)	Low
Add-on Therapy: Pain (Exercise) Laminoplasty	1 RCT (N=65)[16]	Moderate	Inconsistent	Direct	Imprecise	Undetected	Similar difference in mean VAS scores (0-100 scale) for neck pain and stiffness at 2 weeks and 3 months postoperative between muscle-preserving laminoplasty with exercises versus laminoplasty alone (25.3 vs. 20.6)	Insufficient
Add-on Therapy: General Function (Collar) Laminoplasty	2 RCTs (N=125)[14,15]	Moderate	Consistent	Direct	Imprecise	Undetected	Similar mean change or absolute NDI scores at 6 months (22.4 vs. 23.1) and 12 months (20.8 vs. 22.9). Greater mean change in SF-36 MCS scores adding collar at 6 months (41.0 vs. 48.3, p<0.05) and 12 months (48.3 vs. 48.9; data NR in one trial). Similar SF-36 PCS scores at 6 months (36.3 vs. 36.0) and 12 months (39.0 vs. 36.7; data NR in one trial).	Low
Add-on Therapy: Neurological Function (Collar) Laminoplasty	2 RCTs (N=125)[14,15]	Moderate	Consistent	Direct	Precise	Undetected	Similar mJOA scores at 6 weeks (13.8 vs. 13.3) in laminoplasty with postoperative collar, with no difference found up to 12 months (14.1 vs. 14.5 in one trial; 11.1 vs. 11.8 in another)	Low

MCS = mental component summary score; mJOA = Modified Japanese Orthopaedic Association Scale; NDI = Neck Disability Index; NR = not reported; PCS = physical component summary score; RCT = randomized controlled trial; SF-36 = 36-Item Short Form Health Survey; VAS = visual analogue scale

Table G-5. Key Question 4: surgery (ACDF) plus add-on therapy versus surgery alone

Outcome	Studies (n)	Limitations	Consistency	Directness	Precision	Reporting Bias	Summary of Findings	Strength of Evidence
Add-on Therapy: Fusion (PEFM) ACDF	1 RCT (N=323)[17]	Moderate	Inconsistent	Indirect	Imprecise	Undetected	Improved rates of fusion at 6 months adding PEFM to ACDF (83.6% vs. 68.6%, p=0.0065); similar rates of fusion with PEFM at 12 months (92.8% vs. 86.7%)	Low
Add-on Therapy: Fusion (Collar) ACDF	1 RCT (N=33)[18]	Moderate	Inconsistent	Indirect	Imprecise	Undetected	Similar rates of fusion adding post-op collar to ACDF vs. no collar at 24 months (100% vs. 100%)	Insufficient
Add-on Therapy: Pain (PEFM) ACDF	1 RCT (N=323)[17]	Moderate	Inconsistent	Indirect	Imprecise	Undetected	Similar VAS scores (0-10) with PEFM added to ACDF at 6 months (2.4 vs. 2.3) and 12 months (2.2 vs. 2.0)	Low
Add-on Therapy: General Function (Collar) ACDF	1 RCT (N=33)[18]	Moderate	Inconsistent	Indirect	Imprecise	Undetected	Similar mean change in NDI scores adding collar to ACDF at 6 months (-6.42 vs. -5.24) and 24 months (-7.94 vs. -9.93). Similar mean change in SF-36 MCS scores adding collar at 6 months (5.01 vs. 4.69) and 24 months (7.44 vs. 5.69). Greater mean change in SF-36 PCS scores adding collar at 6 months (10.02 vs. 3.24); similar mean change at 24 months (8.11 vs. 6.28).	Insufficient
Add-on Therapy: General Function (PEFM) ACDF	1 RCT (N=323)[17]	Moderate	Inconsistent	Indirect	Imprecise	Undetected	Similar mean change or absolute NDI scores adding PEFM to ACDF at 6 months (31.0 vs. 23.0) and 12 months (25.6 vs. 22.8)	Low

ACDF = anterior cervical discectomy and fusion; CI = confidence interval; MCS = Mental Component Score; mJOA = modified Japanese Orthopaedic Association score; NDI = Neck Disability Index; NR = not reported; PCS = Physical Component Score; PEFM = pulsed electromagnetic field; RCT = randomized controlled trial; SF-36/12 = 36- or 12-Item Short Form Health Survey; VAS = visual analog scale

Table G-6. Key Question 5. anterior versus posterior procedures in ≤ 2 levels in patient with radiculopathy

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect Anterior Versus Posterior
Fusion	1 RCT (N=30)[19]	High	Unknown	Imprecise	Undetected	Insufficient	No patient had evidence of instability on x-rays; criteria for stability or fusion were not described
Pain, Neck Pain scores ***Discharge***	1 RCT(N=30)[19]	High	Unknown	Imprecise	Undetected	Insufficient	MD -3.13, 95% CI -4.52 to 1.74, p<0.001 Authors reported p-value and confidence interval do not coincide.
Pain, Pain scores ***Short-term (3 months, 6 months)***	1 RCT (N=175)[20] 1 NRSI (N=688)[21] (moderate)	Moderate	Consistent	Imprecise (no information on variation from studies)	Undetected	Low	**3 months** **RCT:** VAS arm pain (0-100), mean: 10 vs. 11; MD -1 VAS neck pain (0-100), mean: 19 vs. 15; MD 4 NASS pain (0-6), mean: 1.5 vs. 1.4; MD 0.1 **NRSI (N=688)** Arm VAS (0-10) means (4.20 vs. 3.82, MD 0.38, p>0.05) **6 months** **RCT:** VAS arm pain (0-100), mean: 8 vs. 9; MD -1 VAS neck pain (0-100), mean: 19 vs. 17; MD 2 NASS pain (0-6), mean: 1.8 vs. 1.6; MD 0.2 Arm VAS (0-10) Neck VAS (0-10) NASS (0-6)

Pain, Arm or Neck pain scores ***Intermediate term (12 months 24 months)***	1 RCT (N=175) (high) 1 RCT (N=243)[22] (moderate) 1 NRSI (N=688)[23] (moderate) 1 NRSI (N=70)[21] (high)	Moderate	Consistent	Imprecise (no information on variation from studies)	Undetected	Low	**12 months** Moderate RCT VAS arm pain (0-100), MD – 2.80, 95% CI, -8.85 to 3.25 VAS neck pain (0-100), MD -2.70, 95% CI -9.67 to 4.27 **1 RCT:** VAS arm pain (0-100), mean: 7 vs. 8; MD -1 VAS neck pain (0-100), mean: 16 vs. 14; MD 2 RCTs pooled: VAS arm pain (0-100), Pooled MD -1.36, 95% CI -5.23 to 1.86, I^2= 0%.) VAS neck pain (0-100), Pooled MD 0.31, 95%CI -620 to 5.81, I^2=10.6% NASS pain (0-6), mean: 1.7 vs. 1.8; MD -0.1 **NRSI N=688)** Arm VAS (0-10) (4.06 vs. 4.07, MD 0.01, p>0.05) **NRSI (N=70)** VAS score (0-10 scale, arm or neck pain not specified) Mean, 95%CI 2.6 (1.7 to 3.4) vs. 3.0 (1.9 to 4.2), p=0.4 **24 months** **RCT:** VAS arm pain (0-100), mean: 8 vs. 7; MD 1 VAS neck pain (0-100), mean: 17 vs. 16; MD 1 NASS pain (0-6), mean: 1.5 vs. 1.4; MD 0.1

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect Anterior Versus Posterior
							NRSI (N=688) Arm VAS (0-10) 3.85 vs. 4.48, MD -0.63, p>0.05
Pain Success VAS Pain (0-100 scale) (41 point improvement in arm pain, 26 point improvement in neck pain,	1 RCT (N=243)[22] (moderate)	Moderate	Unknown	Imprecise (no information on variation from studies)	Undetected	Low	VAS arm pain 60% vs. 54%, VAS neck pain 62% vs. 52% Authors report groups were comparable in proportion responding
Function, Neurologic	1 RCT (N=175)[20]	High	Unknown	Imprecise (no information on variation)	Undetected	Insufficient	NASS neurology scores (0-6 scale) Means similar for ACDF and PCF (range, MD -0.2 to 0.2); no detail reported

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect Anterior Versus Posterior
Function, General **Odom's Criteria** **NDI "success (improvement) and scores** **Core Outcome Measures Index-neck (COMI)** **Pain Disability Questionnaire (PDQ) Functional status component**	2 RCT (N=273)[19,22] 1 NRSI (N=688)[23] 1 NRSI (N=70)[21]	Moderate	Unknown	Imprecise	Undetected	Low	**Odom's Criteria (2 RCTs)** Excellent or good 68.3% vs. 74.6%, RR 0.95, 95%CI 0.81 to 1.12, I^2= 0%) NDI (0-100), 12 months Improvement:63% vs. 66% Scores: mean change scores on MD -1.2 , 95% CI -5.8 to 3.5 NRSI N=688 (appear to be unadjusted estimates) **COMI-neck scores (0-10 scale**) Mean change:3 months (2.38 vs. 2.31, p=0.88) and 6 months (2.94 vs. 2.67, p=0.55) 24 months the mean scores were 4.16 vs. 4.72, p>0.05; **COMI-neck success (response)** 3 months (50% vs. 56%, RR 0.89, 95% CI 0.65 to 1.24), 12 months (59% vs. 58%, RR 1.02, 95% CI 0.76 to 1.36), and 24 months (57% vs. 50%, RR 1.14, 95% CI 0.71 to 1.83) NRSI N=70 **PDQ** (0-90, unadjusted estimates) **functional status subscale** 31.3 vs. 43.2, MD – 11.9, p=0.30 **PDQ total score** (52.8 vs. 69.6, p=0.50)

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect Anterior Versus Posterior
Quality of Life – 12 months	1 RCT (N=243)[22] 1 NRSI (N=70)[21]	Moderate	Unknown	Imprecise	Undetected	Low	EQ-5D/QALY (Scale 0 to 1) RCT: Success (Improvement of 0.24): 38% vs. 38%, Scores: MD -0.01, 95% CI -0.06 to 0.10 (change scores) NRSI: ACDF (0.69, 95% CI 0.61 to 0.77) versus PCF (0.72, 95% CI 0.64 to 0.80), p=0.60)
Reoperation (any time)	4 RCTs (N=519)[19,20,22,24] 1 NRSI (N=328)[25]	Moderate	Consistent	Imprecise	Undetected	Low	RCTs: RR 0.71, 95% CI 0.39 to 1.32, I^2=0% NRSI: RR 0.74, 95% CI 0.30 to 1.32)

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect Anterior Versus Posterior
New neurological deficit or neurologic complication	4 RCT (N=519)[19,20,22,24] 1 NRSI (N=70)[21] 1 NRSI (N=46,598)[26]	Moderate	Consistent	Imprecise	Undetected	Low	1 RCT (n=243) New radicular symptoms 3.2% vs. 0.8%, RR 3.84, 95%CI 0.43 to 33.85) Persistent radicular symptoms (1.6% vs. 6.7%, RR 0.24, 95% CI 0.05 to 1.11 1 RCT (N=72) New weakness 8% vs. 14%, RR 0.59, 95% CI 0.14 to 2.40 New numbness 6% vs. 9%, RR 0.66, 95% CI 0.12 to 3.68 1 RCT (N=30) Horner's Syndrome 0% vs. 0% 1 RCT (175) Myelon damage resulting in any paralysis: 0% vs. 0% 1 NRSI (N=70) C5 Palsy: Anterior (NR) vs. 1 patient (PCF) 1 NRSI (N=46,598) CNS complication: MD 4 per 10,000, 95% CI -14 to 22 per 10,000, p=0.68
Mortality	1 RCT (N=72)[24] 1 NRSI (N=46,598)[26]	Moderate	Unknown	Imprecise (RCT) Precise (NRSI)	Undetected	Insufficient	RCT: 0% vs. 0% NRSI (N=46,598) 30-day mortality for ACDF versus PCF (MD 1 events per 10,000 cases, 95% CI 0.0 to 2 per 10,000 cases, p=0.012).

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect Anterior Versus Posterior
Serious AEs	4 RCTs (N=519)[19,20,22,24]	Moderate	Consistent	Imprecise	Undetected	Insufficient	1 RCT (N= 243): surgery-related adverse events 6% in both groups (not specified) AEs during hospitalization anaphylactic reaction to antibiotics n=1 ACDF wound hematoma not requiring surgery, n=1 PCF pulmonary embolius, n=1 ACDF AEs requiring hospitalization wound problems 0.8% vs. 1.7%, cardio-thoracic problems 0.08% vs. 2.5%). Slight cage subsidence, n=1 (no reoperation needed) Three RCTs reported that there were no serious adverse events for any patients; however, studies were likely underpowered to detect rare events
Specific AEs 30 days post-operatively	1 NRSI (N=46,598)[26]	Moderate	Unknown	Precise	Undetected	Insufficient	Vascular injury MD 2 per 10,000 cases, 95% CI 1 to 3 per 10,000 cases, p=0.001 CSF fluid leak MD 2 per 10,000 cases, 95% CI 1 to 3 per 10,000 patients, p=0.002 Deep vein thrombus (9 per 10,000 cases, 95%CI 2 to 16 per 10,000 patients, p=0.01 Pulmonary embolism 2 per 10,000, 95% CI -9 to 12 per 10,000 cases, p=0.75

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect Anterior Versus Posterior
Unresolved dysphagia at 12 months	1 RCT (N=243)[22]	Moderate	Unknown	Imprecise	Undetected	Insufficient	1 case reported in the ACDF group

AE = adverse event; CSF = cerebral spinal fluid; COMI = Core Outcome Measures Index-neck; CI = confidence interval; MD = mean difference; NRSI = nonrandomized study of intervention; PDQ = Pain Disability Questionnaire; RCT = randomized controlled trial; RR = risk ratio

Table G-7. Key Question 6: anterior versus posterior procedures in ≥ 3 levels

Outcome Timing	Number of Studies (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect
Fusion ***Intermediate term***	1 NRSI (N=3,714) [27]	Moderate	Unknown	Imprecise	Undetected	Insufficient	**Pseudarthrosis**, 12 months: OR 2.43, 95% CI 1.96 to 3.01 (propensity-score matching)
Pain **Neck Pain scores** ***Short term***	1 RCT (N=32)[28]	High	Unknown	Imprecise	Undetected	Insufficient	**VAS pain (0-10 scale**) 3 months: MD -0.10, 95% CI -0.46 to 0.26 6 months: MD 0, 95% CI -0.18 to 0.18
Pain **Neck Pain scores** ***Intermediate term***	1 RCT (N=32)[28] 1 NSRI (N=245)[29]	RCT (High) NRSI (Moderate)	Consistent	Imprecise	Undetected	Low	**VAS/NRS pain (0-10 scale)** 1 RCT 12 months: MD 0.10, 95% CI -0.23 to 0.43) 15 months: MD -0.10, 95% CI -0.44 to 0.24 1 NRSI 12 months: adjusted OR 0.67, 95% CI 0.37 to 1.21
Pain **Arm Pain scores** ***Intermediate term***	1 NSRI (N=245)[29]	Moderate	Unknown	Imprecise	Undetected	Insufficient	**NRS pain (0-10 scale)**, 12 months: adjusted OR 0.99, 95% CI 0.51 to 1.93
Function, Neurologic **JOA** ***Short term***	1 RCT (N=32)[28]	High	Unknown	Imprecise	Undetected	Insufficient	**JOA scores (0-17)** 3 months: MD -0.40, 95% CI -1.76 to 0.96 6 months: MD 0.20, 95% CI -1.14 to 1.54
Function, Neurologic **mJOA or JOA, Nurick** ***Intermediate term***	1 RCT (N=32)[28] 2 NRSIs (N=509)[29,30]	RCT (High) NRSI (Moderate)	Consistent	Imprecise	Undetected	Low	**JOA/mJOA scores (0-18)**, 12 months 3 studies, pooled MD 0.16, 95% CI -0.15 to 0.51, I^2=50% **Nurick scores (0-5)**, 12 months 1 NRSI (N=264) MD in change scores 0.19, 95% CI -0.20 to 0.58

Outcome Timing	Number of Studies (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect
Function, General **NDI, SF-36 PCS and MCS** ***Intermediate term***	2 NRSIs (N=509)[29,30]	Moderate	Consistent	Imprecise	Undetected	Low	**NDI scores (scale unclear)**, 12 months 1 NRSI: (N=264): MD in change scores -0.97, 95% CI -7.15 to 5.21 1 NRSI (N=245): adjusted OR 0.76, 95% CI 0.42 to 1.37 **SF-36 scores (0-100),** 1 NRSI (N=264),12 months PCS: MD in change scores -1.90, 95% CI -5.30 to 1.50 MCS: MD in change scores 0.42, 95% CI -2.30 to 3.14
Quality of Life ***Intermediate term***	1 NSRI (N=245)[29]	Moderate	Unknown	Imprecise	Undetected	Insufficient	**EQ5D scores**, 12 months Adjusted OR 1.36, 95% CI 0.76 to 2.44, referent=ACDF
Reoperation ***Any time, longest followup***	7 NRSIs (N=27,579) [27,29,31-35]	Moderate	Inconsistent	Imprecise	Undetected	Insufficient	**ACDF versus laminoplasty** 2 NRSIs (N=3,406), 1 to 24 months 5.4% (92/1703) vs. 6.2% (105/1703) Pooled RR 0.87, 95% CI 0.59 to 1.79, I^2=0% **ACDF versus PCDF** 6 NRSIs (N=24,355), 1 to 60 months 10.1% (1,344/13,354) vs. 11.8% (1,293/11,001) Pooled RR 0.79, 95% CI 0.47 to 1.35, I^2=96.5% Excluding outlier study at 60 months (Joo, 2022) 5 NRSIs (N=20,641), 1-18 months 7.4% (856/11,497) vs. 10.4% (953/9,144), Pooled RR 0.59, 95% CI 0.42 to 0.95, I^2=82.4%

Outcome Timing	Number of Studies (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect
New neurological deficit	1 RCT (N=32)[28] 6 NRSIs (N=37,095) [27,29-32,36]	High (RCT) Moderate (NRSI)	Consistent	Imprecise	Undetected	Low	**RCT**: no cases of postoperative worsening of myelopathy or C5 root palsy **Central nervous system complications** 1 NRSI (N=3,042), 3 months <0.7% (<11/1521) vs. 0.9% (14/1521), p=NS **Neurologic complications** 2 NRSIs (N=21,296) Inpatient: 0.35% (24/6942) vs. 0.59% (41/6942), adjusted OR for PCDF 1.7, 95% CI 1.0 to 2.8 1 month: 1.1% (55/4895) vs. 1.8% (45/2517), OR for PCDF 1.6, 95% CI 1.08 to 2.38 **New neurological or motor deficit** 2 NRSIs (N=209), 12 months 4.1% (7/169) vs. 3.2% (3/95), RR 1.31, 95% CI 0.35 to 4.95) 2% (4/163) vs. 0% (0/82) **Postoperative coma** 1 NRSI (N=12,248) 0.4% (27/6124) vs. 0.6% (34/6124), OR 1.26 for PCDF, 95% CI 0.75 to 1.77

Outcome Timing	Number of Studies (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect
Mortality	4 NRSIs (N=27,305)[27,34-36]	Moderate	Consistent	Imprecise	Undetected	Low	**ACDF vs. laminoplasty at 1 month:** 1 NRSI (N=364) 0% (0/182) vs. 0.05% (1/182) RR 0.33, 95% CI 0.01 to 8.13 **ACDF vs. PCDF at discharge to 1 month** 3 NRSIs (N=14,875) 0.3% (22/7431) vs. 0.3% (25/7444) Pooled RR 0.96, 95% CI 0.25 to 1.81, I^2=17.8% **ACDF vs. PCDF at 3 months** 1 NRSI (N=12,248) 0% (0/6124) vs. 0% (0/6124) Studies other than the largest administrative data study (N=13,884) were likely underpowered to detect rare events.
Severe dysphagia	2 NRSIs (N=609)[29,35]	Moderate	Consistent	Imprecise	Undetected	Low	Dysphagia requiring NG tube (1 NRSI): 1% (2/163) vs. 0% (0/82), p=0.31 Unplanned readmission due to dysphagia (1 NRSI): 0.5% (1/182) vs. 0% (0/182), p=NR

Serious AEs	1 RCT (N=32)[28] 9 NRSIs (N=41,982)[27,29-36]	High (RCT) Moderate (NRSI)	Inconsistent	Imprecise	Undetected	Low	**RCT** Intraoperative dural tear: 5.9% (1/17) vs. 11.8% (2/17), RR 0.50, 95% CI 0.05 to 5.01 No cases of instrumentation failure or malposition, infection or hematoma **Deep vein thrombosis/pulmonary embolism** 8 NRSIs (N=41,718), consistent results Range, 0% to 2.3% vs. 0% to 4.3% 4 studies found PCDF associated with higher odds of DVT/PE (range of ORs, 1.8 to 3.7) **Stroke/cerebrovascular events** 3 NRSIs (N=13,421), inconsistent results 0% (0/182) vs. 0% (0/364); 1.8% (6/307) vs. 0% (0/320), p=0.016; 2.5% (154/6124) vs. 4.2% (255/6124), OR 1.68, 95% CI 1.48 to 1.89 **Sepsis** 3 NRSIs (N=7,302), inconsistent results 1 NRSI: 0.7% (13/1857) vs. 2.5% (46/1857), adjusted OR 3.56, 95% CI 1.96 to 6.91 2 NRSIs (N=3,588), range <0.7% to 1.1 vs. <0.7% to 1.7%, p=NS **Surgical site infection** 4 NRSIs (N=22,947), consistent results 3 NRSIs (N=22,702): range, 0.8% to 1.0% vs. 2.4% to 4.7%, range of ORs for PCDF 3.1 to 3.7 (p<0.05) 1 NRSI (N=245): 1% (1/163) vs. 1% (1/82), p=0.62 **Wound dehiscence** 4 NRSIs (N=22,947), inconsistent results 2 NRSI (N=19,660): range, 1.3% to 2.7% vs. 0.1% to 0.5%, range of ORs for PCDF 5.6 to 10.8, p<0.05 2 NRSIs (N=509): range 0% to 1% vs. 0% to 1%, p=NS

Outcome Timing	Number of Studies (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect
							Dural tear/durotomy 2 NRSIs (N=891), inconsistent results 1 NRSI (N=627): 9.4% (29/307) vs. 3.2% (10/320), RR 3.02, 95% CI 1.50 to 6.10 1 NRSI (N=264): 0% (0/169) vs. 0/95) **Any serious AE (not defined)** 1 NRSI (N=3,714): 6.1% (113/1857) vs. 13.0% (242/1857), OR 2.31 for PCDF, 95% CI 1.83 to 2.93

ACDF = anterior cervical discectomy and fusion; AE = adverse event; CI = confidence interval; EQ52 = EuroQOL-5D; MCS = Mental Component Score; mJOA = modified Japanese Orthopaedic Association score; NDI = Neck Disability Index; NRS = Numeric Rating Scale; NS = not significant; OR = odds ratio; PCDF = posterior cervical decompression and fusion; PCS = Physical Component Score; RCT = randomized controlled trial; SF-36/12 = 36- or 12-Item Short Form Health Survey; VAS = visual analog scale

Table G-8. Key Question 7: laminectomy with fusion vs. laminoplasty

Outcome	Studies (n)	Limitations	Consistency	Directness	Precision	Reporting Bias	Summary of Findings	Strength of Evidence
Neurologic function: JOA	2 RCTs (N=46)[37,38] 4 observational studies (N=582)[39-42]	Moderate	Consistent	Direct	Precise	Not detected	No difference between cervical laminoplasty and cervical laminectomy and fusion in JOA scores in the trials (pooled MD -0.03; 95% CI -0.68 to 0.74) or in 3 of 4 observational studies	Moderate
Neurologic function: Nurick grade	2 RCTs (N=46)[37,38] 1 observational study (N=266)[40]	Moderate	Inconsistent	Direct	Imprecise	Not detected	No difference between cervical laminoplasty and cervical laminectomy and fusion in Nurick grade in one trial (1.40 vs. 1.67; p=0.23) but a significant pre-post difference in Nurick grade only among laminoplasty patients in the other trial (numeric values not reported; p<0.05); no difference between groups in the observational study	Low
Pain	2 RCTs (N=46)[37,38] 3 observational studies (N=371)[39,41,42]	Moderate	Inconsistent	Direct	Imprecise	Not detected	One trial found a moderate benefit in neck pain with laminectomy and fusion (MD -1.33; p<0.05), but no difference in limb pain, while the other trial reported greater improvements in neck and arm pain only in patients undergoing laminoplasty (numeric values not reported; p<0.05 for both outcomes); three observational studies reported no differences in pain between groups	Insufficient
Neck disability: NDI	2 RCTs (N=46)[37,38] 2 observational studies (N=357)[39,41]	Moderate	Inconsistent	Direct	Imprecise	Not detected	One trial reported no differences in NDI between groups (MD 3.86; p=0.20), while the other reported improved NDI only in patients undergoing laminoplasty (numeric value not reported; p=0.05); two observational studies reported no differences in NDI	Low

Outcome	Studies (n)	Limitations	Consistency	Directness	Precision	Reporting Bias	Summary of Findings	Strength of Evidence
Neurologic function: JOA	2 RCTs (N=46)[37,38] 4 observational studies (N=582)[39-42]	Moderate	Consistent	Direct	Precise	Not detected	No difference between cervical laminoplasty and cervical laminectomy and fusion in JOA scores in the trials (pooled MD -0.03; 95% CI -0.68 to 0.74) or in 3 of 4 observational studies	Moderate
Function: SF-36	1 RCT (N=16)[38] 3 observational studies (N=461)[39-41]	Moderate	Inconsistent	Direct	Imprecise	Not detected	One trial reported improvements in SF-36 in patients undergoing laminoplasty only (numeric value not reported; p<0.05); three observational studies reported no differences in SF-12, SF-36, or SF-36 MCS	Low
Reoperation	2 RCTs (N=46)[37,38] 4 observational studies (N=582)[39-42]	Moderate	Consistent	Direct	Imprecise	Not detected	Two trials and four observational studies found no differences in reoperation rates between groups	Moderate
Infection	2 RCTs (N=46)[37,38] 4 observational studies (N=582)[39-42] 1 database study (N=11,860)[43]	Moderate	Inconsistent	Direct	Imprecise	Not detected	Two trials and four observational studies found no differences in infection between groups, while one database study found fewer infections (matched OR 0.60; p=0.002) with laminoplasty than laminectomy and fusion	Low
Dysphagia	2 observational studies (N=387)[40,42] 1 database study (N=11,860)[44]	Moderate	Inconsistent	Direct	Imprecise	Not detected	Dysphagia was more common with laminectomy and fusion than laminoplasty in one database study (matched OR 0.77; p=0.01), while two other observational studies reported no association	Low

MCS=Mental Component Score; MD = mean difference; mJOA=modified Japanese Orthopaedic Association score; NDI=Neck Disability Index; PCS=Physical Component Score; RCT=randomized controlled trial; SF-36/12=36- or 12-Item Short Form Health Survey

Table G-9. Key Question 8: C-ADR versus ACDF strength of evidence – single-level interventions

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect C-ADR Vs. ACDF
Pain, **Neck pain success** **Neck pain scores** ***Short-term***	**Success** 2 (N=482)[45,46] **Pain scores** 8 (N=1,789)[47-54]	Moderate	Consistent	Precise	Undetected	Moderate	**Success** 79.0% (230/291) vs. 75.9% (145/191) Pooled RR 1.04, 95% CI 0.93 to 1.17, I^2=0% **Pain scores (0-100 VAS)** Pooled MD -3.02, 95% CI -5.53 to -0.40, I^2=15.5%
Pain, **Neck pain success** **Neck pain scores** ***Intermediate term***	**Success** 4 (N=948)[45,46,55,56] **Pain scores** 11 (N=1,898)[47,48,50,53,55,57-62]	Moderate	Consistent	Precise	Undetected	Moderate	**Success** 76.4% (418/547) vs.74.1% (297/401) Pooled RR 1.03, 95% CI 0.95 to 1.12, I^2=0% **Pain scores (0-100 VAS)** Pooled MD -3.39, 95% CI -6.14 to -1.23, I^2=63.4%
Pain, **Neck pain success** **Neck pain scores** ***Long term***	**Success** 1 (N=232)[63] **Pain scores** 5 (N=1,195)[57,63-66]	Moderate	Unknown (success) Consistent (scores)	Precise	Undetected	Moderate	**Success** 85.7% (108/126) vs. 78.3% (83/106) RR 1.09, 95% CI 0.97 to 1.24 **Pain scores (0-100 VAS)** Pooled MD -4.77, 95% CI -7.63 to -1.76, I^2=0%
Pain, **Arm pain success**[a] **Arm pain scores**[b] ***Short-term***	**Success** 2 (N=482)[45,56] **Pain scores** 6 (N=1,761)[49-54]	Moderate	Consistent	Imprecise	Undetected	Moderate	**Success** 49.5% (144/291) vs. 46.6% (89/191) Pooled RR 1.02, 95% CI 0.81 to 1.29, I^2=0% **Pain scores (0-100 VAS)** Pooled MD -0.66, 95% CI -2.93 to 1.43, I^2=0%

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect C-ADR Vs. ACDF
Pain, **Arm pain success**[a] **Arm pain scores**[b] ***Intermediate term***	**Success** 4 (N=948)[45,46,55,56] **Pain scores** 9 (N=1,741)[50,53,55,57,58,60-62,67]	Moderate	Consistent	Imprecise	Undetected	Moderate	**Success** 61.1% (334/547) vs. 62.6% (251/401) Pooled RR 1.0, 95% CI 0.85 to 1.14, I^2=37.9% **Pain scores (0-100 VAS)** Pooled MD -1.86, 95% CI -4.03 to -0.56, I^2=0%)
Pain, **Arm pain success**[a] **Arm pain scores**[b] ***Long Term***	**Success** 1 (N=232)[63] **Pain scores** 5 (N=1,195)[57,63-66]	Moderate	Unknown (success) Consistent (scores)	Precise	Undetected	Moderate	**Success** 85.7% (108/126) vs. 75.5% (80/106) RR 1.14, 95% CI 1.0 to 1.29 **Pain scores (0-100 VAS)** Pooled MD -4.55, 95% CI -7.62 to -1.68, I^2=0%,
Function, Neurologic **Neurological Success** **JOA** ***Short-term***	**Success** 5 (N=1,493)[45,46,51,54,56] **JOA scores** 1 (N=60)[68]	Moderate	Consistent	Precise	Undetected	Moderate	**Success** 95.5% (791/828) vs. 90.5% (602/665) Pooled RR 1.05, 95% CI 1.02 to 1.08, I^2=0% **JOA scores (0-17)** MD 0.25, 95% CI -0.25 to 0.75

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect C-ADR Vs. ACDF
Function, Neurologic **Neurological Success** **JOA** ***Intermediate term***	**Success** 6 (N=1,574)[50,53,55,57,61,69] **JOA scores** 4 (N=354)[59,68,70,71] **Nurick** 1 (N=285)[72]	Moderate	Consistent	Precise (success and Nurick) Imprecise (JOA)	Unreported	Moderate	**Success** 93.3% (835/895) vs.89.5% (608/679) Pooled RR 1.03 95% CI 1.0 to 1.06, I^2=0% **JOA scores (0-17)** Pooled MD 0.60, 95% CI -0.007 to 0.97, I^2=1.9% (Highest quality RCT: RR 0.20, 95% CI -1.30 to 1.70) **Nurick Grade** 99.4% (156/157) vs. 96.9% (124/128) RR 1.03, 95% CI 0.99 to 1.06
Function, Neurologic **Neurological Success** ***Long-term***	**Success** 5 (N=1,180)[57,63-66]	Moderate	Consistent	Precise	Unreported	Moderate	**Success** 89.9% (599/666) vs. 866% (445/514) Pooled RR 1.02, 95% CI 0.97 to 1.09, I^2=43.3%

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect C-ADR Vs. ACDF
Function, General **NDI Success** **NDI Scores** **SF-36/12 Success (PCS and MCS)** **SF-36/12 scores (PCS and MCS)** ***Short-term***	**NDI Success** 6 (N=1,900)[45,46,51,54,56,61] **NDI Scores** 8 (N=2,125)[47-51,58,63,72] **SF-36/12 Success (PCS)** 2 (N=466)[45,56] **SF-36/12 PCS scores** 6 (N=1,779)[48,49,51,53,54,73] **SF-36/12 Success (MCS)** 2 (N=466)[45,56] **SF-36/12 MCS scores** 6 (N=1,779)[48,49,51,53,54,73]	Moderate	Consistent	Precise	Unreported	Moderate	**NDI Success** 85.7% (490/572) vs. 82.3% (348/423) Pooled RR 1.07, 95%CI 1.01 to 1.13, I^2=31.6% **NDI scores (0-100)** Pooled MD -3.13, 95%CI -4.29 to -1.99, I^2=0% **SF-36/12 PCS Success** 81.7% (228/279) vs. 75.9% (142/187) Pooled RR 1.08, 95%CI 0.96 to 1.23, I^2=0% **SF-36/12 PCS Scores (0-100)** Pooled MD 1.67, 95% CI 0.59 to 2.87, I^2=0% **SF-36/12 MCS Success** 49.1% (137/279) vs.42.8% (80/187) Pooled RR 1.13 95%CI 0.86 to 1.50, I^2=0% **SF-36/12 scores (MCS) (0-100)** MD 1.14, 95% CI -0.14 to 2.17, I^2=0%

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect C-ADR Vs. ACDF
Function, General **NDI Success** **NDI Scores** **SF-36/12 Success (PCS and MCS)** **SF-36/12 scores (PCS and MCS)** **Odom's Criteria** ***Intermediate term***	**NDI Success** 6 (N=1,678)[50,53,55,57,61,74] **NDI Scores** 12 (N=2,027)[47,48,50,53,55,57-59,61,62,71,75] **SF-36/12 Success (PCS)** 4 (N=939)[45,46,53,55] **SF-36/12 PCS scores** 7 (N=1,684)[48,50,53,55,57,61,64] **SF-36/12 Success (MCS)** 4 (N=939)[45,46,53,55] **SF-36/12 scores (MCS)** 7 (N=1,684)[45,46,53,55] **Odom's Criteria** 1 (N=682)[c72]	Moderate	Consistent	Precise	Undetected	Moderate	**NDI Success** 82.9% (780/941) vs. 78.2% (576/737) Pooled RR 1.07, 95% CI 1.01 to 1.14, I^2=8.4% **NDI scores (0-100)** Pooled MD -2.10, 95% CI -3.94 to -0.35, I^2=49.3% **SF-36/12 PCS success** 73.2% (396/541) vs. 60.6% (241/398) Pooled RR 1.16 95% CI 1.00 to 1.41, I^2=61.2% **SF-36/12 PCS scores (0-100)** Pooled MD 2.13, 95% CI 0.77 to 3.33, I^2=0% **SF-36/12 MCS success** 47.3% (256/541) vs. 48.0% (191/398) Pooled RR 0.97 95% CI 0.80 to 1.16, I^2=27.5% **SF-36/12 scores (MCS) (0-100)** Pooled MD 0.83, 95% CI -0.75 to 2.41, I^2=32.2% **Odom's Criteria[c]** Excellent or Good 45.7% (172/376) vs. 43.1% (132/306), RR 1.06, 95% CI 0.90 to 1.26 Fair: 8.0% (15/188) vs. 9.8% (15/153), RR 0.81, 95% CI 0.41 to 1.61 Poor: 0.5% (1/188) vs. 3.9% (6/153), RR 0.14, 95% CI 0.02 to 1.11

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect C-ADR Vs. ACDF
Function, General **NDI Success** **NDI Scores** **SF-36/12 Success (PCS and MCS)** **SF-36/12 scores (PCS and MCS)** ***Long-term***	**NDI Success** 4 (N=1,047)[57,63,65,66] **NDI Scores** 6 (N=1,291)[48,57,63-66] **SF-36/12 Success (PCS)** 1 (N=231)[63] **SF-36/12 PCS scores** 5 (N=1,191)[57,63-66] **SF-36/12 success (MCS)** 1 (N=231)[63] **SF-36/12 MCS scores** 3 (N=574)[63,64,66]	Moderate	Consistent	Precise	Undetected	Moderate	**NDI success** 86.4% (513/594) vs.80.8% (366/453) Pooled RR 1.06, 95% CI 0.99 to 1.15, I^2=35.5% **NDI scores (0-100**) Pooled MD -3.30 95%CI -5.13 to 1.02, I^2=0% **SF-36/12 PCS success** 72.0% (90/125) vs.74.5% (79/106) RR 0.97, 95%CI 0.83 to 1.13 **SF-36/12 PCS scores (0-100)** MD 1.76, 95% CI 0.44 to 3.07, I^2=0% **SF-36/12 MCS success** 47.2% (59/125) vs. ACDF: 43.4% (46/106) RR 1.09, 95% CI 0.82 to 1.45 **SF-36/12 MCS scores (0-100)** Pooled MD 0.64, 95% CI -1.47 to 2.82, I^2=0%
Quality of Life	No studies	N/A	N/A	N/A	N/A	N/A	N/A

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect C-ADR Vs. ACDF
Reoperation at index level ***24 months*** ***36-40 months*** ***60 months*** ***>60 months***	**24 months** 9 (N=2,323)[53,54,57,61,62,67,74-76] **48 months** 3 (N=847)[47,70,72,75] **60 months** 4 (N=957)[55,59,77,78] **>60 months** 7 (N=1,992)[48,55,57,63,64,66,79]	Low	Consistent	Precise	Undetected	High	**24 months** 2.9% (36/1250) vs. 6.2% (66/1073) Pooled RR 0.49, 95% CI 0.28 to 0.80, I^2=16.2% **48 months** 3.6% (18/494) vs. 7.4% (28/380) Pooled RR 0.50, 95% CI 0.22 to 0.98, I^2=0% **60 months** 4.9% (27/547) vs. 12.4% (51/410) Pooled RR 0.39, 95% CI 0.15 to 0.71, I^2=37.4% **>60 months** 5.2% (56/1085) vs. 12.5% (113/907) Pooled RR 0.44, 95% CI 0.29 to 0.60, I^2=0%

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect C-ADR Vs. ACDF
Neurological deficit (variably defined by authors)	**24 months (cumulative)** 1 (N=463)[80] **24-48 months** 1 (N=463)[61] **120 months (cumulative)** 1 (N=463)[79] **84 months (cumulative)** 1 (N=245)[66]	Moderate	Unknown[d]	Imprecise	Undetected	Low	**1 RCT** 24 months, acute neurologic change[e]: 3.3% (8/242) vs. 3.2% (7/221) RR 1.04, 95% CI 0.38 to 2.83 24-48 months, severe deficit (WHO grade 3 or 4): 0% (0/242) vs. 1.0% (2/221) 120 months, neurological AEs Any: 43.1% (104/242) vs. 43.8% (97/221), RR 0.98, 95% CI 0.80 to 1.21 WHO grade 3 or 4: 4.5% (11/242) vs. 6.9% (15/221), RR 0.67, 95% CI 0.31 to 1.43 **1 RCT** 84 months, neurological failure: 11.4% (19/164) vs. 11.5% (9/81), RR 1.04, 95% CI 0.49 to 2.20
Mortality (all cause)	**24 months** 3 (N=1,181)[53,57,76] **36 months** 2 (N=504)[52,80] **>60 months** 2 (N=773)[57,79]	Moderate	Consistent	Imprecise downgrade 2 for rare event	Undetected	Insufficient	Mortality was uncommon; most deaths do not appear to be procedure related. **24 months** (N range, 260–532) Range: 0%–0.4% vs. 0%–1.3% **36 months** (Ns, 463 and 41) Range: 0%–5.0% vs. 0%–0.5% (0% to 0.5% in larger trial) **>60 months** (Ns, 232 and 541) Range: 0.9%–1.4% vs. 2.2%–2.4% Individual studies may have been underpowered to detect rare events, particularly procedure-specific events

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect C-ADR Vs. ACDF
Serious AEs (any, cumulative)	**24 months** 5 (N=1,611)[53,72,74,76,80] **48 months** 2 (N=723)[61,73] **60 months** 1 (N=304)[55] **>60 months** 2 (N=614)[63,79]	Moderate	Unknown[f]	Imprecise	Undetected	Low	**24 months** 24.6% (216/878) vs. 30.6% (224/733 Pooled RR 0.83, 95% CI 0.64 to 0.97, I^2=24.6% **48 months** 32.1% (135/421) vs. 41.1% (124/302) Pooled RR 0.93, 95% CI 0.71 to 1.24, I^2=0% **60 months** 21.0% (45/214) vs. 17.4% (33/190) RR 1.21, 95% CI 0.81 to 1.81 **>60 months** 48.1% (176/366) vs. 56.9% (141/248) Pooled RR 0.90, 95% CI 0.73 to 1.06, I^2=0%

ACDF=anterior cervical discectomy and fusion; AE=adverse events; C-ADR=cervical artificial disc replacement; CI=confidence interval; MCS=Mental Component Score; MD=mean difference; mJOA=modified Japanese Orthopaedic Association score; NDI=Neck Disability Index; PCS=Physical Component Score; RCT=randomized controlled trial; RR=risk ratio; SF-36/12=36- or 12-Item Short Form Health Survey; SSED=Summary of Safety and Effectiveness Data (FDA); VAS=visual analog scale; WHO=World Health Organization.

[a] Some studies reported arm pain success in both arms. We used the lower risk ratio reported for the conservative analysis.

[b] Some studies reported arm pain success in both arms. We the smaller difference reported for the conservative analysis.

[c] Based on the largest, highest quality trial.

[d] Categorization, types of conditions included, and definitions were not well described in studies various general terms were used (e.g., new deficit, neurological failure, neurological AE).

[e] Sensory upper extremity and lower extremity, motor upper extremity, myelopathy, and SCI.

[f] Definitions of serious adverse events varied across RCTs; many RCTs included events that may not be attributed to the devices/procedures.

Table G-10. Key Question 8: C-ADR versus ACDF strength of evidence – 2-level interventions

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect C-ADR Vs. ACDF
Pain, **Neck pain success** **Neck pain scores** ***Short-term***	**Success** 2 (N=692)[81,82] **Pain scores** 3 (N=764)[83-85]	Moderate	Consistent	Precise (success) Imprecise (scores)	Undetected	Moderate	**Success** 88.2% (372/422) vs. ACDF: 80.7% (218/270) Pooled RR 1.10, 95% CI 1.01 to 1.23, I^2=0.8% **Pain scores (0-100 VAS)** Pooled MD -5.83, 95% CI -12.28 to 0.61, I^2=50.3%)
Pain, **Neck pain success** **Neck pain scores** ***Intermediate term***	**Success** 2 (N=678)[81,82] **Pain scores** 4 (N=707)[68,83,85,86]	Moderate	Consistent	Precise (success) Imprecise (scores)	Undetected	Moderate	**Success** 86.9% (365/420) vs. ACDF: 83.3% (215/258) Pooled RR 1.06, 95% CI 0.98 to 1.15, I^2=0% **Pain scores (0-100 VAS)** Pooled MD -8.21, 95% CI -13.83 to -4.25, I^2=23%
Pain, **Neck pain success** **Neck pain scores** ***Long Term***	**Success** 1 (N=221)[82] **Pain scores** 3 (N=615)[66,85,86]	Moderate	Consistent	Precise (success) Imprecise (scores)	Undetected	Moderate	**Success** 91.2% (114/125) vs. ACDF: 81.3% (78/96) RR 1.12, 95% CI 1.01 to 1.25 **Pain scores (0-100 VAS)** Pooled MD -8.13, 95% CI -15.18 to -2.97, I^2=55.9%
Pain, **Arm pain success**[a] **Arm pain scores**[b] ***Short-term***	**Success** 2 (N=692)[81,82] **Pain scores** 2 (N=692)[81,82]	Moderate	Consistent	Precise (success) Imprecise (scores)	Undetected	Moderate	**Success** 70.6% (298/422) vs. 74.1% (200/270) Pooled RR, 1.00, 95% CI 0.90 to 1.14, I^2=0% **Pain scores (0-100 VAS)** Pooled MD -3.72, 95% CI -9.53 to 1.62, I^2=0%

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect C-ADR Vs. ACDF
Pain, **Arm pain success**[a] **Arm pain scores**[b] ***Intermediate term***	**Success** 2 (N=678)[81,82] **Pain scores** 3 (N=627)[68,83,86]	Moderate	Consistent	Precise (success) Imprecise (scores)	Undetected	Moderate	**Success** 71.9% (302/420) vs. 74.0% (191/258) Pooled RR, 1.02, 95% CI 0.92 to 1.14, I^2=0% **Pain scores (0-100 VAS)** Pooled MD -9.95, 95% CI -15.10 to -5.15, I^2=0%
Pain, **Arm pain success**[a] **Arm pain scores**[b] ***Long term***	**Success** 1 (N=220)[82] **Pain scores** 2 (N=535)[66,86]	Moderate	Consistent	Precise (success) Imprecise (scores)	Undetected	Moderate	**Success** 82.3% (102/124) vs. 87.5% (84/96) RR, 0.94, 95%CI 0.84 to 1.05 **Pain scores (0-100 VAS)** Pooled MD -5.08, 95% CI -11.73 to 1.70, I^2=1.4%
Function, Neurologic **Neurological Success** **JOA** ***Short-term***	**Success** 2 (N=692)[81,82] **JOA** 1 (N=96)[85]	Moderate	Consistent	Precise (success) Imprecise (JOA)	Undetected	Moderate	**Success** C-ADR: 91.0% (382/420) vs. ACDF: 87.9% (239/272) Pooled RR 1.03, 95% CI 0.96 to 1.10, I^2=0% **Mean JOA (0-17 scale)** 15.2 vs. 14.9, p>0.05
Function, Neurologic **Neurological Success** **JOA** ***Intermediate term***	**Success** 2 (N=604)[83,86] **JOA** 1 (N=96)[85]	Moderate	Consistent	Precise (success) Imprecise (JOA)	Undetected	Moderate	**Success** 91.4% (339/371) vs. ACDF: 90.6% (211/233) Pooled RR 0.99, 95% CI 0.93 to 1.07, I^2=0% **Mean JOA (0-17 scale**) 15.4 vs. 15.3, p>0.05
Function, Neurologic **Neurological Success** **JOA** ***Long term***	**Success** 2 (N=535)[66,86] **JOA** 1 (N=96)[85]	Moderate	Consistent	Precise (success) Imprecise (JOA)	Undetected	Moderate	**Success** 93.2% (315/338) vs. ACDF: 84.8% (167/197) Pooled RR 1.10, 95% CI 1.01 to 1.20 I^2=0% **Mean JOA (0-17 scale)** 15.4 vs. 15.2, p>0.05

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect C-ADR Vs. ACDF
Function, General **NDI Success** **NDI Scores** **SF-36/12 Success (PCS and MCS)** **SF-36/12 scores (PCS and MCS)** ***Short-term***	**NDI Success** 2 (N=692)[83,84] **NDI Scores** 3 (N=772)[83-85] **SF-36/12 Success (PCS)** 2 (N=657)[81,82] **SF-36/12 scores (PCS)** 2 (N=692)[83,84] **SF-36/12 Success (MCS)** 2 (N=657)[81,82] **SF-36/12 scores (MCS)** 1 (N=380)[84]	Moderate	Consistent	Precise (success) Imprecise (scores)	Undetected	Moderate	**NDI success** 89.3% (377/422) vs. 80.0% (216/270) Pooled RR 1.12, 95% CI 1.04 to 1.22, I2=0% **NDI scores** Pooled MD -5.79, 95% CI -8.44 to -3.21, I2=0% **SF-36/12 success (PCS)** 76.5% (303/396) vs. 69.3% (181/261) Pooled RR 1.11, 95% CI 0.88 to 1.46 I2=72.7% **SF-36/12 scores (PCS) (0-100)** Pooled MD 3.29, 95% CI 0.63 to 6.19, I2=36.6% **SF-36/12 success (MCS)** 50.3% (199/396) vs. 45.2% (118/261) Pooled RR 1.08, 95% CI 0.82 to 1.41, I2=43.9% **SF-36/12 scores (MCS) (0-100)** MD 1.00 95% CI -1.37 to 3.37

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect C-ADR Vs. ACDF
Function, General **NDI Success** **NDI Scores** **SF-36/12 Success (PCS and MCS)** **SF-36/12 scores (PCS and MCS)** **Odom's Criteria** ***Intermediate term***	**NDI success** 1 (N=307)[86] **NDI scores** 4 (N=707)[68,83,85,86] **SF-36/12 success (PCS)** 2 (N=639)[81,84] **SF-36/12 scores (PCS)** 3 (N=627)[68,83,86] **SF-36/12 scores (MCS)** 2 (N=639)[81,84] **SF-36/12 scores (MCS)** 2 (N=665)[84,87] **Odom's Criteria** 1 RCT (N=62)[68]	Moderate	Consistent	Precise (success) Imprecise (scores)	Undetected	Moderate	**NDI success** 89.2% (149/167) vs. 77.9% (109/140) RR 1.15, 95% CI 1.03 to 1.27 **NDI scores (0-100)** Pooled MD -7.69, 95% CI -10.30 to -5.10, I^2=0% **SF-36/12 success (PCS)** 83.7% (335/400) vs. 79.1% (189/239) Pooled RR 1.06, 95% CI 0.92 to 1.36 I^2=69.7% **SF-36/12 scores (PCS) (0-100)** Pooled MD 4.80, 95% CI 2.74 to 6.87, I2=0% **SF-36/12 Success (MCS)** 62.3% (249/400) vs. 65.3% (156/239) Pooled RR 0.98, 95% CI 0.85 to 1.18, I^2=0% **SF-36/12 scores (MCS) (0-100)** Pooled MD 1.12, 95% CI -1.07 to 3.29, I^2=0% **Odom's Criteria** 96.7% vs. 84.4%, RR 1.15, 95% CI 0.97 to 1.34

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect C-ADR Vs. ACDF
Function, General **NDI Success** **NDI Scores** **SF-36/12 Success (PCS)** **SF-36/12 scores (MCS)** ***Long term***	**NDI success** 2 (N=535)[66,86] **NDI scores** 3 (N=615)[66,85,86] **SF-36/12 success (PCS)** 1 (N=216)[82] **SF-36/12 scores (PCS)** 2 (N=535)[66,86] **SF-36/12 success (MCS)** 1 (N=216)[82] **SF-36/12 scores (MCS)** 1 (N=269)[66]	Moderate	Consistent	Precise (success) Imprecise (scores)	Undetected	Moderate	**NDI success** 84.3% (285/338) vs. 73.6% (145/197) Pooled RR 1.16, 95% CI 1.04 to 1.30, I^2=0% **NDI scores (0-100)** Pooled MD -7.63, 95% CI -10.64 to -4.52, I^2=0% **SF-36/12 success (PCS)** 76.4% (94/123) vs. 71.0% (66/93) RR 1.08 95% CI 0.91 vs. 1.27 **SF-36/12 scores (PCS) (0-100)** Pooled MD 2.32, 95% CI -0.03 to 4.71, I2=0% **SF-36/12 success (MCS)** 53.7% (66/123) vs. 52.7% (49/93), RR 1.02, 95% CI 0.79 to 1.31 **SF-36/12 scores (MCS) (0-100)** MD 2.90, 95% CI -0.25 to 6.05
Quality of Life	No studies	NA	NA	NA	NA	NA	NA

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect C-ADR Vs. ACDF
Reoperation at index level **24 months** **36 to 48 months** **60 months** **>60 months**	**24 months** 2 (N=727)[84,88] **36 to 48 months** 1 (N=330)[87] **60 months** 1 (N=339)[78] **>60 months** 2 (N=727)[66,86]	Moderate	Consistent	Imprecise	Undetected	Low	**24 months** 2.8% (12/434) vs. 9.2% (27/293) Pooled RR 0.28, 95% CI 0.13 to 0.61, I^2=0% **36 to 48 months** 4.0% (9/225) vs. 15.2% (16/105) RR 0.26, 95% CI 0.12 to 0.57 **60 months** 4.7% (11/234) vs. 18.1% (19/105) RR 0.26, 95% CI 0.13 to 0.53 **>60 months** 4.4% (19/434) vs. 15.0% (44/293) Pooled RR 0.29, 95% CI 0.16 to 0.52, I^2=0%
Neurological deficit or events	**24 months** 1 (N=65)[68] **48 months** 1 (N=330)[87] **84 months** 1 (N=330)[87]	Moderate	Unknown (various definitions)	Imprecise	Undetected	Insufficient	**24 months** 0% (0/31) vs. 0% (0/34) **48 months** 6.2% (14/225) vs. 7.6% (8/105) RR 0.82, 95% CI 0.35 to 1.89 **84 months** 6.4% (14/225) vs. 17.1% (18/105) RR 0.36, 95% CI 0.19 to 0.70
Mortality (all cause, cumulative)	1 (N=397)[84]	Moderate	Unknown	Imprecise (Downgrade 2 for rare event)	Undetected	Insufficient	1.0% (2/209) vs. 1.6% (3/188) RR 0.60, 95% CI 0.10 to 3.55 Individual studies may have been underpowered to detect rare events, particularly procedure-specific events

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect C-ADR Vs. ACDF
Serious AEs[c]	**24 months** 2 (N=727)[84,86-89] **120 months** 1 (N=397)[86]	Moderate	Unknown	Imprecise	Undetected	Low	**24 months** 29.3% (127/434) vs. 42.3% (124/293) Pooled RR 0.73, 95% CI 0.58 to 0.93, I^2=0% **120 months** 66.7% (124/209) vs. 70.9% (120/188) RR 0.93, 95% CI 0.80 to 1.09

ACDF=anterior cervical discectomy and fusion; AE=adverse events; C-ADR=cervical artificial disc replacement; CI=confidence interval; MCS=Mental Component Score; MD=mean difference; mJOA=modified Japanese Orthopaedic Association score; NA = not applicable; NDI=Neck Disability Index; PCS=Physical Component Score; RCT=randomized controlled trial; RR=risk ratio; SF-36/12=36- or 12-Item Short Form Health Survey; SSED=Summary of Safety and Effectiveness Data (FDA); VAS=visual analog scale.

[a] Some studies reported arm pain success in both arms. We used the lower risk ratio reported for the conservative analysis.

[b] Some studies reported arm pain success in both arms. We the smaller difference reported for the conservative analysis.

[c] Serious adverse events were variably defined across studies and included broad range of events that may not be linked with either procedure; see full report.

Table G-11. Key Question 8: C-ADR versus ACDF strength of evidence – mixed level (i.e., 1, 2, or 3) interventions

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect C-ADR Vs. ACDF
Pain, **Neck pain scores** ***Intermediate term***	1 (N=50)[90]	Moderate	Unknown	Imprecise	Undetected	Low	60 months **VAS neck pain (0-10),** median (IQR): 3.6 (3.2 to 4.1) vs. 3.9 (3.0 to 4.4), p=0.203
Function, Neurologic **JOA** ***Intermediate term***	1 (N=81)[91]	Moderate	Unknown	Imprecise	Undetected	Insufficient	36 months **JOA score (0-17 scale),** mean (estimated from graph): 15.4 vs. 14.7, p=0.016
Function, General **NDI scores** **SF-36 PCS scores** **Odom's Criteria** ***Intermediate term***	**NDI scores** 2 (N=133)[90,91] **SF-36 PCS, Odom's Criteria** 1 (N=51)[91]	Moderate	Unknown	Imprecise	Undetected	Insufficient	**NDI scores (0-50 scale)** 1 RCT, 36 months: Mean 12 vs. 18 (estimated from graph), p<0.001 1 RCT, 60 months: Median 7 (IQR 6 to 8) for both groups **SF-36 PCS scores (0-100),** 1 RCT, 36 months: Mean 50.5 vs. 44.5 (estimated from graph), p<0.05 **Odom's Criteria**, 1 RCT, 36 months: Excellent: 58.5% (24/41) vs. 58.5% (23/40), RR 1.02, 95% CI 0.70 to 1.47 Good: 34.1% (14/41) vs. 25% (10/40), RR 1.37, 95% CI 0.69 to 2.71
Quality of Life	No studies	NA	NA	NA	NA	NA	NA
Reoperations at index level	2 (N=136)[91,92]	High	Unknown	Imprecise	Undetected	Insufficient	12–36 months, 1 RCT (N=53): 4% (1/25) vs. 7.1% (2/28), RR 0.56, 95% CI 0.05 to 5.81 36 months, 1 RCT (N=83): none in either group

Outcome Timing	Number of RCTs (Patients) Author Year	Study Limitations	Consistency	Precision	Reporting Bias	Strength of Evidence	Findings, Direction, and Magnitude of Effect C-ADR Vs. ACDF
Neurologic deficit	2 (N=136)[91,92]	High	Unknown	Imprecise	Undetected	Insufficient	1 RCT: Transient recurrent nerve paralysis, 4% (1/25) vs. 3.6% (1/28), RR 1.12, 95% CI 0.07 to 16.98 Worsening arm pain and neurological deficit, 0% (0/25) vs. 3.6% (1/28) 1 RCT (N=83): No intraoperative neurologic complications in either group
Mortality	1 (N=83)[91]	Moderate	Unknown	Imprecise (Downgrade 2 for rare event)	Undetected	Insufficient	No deaths occurred in either group through 90 months.
Serious AEs	2 (N=136)[91,92]	High	Unknown	Imprecise	Undetected	Insufficient	1 RCT DVT: 2.4% (1/41) vs. 0% (0/42) HO (severity NR): 2.4% (1/41) vs. N/A CSF leak and wound hematoma: no cases in either group 1 RCT Wound hematoma, required urgent evacuation: 0% (0/25) vs. 3.6% (1/28) Recurrent cervical pain, required local infiltration (3–6 months): 0% (0/25) vs. 10.7% (3/28)

ACDF=anterior cervical discectomy and fusion; AE=adverse events; C-ADR=cervical artificial disc replacement; CI=confidence interval; CSF=cerebrospinal fluid; DVT=deep vein thrombosis; HO=heterotopic ossification; JOA=Japanese Orthopaedic Association score; MD=mean difference; NA=not applicable; NDI=Neck Disability Index; PCS=Physical Component Score; RCT=randomized controlled trial; RR=risk ratio; SF-36=Short-form 36 questionnaire; VAS=visual analog scale.

Table G-12. Key Question 9: Interbody graft material or device – standalone cage versus plate and cage

Outcome	Studies (n)	Limitations	Consistency	Directness	Precision	Reporting Bias	Summary of Findings	Strength of Evidence
Fusion	8 RCTs (N=515)[93-100]	Moderate	Consistent	Direct	Precise	Undetected	12 months: RR 0.99, 95% CI 0.92 to 1.06 24 months: RR 1.00, 95% CI 0.93 to 1.08 36 months: RR 1.00, 95% CI 0.97 to 1.03	Moderate
Neck or nonspecific pain **VAS**	4 RCTs (N=230)[96,97,99,101]	Moderate	Inconsistent	Direct	Imprecise	Undetected	<3 months: MD -0.90, 95% CI -1.29 to 0.73 3 months: MD 0.20, 95% CI -0.35 to 0.75 6 months: MD 0.64, 95% CI -0.66 to 2.17 12 months: MD 0.30, 95% CI -0.54 to 1.43 24 months: MD -0.20, 95% CI -0.63 to 0.23	Insufficient
Arm pain **VAS**	4 RCTs (N=186)[96,97,99,101]	Moderate	Consistent	Direct	Imprecise	Undetected	<3 months: MD -0.24, 95% CI -1.55 to 1.12 3 months: MD 0.06, 95% CI -0.57 to 0.58 6 months: MD -0.15, 95% CI -0.56 to 0.14 12 months: MD -0.11, 95% CI -0.55 to 0.29 24 months: MD 0.20, 95% CI -0.09 to 0.49	Low
Neurologic Function **JOA scores**	5 RCTs (N=424)[93-95,100,101]	Moderate	Consistent	Direct	Imprecise	Undetected	<3 months: MD 2.63, 95% CI -3.86 to 9.29 3 months: MD 0.00, 95% CI -1.70 to 1.70 6 months: MD -0.08, 95% CI -0.70 to 0.59 12 months: MD -0.08, 95% CI -0.56 to 0.46 24 months: MD 0.00, 95% CI -0.69 to 0.69 36 months: -0.13, 95% CI -1.03 to 0.81)	Low

Outcome	Studies (n)	Limitations	Consistency	Directness	Precision	Reporting Bias	Summary of Findings	Strength of Evidence
General Function **NDI scores** **Neck Pain Disability Index (German)** **Odom Criteria**	6 RCTs (N=472)[93,94,97,99-101] 1 RCT (N=41)[98] 3 RCTs (N=202)[96,98,100]	Moderate	Consistent	Direct	Imprecise	Undetected	<3 months: MD -5.39, 95% CI -9.91 to 5.19 3 months: MD -0.14, 95% CI -3.14 to 2.16 6 months: MD -0.08, 95% CI -3.25 to 4.70 12 months: MD -0.13, 95% CI -2.31 to 1.59 24 months: MD -0.13, 95% CI -2.41 to 2.04 36 months: MD 0.15, 95% CI -2.73 to 2.88 Endpoint scores at 24 months: 25.8% vs. 22.2% Trials reported no differences between treatments on ratings of excellent, good, fair and bad; or between excellent+good and fair+poor; or a mean score (1-4 scale)	Low
Quality of Life **Various**	5 RCTs (N=253)[93,95,97-99]	Moderate	Consistent	Direct	Imprecise	Undetected	There were no differences at longer followups (beyond 3 months) on the SWAL-QOL questionnaire, the Eating Assessment Tool, or dysphagia ratings. No study reported a return to the operating for dysphagia. There were no differences on the Voice Handicap Index in one trial.	Low
Adverse Event: Adjacent-level ossification	3 RCTs (N=239)[93,96,100]	Moderate	Consistent	Direct	Precise	Undetected	8% vs. 27%, RR 0.25, 95% CI 0.12 to 0.52 ALO severity favored standalone cage in 1 trial (0.208 vs. 0.818, p=0.001)	Low
Adverse Event: Subsidence	1 RCT (N=46)[96]	Moderate	Unknown	Direct	Imprecise	Undetected	12 months: 12.5% vs. 9.1%, RR 1.38, 95% CI 0.25 to 7.48 24 months: 16.7% vs. 13.6%, RR 1.22, 95% CI 0.31 to 4.87	Insufficient

ALO=adjacent level ossification; CI=confidence interval; JOA=Japanese Orthopedic Association; MD=mean difference; NDI=Neck Disability Index; RCT=randomized controlled trial; RR=relative risk; VAS=Visual Analogue Scale

Table G-13. Key Question 9: Interbody graft material or device – titanium cage/titanium-coated PEEK cage versus PEEK cage

Outcome	Studies (n)	Limitations	Consistency	Directness	Precision	Reporting Bias	Summary of Findings	Strength of Evidence
Fusion	3 RCTs (N=217)[102-104]	Moderate	Consistent	Direct	Imprecise	Undetected	1 trial at 99.7 months: 60/60 patients achieved 3-level fusion 1 trial at 24 months: 32/27 (86.5%) levels fused vs. 34/34 (100%) levels, p=0.0335 1 trial at 12 months: 26/59 (44.1%) levels completely fused vs. 75/85 (88.2%) levels completely fused (p<0.001)	Low
Neurologic Function	1 RCT (N=60)[102]	Moderate	Unknown	Direct	Imprecise	Undetected	Endpoint difference favored PEEK: -1.4, 95% CI -2.33 to -0.47	Insufficient
General Function **Odom's Criteria** **NDI**	2 RCT (N=113)[102,104] 1 RCT (N=60)[102]	Moderate	Consistent	Direct	Imprecise	Undetected	Odom Criteria: 1 trial (p<0.05): Excellent: 24% vs. 35% Good: 31% vs. 39% Fair: 28% vs. 16% Bad: 17% vs. 10% 1 trial: Excellent: 21% vs. 28% Good: 54% vs. 52% Fair: 14% vs. 8% Poor: 11% vs. 12% Success: 75% vs. 80%, p=0.6642 NDI: Endpoint difference favors PEEK: 6.4, 95% CI 5.13 to 7.67	Low
Quality of Life	No studies	NA	NA	NA	NA	NA	NA	NA
Adverse Events: Subsidence	3 RCTs (N=217)[102-104]	Moderate	Inconsistent	Direct	Imprecise	Undetected	1 trial (N=104, 166 levels): 20.6% vs. 21.4%, p=0.875 1 trial (N=60, 180 levels): 34.5% vs. 5.4%, p<0.05 1 trial (N=53, 71 levels): 16.2% vs. 0%, p<0.001	Insufficient

CI=confidence interval; NA=not applicable; NDI=Neck Disability Index; PEEK=polyetheretherketone; RCT=randomized controlled trial

Table G-14. Key Question 9: Interbody graft material or device – autograft, allograft, other osteogenic materials

Outcome	Studies (n)	Limitations	Consistency	Directness	Precision	Reporting Bias	Summary of Findings	Strength of Evidence
Fusion	6 RCTs (N=534)[105-110]	Moderate	Unknown	Direct	Imprecise	Undetected	1 trial (N=244) i-FACTOR vs. Local graft: 97.30% vs. 94.44%, p=0.2513 1 trial (N=20) BMP-2 vs. ICBG: 100% vs. 100%, p=1.0 1 trial (N=100) Biphasic calcium phosphate ceramic vs. ICBG: 100% vs. 100%, p=1.0 1 trial (N=27) Allograft vs. Local graft: 100% vs. 100%, p=1.0 Fusion grade: (p=0.73) F: 23.2% vs. 28.6% F+: 38.4% vs. 42.8% F++: 38.4% vs. 28.6% 1 trial (N=66) Calcium sulphate + demineralized bone matrix vs. Iliac cancellous bone,12 mos 104 levels, 24 mos levels NR: 12 months: 94.3% vs. 100%, p=NR 24 months: 100% vs. 100%, p=1.0 1 trial (N=77) Hydroxyapatite + demineralized bone matrix vs. B-tricalcium phosphate + hydroxyapatite: X-ray: 87% vs. 87%, p=1.0 CT: 87% vs. 72%, p=0.16	Insufficient for all comparisons

Outcome	Studies (n)	Limitations	Consistency	Directness	Precision	Reporting Bias	Summary of Findings	Strength of Evidence
Neck Pain **VAS** **NRS** **NPRS**	5 RCTs (N=440)[105,106,108-110]	Moderate	Unknown	Direct	Imprecise	Undetected	1 trial (N=244) i-FACTOR vs. Local graft, VAS endpoint: 1.79, 95% CI 1.33 to 2.24 vs. 2.25, 95% CI 1.78 to 2.72, p=0.4619 1 trial (N=26) BMP-2 vs. ICBG: 20-point NRS: MD 13.0 vs. MD 9.0, p>0.05 1 trial (N=27) Allograft vs. Local graft, 0-10 NPRS: MD -5.09 vs. MD -6.15, p<0.05 1 trial (N=64) Calcium sulphate + demineralized bone matrix vs. Local graft, Improved VAS neck pain: 69% vs. 68%, p>0.05 1 trial (N=77) Hydroxyapatite + demineralized bone matrix vs. B-tricalcium phosphate + hydroxyapatite, VAS: MD -1.6 vs. -1.8, p=0.82	Insufficient for all comparisons
Arm Pain **VAS** **NRS** **NPRS**	5 RCTs (N=440)[105,106,108-110]	Moderate	Unknown	Direct	Imprecise	Undetected	1 trial (N=244) i-FACTOR vs. Local graft, VAS endpoint: 1.56, 95% CI 1.06 to 2.05 vs. 1.95, 95% CI 1.51 to 2.39, p=0.0306 1 trial (N=26) BMP-2 vs. ICBG: 20-point NRS: MD -14.0 vs. -8.5, p<0.03 1 trial (N=27) Allograft vs. Local graft, 0-10 NPRS: MD -4.55 vs/ -7.24, p<0.05 1 trial (N=64) Calcium sulphate + demineralized bone matrix vs. Local graft, Improved VAS neck pain: 70% vs. 68%, p>0.05 1 trial (N=77) Hydroxyapatite + demineralized bone matrix vs. B-tricalcium phosphate + hydroxyapatite, VAS: MD -4.2 vs. -3.6, p=0.27	Insufficient for all comparisons

Outcome	Studies (n)	Limitations	Consistency	Directness	Precision	Reporting Bias	Summary of Findings	Strength of Evidence
Neurologic Function **Neurologic success** **JOA**	4 RCTs (N=436)[105-107,109]	Moderate	Unknown	Direct	Imprecise	Undetected	1 trial (N=244) i-FACTOR vs. Local graft, Neurologic success: 94.87% vs. 93.70%, p=0.6944 1 trial (N=26) BMP-2 vs. ICBG: Neurologic success: 100% vs. 100%, p=1.0 1 trial (N=100) Biphasic calcium phosphate ceramic vs. ICBG, JOA score: MD 2.84 vs. 2.48, p=0.17 JOA recovery rate: 86.51% vs. 83.48%, p=0.22 1 trial (N=66) Calcium sulphate + demineralized bone matrix vs. Iliac cancellous bone, JOA score: MD 3.62 vs. 3.22, p>0.05	Insufficient for all comparisons

Outcome	Studies (n)	Limitations	Consistency	Directness	Precision	Reporting Bias	Summary of Findings	Strength of Evidence
General Function **NDI** **SF-36** **2-item SF-12**	4 RCTs (N=374)[105,106,108,110]	Moderate	Unknown	Direct	Imprecise	Undetected	1 trial (N=244) i-FACTOR vs. Local graft, NDI endpoint: 22.33, 95% CI 18.90 to 25.76 vs. 25.66, 95% CI 22.55 to 28.78, p=0.5607 1 trial (N=26) BMP-2 vs. ICBG: NDI improvement from preoperative scores: 52.7 vs. 36.9, p<0.03 1 trial (N=27) Allograft vs. Local graft, NDI: MD 41.4 vs. MD 56.5, p<0.05 1 trial (N=77) Hydroxyapatite + demineralized bone matrix vs. B-tricalcium phosphate + hydroxyapatite, NDI: MD 22 vs. MD 20, p=0.62 1 trial (N=244) i-FACTOR vs. Local graft, SF-36 PCS endpoint: 45.40, 95% CI 43.60 to 47.20 vs. 44.47, 95% CI 42.70 to 46.24, p=0.6461 SF-36 MCS endpoint: 48.43, 95% CI 46.43 to 50.44 vs. 48.41, 95% CI 46.42 to 50.40, p=0.9040 1 trial (N=26) BMP-2 vs. ICBG: SF-36 PCS: MD 16.7 vs. MD 14.7, p>0.05 SF-36 MCS: MD 21.8 vs. MD 7.2, p>0.05 1 trial (N=27) Allograft vs. Local graft, 2-item SF-12: MD 48.7 vs. MD 65.9, p<0.05	Insufficient for all comparisons
Adverse Events: Adjacent level degeneration	1 RCT (N=319)[105]	Moderate	Unknown	Direct	Imprecise	Undetected	iFACTOR vs. Local graft (N=319): Adjacent segment degeneration: 13.04% vs. 16.45%, p=0.4274	Insufficient

Outcome	Studies (n)	Limitations	Consistency	Directness	Precision	Reporting Bias	Summary of Findings	Strength of Evidence
Adverse Events: Complications	1 RCT (N=33)[106] 2 NRSI (N=944)[111,112]	Moderate	Consistent	Direct	Imprecise	Detected in RCT (Reported harms as "No device-related adverse events")	BMP-2 vs. No BMP-2 (ICBG, cortical allograft, no BMP-2): 1 RCT (N=33), Additional cervical spine surgery: 5.6% vs. 0%, p>0.05 1 NRSI (N=710), Heterotopic ossification: 78.6% vs. 59.2%, p<0.001 1 NRSI (N=234), Neck Swelling Complications (e.g., delay in discharge, severe dysphagia, reintubation, PEG placement, incision and drainage of surgical site, readmission for swelling): 27.5% vs. 3.6%, p<0.001	Low
Adverse Events: Worse Neurologic Status	1 RCT (N=319)[105]	Moderate	Unknown	Direct	Imprecise	Undetected	iFACTOR vs. Local graft, New intractable neck pain: 44.72% vs. 42.11%, p=0.1149 New radiculopathy: 13.66% vs. 25.00%, p=0.0142 Progression of myelopathy: 0.62% vs. 0%, p=1.0	Insufficient
Adverse Events: Additional surgery	1 RCT (N=319)[105]	Moderate	Unknown	Direct	Imprecise	Undetected	iFACTOR vs. Local graft, Additional cervical spine surgery: 7.45% vs. 10.53%, p=0.34	Insufficient

BMP=bone morphogenic protein; CI=confidence interval; CT=computed tomography; ICBG=iliac crest bone graft; JOA=Japanese Orthopedic Association; MD=mean difference; NDI=Neck Disability Index; N(P)RS=Numeric (Pain) Rating Scale; NRSI=non-randomized studies of interventions; RCT=randomized controlled trial; VAS=Visual Analogue Scale

Table G-15. Key Question 11: Prognostic utility of MRI findings

Outcome	Studies (n)	Limitations	Consistency	Directness	Precision	Reporting Bias	Summary of Findings	Strength of Evidence
Diagnostic accuracy: Presence/longitudinal extent of signal changes	1 systematic review (including 12 observational studies; n=531)[113] 4 NRSI (n=309)[114-117]	Medium	Inconsistent	Indirect	Imprecise	Not detected	Seven studies reported significant associations between presence/longitudinal extent of signal changes and poorer functional outcomes, while four studies reported absence of signal changes associated with better outcomes and five studies reported no association with functional outcomes.	Low
Diagnostic accuracy: qualitative T2-weighted signal changes	1 systematic review (including 10 observational studies; n=731)[113] 6 NRSI (n=848)[115,118-122]	Medium	Consistent	Indirect	Imprecise	Not detected	Eleven studies found qualitative T2-weighted signal changes to be associated with functional outcomes measured using JOA or NDI; absence of T2-weighted qualitative signal changes was associated with better outcomes in two studies. Qualitive intensity was not associated with functional outcomes in three studies.	Low
Diagnostic accuracy: signal intensity ratio	1 systematic review (including 1 observational study; n=73)[113] 3 NRSI (n=368)[123-125]	Medium	Consistent	Indirect	Imprecise	Not detected	Three studies found higher SIR associated with JOA recovery ($p<0.001$, $p=0.006$, and $p<0.001$; AUC 78.6%-84.4%), while one study found no association with T2-weighted SIR while lower T1-weighted SIR was associated with poorer recovery (JOA recovery 48% vs. 19% vs. 60.7%; T1- and T2-weighted ISI changes vs. T2-weighted ISI change only, $p=0.0259$).	Low
Diagnostic accuracy: segmental abnormalities	1 systematic review (including 2 observational studies; n=208)[113] 2 NRSI (n=982)[126-128]	Medium	Inconsistent	Indirect	Imprecise	Not detected	Snake-eye appearance on axial T2-weighted MRI, ISI in gray and white matter, and endplate abnormalities associated with poorer functional outcomes in one study each, while modic changes were not associated with functional outcomes in one study.	Insufficient

Outcome	Studies (n)	Limitations	Consistency	Directness	Precision	Reporting Bias	Summary of Findings	Strength of Evidence
Diagnostic accuracy: diffusion tensor tractography grading	2 NRSI (n=177)[129,130]	Medium	Inconsistent	Indirect	Imprecise	Not detected	Diffusion tensor tractography grading was correlated with JOA scores (r=-0.813; p<0.001) and JOA recovery rates (r=-0.429; p<0.001) in one study; another study found no DTI metrics associated with treatment outcomes	Insufficient
Diagnostic accuracy: diffusion-based spectrum imaging	1 NRSI (n=100)[130,131]	Medium	Unknown consistency	Indirect	Imprecise	Not detected	Diffusion-based spectrum imaging features were associated with treatment outcomes; accuracy for predicting mJOA scores was 78.6% (AUC 75.3%), while accuracy for predicting NDI was 64.3% (AUC 54.6%)	Insufficient
Diagnostic accuracy: radiomics-based extra tree model	1 NRSI (n=302)[132]	Medium	Unknown consistency	Indirect	Imprecise	Not detected	Radiomics-based extra tree modeling had superior accuracy compared to radiological or clinical-radiological modeling (Accuracy 71%, AUC 75%)	Insufficient

AUC=area under the curve; ISI=increased signal intensity; JOA=Japanese Orthopaedic Association score; MRI=magnetic resonance imaging; NDI=Neck Disability Index; NRSI=nonrandomized studies of intervention; RCT=randomized controlled trial; SIR=signal intensity ratio

Table G-16. Key Question 12: Diagnostic accuracy of imaging assessment

Outcome	Studies (n)	Limitations	Consistency	Directness	Precision	Reporting Bias	Summary of Findings	Strength of Evidence
Diagnostic Accuracy: Predicting Pseudarthrosis	1 retrospective cohort (N=597)[133]	Moderate	Unknown	Indirect	Precise	Undetected	Dynamic radiographs were highly sensitive (89.7%; 95% CI 0.758 to 0.971) and moderately specific (81%; 95% CI 0.786 to 0.835) in predicting symptomatic pseudarthrosis in patients requiring revision surgery, with intraoperative documentation of pseudarthrosis as the index and interspinous motion <1 mm as the cutoff.	Low
	1 retrospective cohort (N=125)[134]	Moderate	Unknown	Indirect	Precise	Undetected	Dynamic radiographs and CT scans had similar accuracy in identifying pseudarthrosis in patients undergoing revision surgery for pseudarthrosis or ASD pathology (sensitivity, 86.3% [95% CI, 81.6 to 91] vs. 87.2% [83.2 to 91.3]; specificity, 96.1% [93.4 to 98.8] vs. 97.4% [95.5 to 99.3]),), with surgical exploration of fusion as the index and interspinous motion ≥1 mm and superadjacent interspinous motion ≥4 mm as the cutoff.	Low
	1 retrospective cohort (N=143; 36 analyzed)[135]	High	Unknown	Indirect	Precise	Undetected	In dynamic radiographs, suspected pseudarthrosis rates were lower using angular versus linear methods (N=143; 18.5% [45/242 levels] vs. 28% [68/242 levels], p=NR). In 1-year validation CTs (n=36; 66 levels), pseudarthrosis was identified in 13 patients (13 levels), of whom 5 underwent revision surgery; use of the angle method resulted in similar sensitivity (85%) but higher specificity (96%) versus the linear method (85% and 87%, respectively).	Insufficient

ASD=adjacent segment disease; CI=confidence interval; CT=computed tomography

Table G-17. Key Question 13: Intraoperative neuromonitoring

Outcome	Studies (n)	Limitations	Consistency	Directness	Precision	Reporting Bias	Summary of Findings	Strength of Evidence
Fusion	No studies	NA	NA	NA	NA	NA	NA	NA
Pain	No studies	NA	NA	NA	NA	NA	NA	NA
Function	No studies	NA	NA	NA	NA	NA	NA	NA
Adverse Events: Neurologic Complications	2 NRSIs (N=34,155)[136,137]	High	Consistent	Direct	Precise	Undetected	IONM vs. no IONM: 1 NRSI: 0.22% vs. 0.17%, p=0.41 1 NRSI: 0.23% vs. 0.27%, p=0.84	Low

IONM=intraoperative neuromonitoring; NA=not applicable; NSRI=nonrandomized studies of intervention

Appendix H. Appendix References

1. Congress of Neurological Surgeons. Guideline for the Surgical Management of Cervical Degenerative Disease. Congress of Neurological Surgeons; 2009. https://www.cns.org/guidelines/browse-guidelines-detail/surgical-management-of-cervical-degenerative-disea2022.
2. Agency for Healthcare Research and Quality. Methods guide for effectiveness and comparative effectiveness reviews Agency for Healthcare Research and Quality. Rockville, MD: 2020. https://effectivehealthcare.ahrq.gov/products/collections/cer-methods-guide.
3. Furlan AD, Malmivaara A, Chou R, et al. 2015 Updated Method Guideline for Systematic Reviews in the Cochrane Back and Neck Group. Spine (Phila Pa 1976). 2015 Nov;40(21):1660-73. doi: 10.1097/BRS.0000000000001061. PMID: 26208232.
4. US Preventive Services Task Force. Methods and Processes. Rockville, MD: 2019. https://www.uspreventiveservicestaskforce.org/uspstf/about-uspstf/methods-and-processes Accessed December 10, 2021.
5. Hardy RJ, Thompson SG. A likelihood approach to meta-analysis with random effects. Stat Med. 1996 Mar 30;15(6):619-29. doi: 10.1002/(sici)1097-0258(19960330)15:6<619::Aid-sim188>3.0.Co;2-a. PMID: 8731004.
6. Higgins JP, Thompson SG, Deeks JJ, et al. Measuring inconsistency in meta-analyses. Bmj. 2003 Sep 6;327(7414):557-60. doi: 10.1136/bmj.327.7414.557. PMID: 12958120.
7. Sterne JA, Sutton AJ, Ioannidis JP, et al. Recommendations for examining and interpreting funnel plot asymmetry in meta-analyses of randomised controlled trials. Bmj. 2011 Jul 22;343:d4002. doi: 10.1136/bmj.d4002. PMID: 21784880.
8. Kadanka Z, Mares M, Bednarík J, et al. Predictive factors for mild forms of spondylotic cervical myelopathy treated conservatively or surgically. Eur J Neurol. 2005 Jan;12(1):16-24. doi: 10.1111/j.1468-1331.2004.00947.x. PMID: 15613142.
9. Kadanka Z, Bednařík J, Novotný O, et al. Cervical spondylotic myelopathy: conservative versus surgical treatment after 10 years. Eur Spine J. 2011 Sep;20(9):1533-8. doi: 10.1007/s00586-011-1811-9. PMID: 21519928.
10. Kadanka Z, Mares M, Bednaník J, et al. Approaches to spondylotic cervical myelopathy: conservative versus surgical results in a 3-year follow-up study. Spine (Phila Pa 1976). 2002 Oct 15;27(20):2205-10; discussion 10-1. doi: 10.1097/01.Brs.0000029255.77224.Bb. PMID: 12394893.
11. Colamaria A, Ciappetta P, Fochi NP, et al. Anterior cervical corpectomy for treatment of spondylotic myelopathy. Results of a prospective double-armed study with a three-year follow-up. J Neurosurg Sci. 2022 Apr 13;13:13. doi: 10.23736/S0390-5616.22.05608-9. PMID: 35416453.
12. Persson LC, Moritz U, Brandt L, et al. Cervical radiculopathy: pain, muscle weakness and sensory loss in patients with cervical radiculopathy treated with surgery, physiotherapy or cervical collar. A prospective, controlled study. Eur Spine J. 1997;6(4):256-66. doi: 10.1007/bf01322448. PMID: 9294750.
13. Persson LC, Lilja A. Pain, coping, emotional state and physical function in patients with chronic radicular neck pain. A comparison between patients treated with surgery, physiotherapy or neck collar--a blinded, prospective randomized study. Disabil Rehabil. 2001 May 20;23(8):325-35. doi: 10.1080/09638280010005567. PMID: 11374522.
14. Cheung JPY, Cheung PWH, Law K, et al. Postoperative rigid cervical collar leads to less axial neck pain in the early stage after open-door laminoplasty-a single-blinded randomized controlled trial. Neurosurgery. 2019;85(3):325-34p. doi: 10.1093/neuros/nyy359.
15. Hida T, Sakai Y, Ito K, et al. Collar fixation is not mandatory after cervical laminoplasty: a randomized controlled trial. Spine. 2017 Mar;42(5):E253-E9. doi: 10.1097/BRS.0000000000001994. PMID: 27879567.
16. Uehara T, Tsushima E, Yamada S, et al. A randomized controlled trial for the intervention effect of early exercise therapy on axial pain after cervical laminoplasty. Spine surgery and related research. 2022;6(2):123-32. doi: 10.22603/SSRR.2021-0110.
17. Foley KT, Mroz TE, Arnold PM, et al. Randomized, prospective, and controlled clinical trial of pulsed electromagnetic field stimulation for cervical fusion. Spine J. 2008 May-Jun;8(3):436-42. doi: 10.1016/j.spinee.2007.06.006. PMID: 17983841.
18. Abbott A, Halvorsen M, Dedering A. Is there a need for cervical collar usage post anterior cervical decompression and fusion using interbody cages? A randomized controlled pilot trial. Physiother. 2013 May;29(4):290-300. doi: 10.3109/09593985.2012.731627. PMID: 23074995.
19. Ebrahim KS, El-Shehaby A, Darwish A, et al. Anterior or posterior foraminotomy for unilateral cervical radiculopathy. Pan arab journal of neurosurgery. 2011;15(2):34-46p.
20. Ruetten S, Komp M, Merk H, et al. Full-endoscopic cervical posterior foraminotomy for the operation of lateral disc herniations using 5.9-mm endoscopes: a prospective, randomized, controlled study. Spine (Phila Pa 1976). 2008

Apr 20;33(9):940-8. doi: 10.1097/BRS.0b013e31816c8b67. PMID: 18427313.
21. Alvin MD, Lubelski D, Abdullah KG, et al. Cost-utility analysis of anterior cervical discectomy and fusion with plating (ACDFP) versus posterior cervical foraminotomy (PCF) for patients with single-level cervical radiculopathy at 1-year follow-up. Clin Spine Surg. 2016 Mar;29(2):E67-72. doi: 10.1097/BSD.0000000000000099. PMID: 26889994.
22. Broekema AEH, Simoes de Souza NF, Soer R, et al. Noninferiority of posterior cervical foraminotomy vs anterior cervical discectomy with fusion for procedural success and reduction in arm pain among patients with cervical radiculopathy at 1 year: the FACET randomized clinical trial. JAMA Neurol. 2023 Jan 1;80(1):40-8. doi: 10.1001/jamaneurol.2022.4208. PMID: 36409485.
23. Foster MT, Carleton-Bland NP, Lee MK, et al. Comparison of clinical outcomes in anterior cervical discectomy versus foraminotomy for brachialgia. Br J Neurosurg. 2019 Feb;33(1):3-7. doi: 10.1080/02688697.2018.1527013. PMID: 30450995.
24. Wirth FP, Dowd GC, Sanders HF, et al. Cervical discectomy. A prospective analysis of three operative techniques. Surg Neurol. 2000 Apr;53(4):340-6; discussion 6-8. doi: 10.1016/s0090-3019(00)00201-9. PMID: 10825519.
25. Lubelski D, Healy AT, Silverstein MP, et al. Reoperation rates after anterior cervical discectomy and fusion versus posterior cervical foraminotomy: a propensity-matched analysis. Spine J. 2015 Jun 01;15(6):1277-83. doi: 10.1016/j.spinee.2015.02.026. PMID: 25720729.
26. Witiw CD, Smieliauskas F, O'Toole JE, et al. Comparison of anterior cervical discectomy and fusion to posterior cervical foraminotomy for cervical radiculopathy: utilization, costs, and adverse events 2003 to 2014. Neurosurgery. 2019 02 01;84(2):413-20. doi: 10.1093/neuros/nyy051. PMID: 29548034.
27. Nunna RS, Khalid S, Chiu RG, et al. Anterior vs posterior approach in multilevel cervical spondylotic myelopathy: a nationwide propensity-matched analysis of complications, outcomes, and narcotic use. Int J Spine Surg. 2022 Feb;16(1):88-94. doi: 10.14444/8198. PMID: 35314510.
28. Jiang YQ, Li XL, Zhou XG, et al. A prospective randomized trial comparing anterior cervical discectomy and fusion versus plate-only open-door laminoplasty for the treatment of spinal stenosis in degenerative diseases. Eur Spine J. 2017 04;26(4):1162-72. doi: 10.1007/s00586-016-4878-5. PMID: 27885472.
29. Asher AL, Devin CJ, Kerezoudis P, et al. Comparison of outcomes following anterior vs posterior fusion surgery for patients with degenerative cervical myelopathy: an analysis from quality outcomes database. Neurosurgery. 2019 04 01;84(4):919-26. doi: 10.1093/neuros/nyy144. PMID: 29741718.
30. Fehlings MG, Barry S, Kopjar B, et al. Anterior versus posterior surgical approaches to treat cervical spondylotic myelopathy: outcomes of the prospective multicenter aospine north america csm study in 264 patients. Spine. 2013;38(26):2247-52. doi: 10.1097/BRS.0000000000000047. PMID: 24108289.
31. Wadhwa H, Sharma J, Varshneya K, et al. Anterior cervical discectomy and fusion versus laminoplasty for multilevel cervical spondylotic myelopathy: a national administrative database analysis. World Neurosurg. 2021 08;152:e738-e44. doi: 10.1016/j.wneu.2021.06.064. PMID: 34153482.
32. Cole T, Veeravagu A, Zhang M, et al. Anterior versus posterior approach for multilevel degenerative cervical disease: a retrospective propensity score-matched study of the marketscan database. Spine. 2015 Jul 01;40(13):1033-8. doi: 10.1097/BRS.0000000000000872. PMID: 25768690.
33. Joo PY, Jayaram RH, McLaughlin WM, et al. Four-level anterior versus posterior cervical fusions: perioperative outcomes and five-year reoperation rates: outcomes after four-level anterior versus posterior cervical procedures. N Am Spine Soc J. 2022 Jun;10:100115. doi: 10.1016/j.xnsj.2022.100115. PMID: 35392022.
34. Lee NJ, Boddapati V, Mathew J, et al. What is the impact of surgical approach in the treatment of degenerative cervical myelopathy in patients with OPLL? a propensity-score matched, multi-center analysis on inpatient and post-discharge 90-day outcomes. Global spine j. 2021 Feb 19:2192568221994797. doi: 10.1177/2192568221994797. PMID: 33601898.
35. Lee NJ, Kim JS, Park P, et al. A comparison of various surgical treatments for degenerative cervical myelopathy: a propensity score matched analysis. Global spine j. 2022 Jul;12(6):1109-18. doi: 10.1177/2192568220976092. PMID: 33375849.
36. Badhiwala JH, Ellenbogen Y, Khan O, et al. Comparison of the inpatient complications and health care costs of anterior versus posterior cervical decompression and fusion in patients with multilevel degenerative cervical myelopathy: a retrospective propensity score-matched analysis. World Neurosurg. 2020 Feb;134:e112-e9. doi: 10.1016/j.wneu.2019.09.132. PMID: 31574327.
37. Elmallawany M, Kandel H, Soliman MAR, et al. The safety and efficacy of cervical laminectomy and fusion versus cervical laminoplasty surgery in degenerative cervical myelopathy: a prospective randomized trial. Open Access

Maced J Med Sci. 2020;8:807-14. doi: 10.3889/oamjms.2020.4841.
38. Manzano GR, Casella G, Wang MY, et al. A prospective, randomized trial comparing expansile cervical laminoplasty and cervical laminectomy and fusion for multilevel cervical myelopathy. Neurosurgery. 2012 Feb;70(2):264-77. doi: 10.1227/NEU.0b013e3182305669. PMID: 22251974.
39. Blizzard DJ, Caputo AM, Sheets CZ, et al. Laminoplasty versus laminectomy with fusion for the treatment of spondylotic cervical myelopathy: short-term follow-up. Eur Spine J. 2017 01;26(1):85-93. doi: 10.1007/s00586-016-4746-3. PMID: 27554354.
40. Fehlings MG, Santaguida C, Tetreault L, et al. Laminectomy and fusion versus laminoplasty for the treatment of degenerative cervical myelopathy: results from the AOSpine North America and International prospective multicenter studies. Spine J. 2017 01;17(1):102-8. doi: 10.1016/j.spinee.2016.08.019. PMID: 27597512.
41. He X, Zhang JN, Liu TJ, et al. Is laminectomy and fusion the better choice than laminoplasty for multilevel cervical myelopathy with signal changes on magnetic resonance imaging? A comparison of two posterior surgeries. BMC Musculoskelet Disord. 2020 Jul 02;21(1):423. doi: 10.1186/s12891-020-03435-7. PMID: 32615953.
42. Woods BI, Hohl J, Lee J, et al. Laminoplasty versus laminectomy and fusion for multilevel cervical spondylotic myelopathy. Clin Orthop. 2011 Mar;469(3):688-95. doi: 10.1007/s11999-010-1653-5. PMID: 21089002.
43. McDonald CL, Hershman SH, Hogan W, et al. Cervical laminoplasty versus posterior laminectomy and fusion: trends in utilization and evaluation of complication and revision surgery rates. J Am Acad Orthop Surg. 2022 May 30;30(17):30. doi: 10.5435/JAAOS-D-22-00106. PMID: 35640093.
44. Mesregah MK, Formanek B, Liu JC, et al. Perioperative complications of surgery for degenerative cervical myelopathy: a comparison between 3 procedures. Global spine j. 2021 Mar 12:2192568221998306. doi: 10.1177/2192568221998306. PMID: 33709809.
45. U.S. Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED). Mobi-C® Cervical Disc Prosthesis (One-level Indication). PMA No.: P110002. August 7, 2013 https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpma/pma.cfm?id=P110002.
46. U.S. Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED). ProDisc™-C Total Disc Replacement. PMA No.: P070001. December 17, 2007. https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpma/pma.cfm?id=P070001.
47. Chen X, Shi L, Yu X, et al. Comparative study of artificial cervical disc replacement and anterior cervical discectomy/fusion in the treatment of cervical spondylotic myelopathy. Int J Clin Exp Med. 2019;12(8):10597-604p.
48. Donk RD, Verbeek ALM, Verhagen WIM, et al. What's the best surgical treatment for patients with cervical radiculopathy due to single-level degenerative disease? A randomized controlled trial. PLoS ONE. 2017;12(8):e0183603. doi: 10.1371/journal.pone.0183603. PMID: 28850600.
49. Heller JG, Sasso RC, Papadopoulos SM, et al. Comparison of BRYAN cervical disc arthroplasty with anterior cervical decompression and fusion: clinical and radiographic results of a randomized, controlled, clinical trial. Spine. 2009 Jan 15;34(2):101-7. doi: 10.1097/BRS.0b013e31818ee263. PMID: 19112337.
50. Hisey MS, Zigler JE, Jackson R, et al. Prospective, randomized comparison of one-level mobi-c cervical total disc replacement vs. anterior cervical discectomy and fusion: Results at 5-year follow-up. Int J Spine Surg. 2016;10:10. doi: 10.14444/3010. PMID: 27162712.
51. Mummaneni PV, Burkus JK, Haid RW, et al. Clinical and radiographic analysis of cervical disc arthroplasty compared with allograft fusion: a randomized controlled clinical trial. J Neurosurg Spine. 2007 Mar;6(3):198-209. doi: 10.3171/spi.2007.6.3.198. PMID: 17355018.
52. Nabhan A, Ahlhelm F, Shariat K, et al. The ProDisc-C prosthesis: clinical and radiological experience 1 year after surgery. Spine. 2007 Aug 15;32(18):1935-41. doi: 10.1097/BRS.0b013e31813162d8. PMID: 17700437.
53. Vaccaro A, Beutler W, Peppelman W, et al. Clinical outcomes with selectively constrained SECURE-C cervical disc arthroplasty: two-year results from a prospective, randomized, controlled, multicenter investigational device exemption study. Spine. 2013 Dec 15;38(26):2227-39. doi: 10.1097/BRS.0000000000000031. PMID: 24335629.
54. U.S. Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED). NuVasive PCM® Cervical Disc System. PMA No.: P100012. October 26, 2012. https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpma/pma.cfm?id=P100012.
55. Phillips FM, Geisler FH, Gilder KM, et al. Long-term outcomes of the US FDA IDE prospective, randomized controlled clinical trial comparing PCM cervical disc arthroplasty with anterior cervical discectomy and fusion. Spine. 2015 May 15;40(10):674-83. doi: 10.1097/BRS.0000000000000869. PMID: 25955086.

56. U.S. Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED). SECURE®-C Artificial Cervical Disc. PMA No.: P100003. September 29, 2012. https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpma/pma.cfm?id=P100003.
57. Burkus JK, Traynelis VC, Haid RW, Jr., et al. Clinical and radiographic analysis of an artificial cervical disc: 7-year follow-up from the Prestige prospective randomized controlled clinical trial: Clinical article. J Neurosurg Spine. 2014 Oct;21(4):516-28. doi: 10.3171/2014.6.SPINE13996. PMID: 25036218.
58. Delamarter RB, Murrey D, Janssen ME, et al. Results at 24 months from the prospective, randomized, multicenter Investigational Device Exemption trial of ProDisc-C versus anterior cervical discectomy and fusion with 4-year follow-up and continued access patients. Sas J. 2010;4(4):122-8. doi: 10.1016/j.esas.2010.09.001. PMID: 25802660.
59. Hou Y, Nie L, Pan X, et al. Effectiveness and safety of Mobi-C for treatment of single-level cervical disc spondylosis: a randomised control trial with a minimum of five years of follow-up. Bone Joint J. 2016 Jun;98-B(6):829-33. doi: 10.1302/0301-620X.98B6.36381. PMID: 27235528.
60. Nabhan A, Steudel WI, Nabhan A, et al. Segmental kinematics and adjacent level degeneration following disc replacement versus fusion: RCT with three years of follow-up. J Long Term Eff Med Implants. 2007;17(3):229-36. doi: 10.1615/jlongtermeffmedimplants.v17.i3.60. PMID: 19023947.
61. Sasso RC, Anderson PA, Riew KD, et al. Results of cervical arthroplasty compared with anterior discectomy and fusion: four-year clinical outcomes in a prospective, randomized controlled trial. J Bone Joint Surg Am. 2011 Sep 21;93(18):1684-92. doi: 10.2106/JBJS.J.00476. PMID: 21938372.
62. Zhang X, Zhang X, Chen C, et al. Randomized, controlled, multicenter, clinical trial comparing BRYAN cervical disc arthroplasty with anterior cervical decompression and fusion in China. Spine (Phila Pa 1976). 2012 Mar 15;37(6):433-8. doi: 10.1097/BRS.0b013e31822699fa. PMID: 21673620.
63. Vaccaro A, Beutler W, Peppelman W, et al. Long-term clinical experience with selectively constrained SECURE-C cervical artificial disc for 1-level cervical disc disease: results from seven-year follow-up of a prospective, randomized, controlled investigational device exemption clinical trial. Int J Spine Surg. 2018 Jun;12(3):377-87. doi: 10.14444/5044. PMID: 30276095.
64. Janssen ME, Zigler JE, Spivak JM, et al. ProDisc-C total disc replacement versus anterior cervical discectomy and fusion for single-level symptomatic cervical disc disease: seven-year follow-up of the prospective randomized u.S. Food and drug administration investigational device exemption study. J Bone Joint Surg Am. 2015 Nov 04;97(21):1738-47. doi: 10.2106/JBJS.N.01186. PMID: 26537161.
65. Lavelle WF, Riew KD, Levi AD, et al. Ten-year outcomes of cervical disc replacement with the bryan cervical disc: results from a prospective, randomized, controlled clinical trial. Spine. 2019 May 01;44(9):601-8. doi: 10.1097/BRS.0000000000002907. PMID: 30325888.
66. Radcliff K, Davis RJ, Hisey MS, et al. Long-term evaluation of cervical disc arthroplasty with the Mobi-C cervical disc: a randomized, prospective, multicenter clinical trial with seven-year follow-up. Int J Spine Surg. 2017 Netherlands ISASS (E-mail: info@ISASS;11(4):244-62. doi: 10.14444/4031.
67. Nabhan A, Ishak B, Steudel WI, et al. Assessment of adjacent-segment mobility after cervical disc replacement versus fusion: RCT with 1 year's results. Eur Spine J. 2011 Jun;20(6):934-41. doi: 10.1007/s00586-010-1588-2. PMID: 21221666.
68. Cheng L, Nie L, Zhang L, et al. Fusion versus Bryan Cervical Disc in two-level cervical disc disease: a prospective, randomised study. Int Orthop. 2009 Oct;33(5):1347-51. doi: 10.1007/s00264-008-0655-3. PMID: 18956190.
69. Zigler JE, Delamarter R, Murrey D, et al. ProDisc-C and anterior cervical discectomy and fusion as surgical treatment for single-level cervical symptomatic degenerative disc disease: five-year results of a Food and Drug Administration study. Spine. 2013 Feb 01;38(3):203-9. doi: 10.1097/BRS.0b013e318278eb38. PMID: 23080427.
70. Peng-Fei S, Yu-Hua J. Cervical disc prosthesis replacement and interbody fusion: a comparative study. Int Orthop. 2008 Feb;32(1):103-6. doi: 10.1007/s00264-006-0287-4. PMID: 17180356.
71. Zhang HX, Shao YD, Chen Y, et al. A prospective, randomised, controlled multicentre study comparing cervical disc replacement with anterior cervical decompression and fusion. Int Orthop. 2014 Dec;38(12):2533-41. doi: 10.1007/s00264-014-2497-5. PMID: 25209344.
72. Phillips FM, Lee JY, Geisler FH, et al. A prospective, randomized, controlled clinical investigation comparing PCM cervical disc arthroplasty with anterior cervical discectomy and fusion. 2-year results from the US FDA IDE clinical trial. Spine. 2013 Jul 01;38(15):E907-18. doi: 10.1097/BRS.0b013e318296232f. PMID: 23591659.
73. Hisey MS, Bae HW, Davis RJ, et al. Prospective, randomized comparison of cervical total disk replacement versus anterior cervical fusion: results at 48 months follow-up. J Spinal Disord

Tech. 2015 May;28(4):E237-43. doi: 10.1097/BSD.0000000000000185. PMID: 25310394.
74. Murrey D, Janssen M, Delamarter R, et al. Results of the prospective, randomized, controlled multicenter Food and Drug Administration investigational device exemption study of the ProDisc-C total disc replacement versus anterior discectomy and fusion for the treatment of 1-level symptomatic cervical disc disease. Spine J. 2009 Apr;9(4):275-86. doi: 10.1016/j.spinee.2008.05.006. PMID: 18774751.
75. Karabag H, Cakmak E, Celik B, et al. Arthroplasty versus fusion for single-level cervical disc disease. JPMA J Pak Med Assoc. 2014 Dec;64(12):1348-51. PMID: 25842575.
76. Hisey MS, Bae HW, Davis R, et al. Multi-center, prospective, randomized, controlled investigational device exemption clinical trial comparing Mobi-C Cervical Artificial Disc to anterior discectomy and fusion in the treatment of symptomatic degenerative disc disease in the cervical spine. Int J Spine Surg. 2014;8:7. doi: 10.14444/1007. PMID: 25694918.
77. Delamarter RB, Zigler J. Five-year reoperation rates, cervical total disc replacement versus fusion, results of a prospective randomized clinical trial. Spine. 2013 Apr 20;38(9):711-7. doi: 10.1097/BRS.0b013e3182797592. PMID: 23124255.
78. Jackson RJ, Davis RJ, Hoffman GA, et al. Subsequent surgery rates after cervical total disc replacement using a Mobi-C Cervical Disc Prosthesis versus anterior cervical discectomy and fusion: a prospective randomized clinical trial with 5-year follow-up. J Neurosurg Spine. 2016 May;24(5):734-45. doi: 10.3171/2015.8.SPINE15219. PMID: 26799118.
79. Loidolt T, Kurra S, Riew KD, et al. Comparison of adverse events between cervical disc arthroplasty and anterior cervical discectomy and fusion: a 10-year follow-up. Spine J. 2021 02;21(2):253-64. doi: 10.1016/j.spinee.2020.10.013. PMID: 33080376.
80. Anderson PA, Sasso RC, Riew KD. Comparison of adverse events between the Bryan artificial cervical disc and anterior cervical arthrodesis. Spine. 2008 May 20;33(12):1305-12. doi: 10.1097/BRS.0b013e31817329a1. PMID: 18496341.
81. U.S. Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED). Mobi-C® Cervical Disc Prosthesis (Two-level Indication). PMA No.: P110009. August,23, 2013 https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpma/pma.cfm?id=P110009.
82. U.S. Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED). PRESTIGE LP™ Cervical Disc. PMA No.: P090029. July 7, 2016. https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpma/pma.cfm?id=P090029.
83. Radcliff K, Coric D, Albert T. Five-year clinical results of cervical total disc replacement compared with anterior discectomy and fusion for treatment of 2-level symptomatic degenerative disc disease: a prospective, randomized, controlled, multicenter investigational device exemption clinical trial. J Neurosurg Spine. 2016 Aug;25(2):213-24. doi: 10.3171/2015.12.SPINE15824. PMID: 27015130.
84. Gornet MF, Lanman TH, Burkus JK, et al. Cervical disc arthroplasty with the Prestige LP disc versus anterior cervical discectomy and fusion, at 2 levels: results of a prospective, multicenter randomized controlled clinical trial at 24 months. J Neurosurg Spine. 2017 Jun;26(6):653-67. doi: 10.3171/2016.10.SPINE16264. PMID: 28304237.
85. Yang W, Si M, Hou Y, et al. Superiority of 2-level total disk replacement using a cervical disk prosthesis versus anterior cervical diskectomy and fusion. Orthopedics. 2018 Nov 01;41(6):344-50. doi: 10.3928/01477447-20180815-01. PMID: 30125034.
86. Gornet MF, Lanman TH, Burkus JK, et al. Two-level cervical disc arthroplasty versus anterior cervical discectomy and fusion: 10-year outcomes of a prospective, randomized investigational device exemption clinical trial. J Neurosurg Spine. 2019 Jun 21;31(4):1-11. doi: 10.3171/2019.4.SPINE19157. PMID: 31226684.
87. Davis RJ, Nunley PD, Kim KD, et al. Two-level total disc replacement with Mobi-C cervical artificial disc versus anterior discectomy and fusion: a prospective, randomized, controlled multicenter clinical trial with 4-year follow-up results. J Neurosurg Spine. 2015 Jan;22(1):15-25. doi: 10.3171/2014.7.SPINE13953. PMID: 25380538.
88. Davis RJ, Kim KD, Hisey MS, et al. Cervical total disc replacement with the Mobi-C cervical artificial disc compared with anterior discectomy and fusion for treatment of 2-level symptomatic degenerative disc disease: a prospective, randomized, controlled multicenter clinical trial: clinical article. J Neurosurg Spine. 2013 Nov;19(5):532-45. doi: 10.3171/2013.6.SPINE12527. PMID: 24010901.
89. Lanman TH, Burkus JK, Dryer RG, et al. Long-term clinical and radiographic outcomes of the Prestige LP artificial cervical disc replacement at 2 levels: results from a prospective randomized controlled clinical trial. J Neurosurg Spine. 2017 Jul;27(1):7-19. doi: 10.3171/2016.11.SPINE16746. PMID: 28387616.
90. Gupta VK, Basantani N, Carvalho AS, et al. Long-term clinicoradiological outcomes of cervical fusion with polyether ether ketone versus cervical disc arthroplasty in a double-blinded randomized control trial. Asian J Neurosurg.

2021 Oct-Dec;16(4):725-31. doi: 10.4103/ajns.AJNS_345_20. PMID: 35071069.
91. Cheng L, Nie L, Li M, et al. Superiority of the Bryan(R) disc prosthesis for cervical myelopathy: a randomized study with 3-year followup. Clin Orthop. 2011 Dec;469(12):3408-14. doi: 10.1007/s11999-011-2039-z. PMID: 21997779.
92. Cincu R, Lorente Fde A, Gomez J, et al. Long term preservation of motion with artificial cervical disc implants: a comparison between cervical disc replacement and rigid fusion with cage. Asian J Neurosurg. 2014 Oct-Dec;9(4):213-7. doi: 10.4103/1793-5482.146608. PMID: 25685218.
93. Chen Y, Chen H, Wu X, et al. Comparative analysis of clinical outcomes between zero-profile implant and cages with plate fixation in treating multilevel cervical spondilotic myelopathy: A three-year follow-up. Clin Neurol Neurosurg. 2016 May;144:72-6. doi: 10.1016/j.clineuro.2016.03.010. PMID: 26999528.
94. He S, Feng H, Lan Z, et al. A randomized trial comparing clinical outcomes between zero-profile and traditional multilevel anterior cervical discectomy and fusion surgery for cervical myelopathy. Spine. 2018 03 01;43(5):E259-E66. doi: 10.1097/BRS.0000000000002323. PMID: 29432408.
95. Li Y, Hao D, He B, et al. The efficiency of zero-profile implant in anterior cervical discectomy fusion: a prospective controlled long-term follow-up study. J Spinal Disord Tech. 2015 Dec;28(10):398-403. doi: 10.1097/BSD.0000000000000032. PMID: 24136051.
96. Nemoto O, Kitada A, Naitou S, et al. Stand-alone anchored cage versus cage with plating for single-level anterior cervical discectomy and fusion: a prospective, randomized, controlled study with a 2-year follow-up. Eur. 2015 Jul;25 Suppl 1:S127-34. doi: 10.1007/s00590-014-1547-4. PMID: 25283362.
97. Panchal RR, Kim KD, Eastlack R, et al. A clinical comparison of anterior cervical plates versus stand-alone intervertebral fusion devices for single-level anterior cervical discectomy and fusion procedures. World Neurosurg. 2017 Mar;99:630-7. doi: 10.1016/j.wneu.2016.12.060. PMID: 28017756.
98. Scholz M, Onal B, Schleicher P, et al. Two-level ACDF with a zero-profile stand-alone spacer compared to conventional plating: a prospective randomized single-center study. Eur Spine J. 2020 11;29(11):2814-22. doi: 10.1007/s00586-020-06454-z. PMID: 32430769.
99. Zavras AG, Nolte MT, Sayari AJ, et al. Stand-alone cage versus anterior plating for 1-level and 2-level anterior cervical discectomy and fusion: a randomized controlled trial. Clin Spine Surg. 2022 05 01;35(4):155-65. doi: 10.1097/BSD.0000000000001332. PMID: 35394961.
100. Zhou J, Li J, Lin H, et al. Could self-locking stand-alone cage reduce adjacent-level ossification development after aneterior cervical discectomy and fusion? J Clin Neurosci. 2020 Aug;78:60-6. doi: 10.1016/j.jocn.2020.06.014. PMID: 32624365.
101. Zhang B, Jiang YZ, Song QP, et al. Outcomes of cervical degenerative disc disease treated by anterior cervical discectomy and fusion with self-locking fusion cage. World j. 2022;10(15):4776-84. doi: 10.12998/wjcc.v10.i15.4776. PMID: 35801046.
102. Chen Y, Wang X, Lu X, et al. Comparison of titanium and polyetheretherketone (PEEK) cages in the surgical treatment of multilevel cervical spondylotic myelopathy: a prospective, randomized, control study with over 7-year follow-up. Eur Spine J. 2013 Jul;22(7):1539-46. doi: 10.1007/s00586-013-2772-y. PMID: 23568254.
103. Godlewski B, Bebenek A, Dominiak M, et al. PEEK versus titanium-coated PEEK cervical cages: fusion rate. Acta Neurochir (Wien). 2022 06;164(6):1501-7. doi: 10.1007/s00701-022-05217-7. PMID: 35471708.
104. Niu CC, Liao JC, Chen WJ, et al. Outcomes of interbody fusion cages used in 1 and 2-levels anterior cervical discectomy and fusion: titanium cages versus polyetheretherketone (PEEK) cages. J Spinal Disord Tech. 2010 Jul;23(5):310-6. doi: 10.1097/BSD.0b013e3181af3a84. PMID: 20124907.
105. Arnold PM, Sasso RC, Janssen ME, et al. i-Factor TM bone graft vs autograft in anterior cervical discectomy and fusion: 2-year follow-up of the randomized single-blinded food and drug administration investigational device exemption study. Neurosurgery; 2018. p. 377-84.
106. Baskin DS, Ryan P, Sonntag V, et al. A prospective, randomized, controlled cervical fusion study using recombinant human bone morphogenetic protein-2 with the CORNERSTONE-SR allograft ring and the ATLANTIS anterior cervical plate. Spine. 2003 Jun 15;28(12):1219-24; discussion 25. doi: 10.1097/01.BRS.0000065486.22141.CA. PMID: 12811263.
107. Cho DY, Lee WY, Sheu PC, et al. Cage containing a biphasic calcium phosphate ceramic (Triosite) for the treatment of cervical spondylosis. Surg Neurol. 2005 Jun;63(6):497-503; discussion -4. doi: 10.1016/j.surneu.2004.10.016. PMID: 15936361.
108. Kanna RM, Perambuduri AS, Shetty AP, et al. A randomized control trial comparing local autografts and allografts in single level anterior cervical discectomy and fusion using a stand-alone cage. Asian spine j. 2021 Dec;15(6):817-24. doi: 10.31616/asj.2020.0182. PMID: 33189111.

109. Xie Y, Li H, Yuan J, et al. A prospective randomized comparison of PEEK cage containing calcium sulphate or demineralized bone matrix with autograft in anterior cervical interbody fusion. Int Orthop. 2015 Jun;39(6):1129-36. doi: 10.1007/s00264-014-2610-9. PMID: 25432324.
110. Yi J, Lee GW, Nam WD, et al. A prospective randomized clinical trial comparing bone union rate following anterior cervical discectomy and fusion using a polyetheretherketone cage: hydroxyapatite/b-tricalcium phosphate mixture versus hydroxyapatite/demineralized bone matrix mixture. Asian spine j. 2015 Feb;9(1):30-8. doi: 10.4184/asj.2015.9.1.30. PMID: 25705332.
111. Arnold PM, Anderson KK, Selim A, et al. Heterotopic ossification following single-level anterior cervical discectomy and fusion: results from the prospective, multicenter, historically controlled trial comparing allograft to an optimized dose of rhBMP-2. J Neurosurg Spine. 2016 Sep;25(3):292-302. doi: 10.3171/2016.1.SPINE15798. PMID: 27129045.
112. Smucker JD, Rhee JM, Singh K, et al. Increased swelling complications associated with off-label usage of rhBMP-2 in the anterior cervical spine. Spine (Phila Pa 1976). 2006 Nov 15;31(24):2813-9. doi: 10.1097/01.brs.0000245863.52371.c2. PMID: 17108835.
113. Vedantam A, Rajshekhar V. Does the type of T2-weighted hyperintensity influence surgical outcome in patients with cervical spondylotic myelopathy? A review. Eur Spine J. 2013 Jan;22(1):96-106. doi: 10.1007/s00586-012-2483-9. PMID: 22926434.
114. Fukushima T, Ikata T, Taoka Y, et al. Magnetic resonance imaging study on spinal cord plasticity in patients with cervical compression myelopathy. Spine (Phila Pa 1976). 1991 Oct;16(10 Suppl):S534-8. doi: 10.1097/00007632-199110001-00016. PMID: 1801267.
115. Sarkar S, Turel MK, Jacob KS, et al. The evolution of T2-weighted intramedullary signal changes following ventral decompressive surgery for cervical spondylotic myelopathy: Clinical article. J Neurosurg Spine. 2014 Oct;21(4):538-46. doi: 10.3171/2014.6.SPINE13727. PMID: 25014501.
116. Suri A, Chabbra RP, Mehta VS, et al. Effect of intramedullary signal changes on the surgical outcome of patients with cervical spondylotic myelopathy. Spine J. 2003 Jan-Feb;3(1):33-45. doi: 10.1016/s1529-9430(02)00448-5. PMID: 14589243.
117. Zhang P, Shen Y, Zhang YZ, et al. Significance of increased signal intensity on MRI in prognosis after surgical intervention for cervical spondylotic myelopathy. J Clin Neurosci. 2011 Aug;18(8):1080-3. doi: 10.1016/j.jocn.2010.12.023. PMID: 21696960.
118. Aggarwal RA, Srivastava SK, Bhosale SK, et al. Prediction of surgical outcome in compressive cervical myelopathy: a novel clinicoradiological prognostic score. J Craniovertebr Junction Spine. 2016 Apr-Jun;7(2):82-6. doi: 10.4103/0974-8237.181828. PMID: 27217653.
119. Li XY, Lu SB, Sun XY, et al. Clinical and magnetic resonance imaging predictors of the surgical outcomes of patients with cervical spondylotic myelopathy. Clin Neurol Neurosurg. 2018 11;174:137-43. doi: 10.1016/j.clineuro.2018.09.003. PMID: 30241007.
120. Morio Y, Teshima R, Nagashima H, et al. Correlation between operative outcomes of cervical compression myelopathy and MRI of the spinal cord. Spine. 2001 Jun 01;26(11):1238-45. PMID: 11389390.
121. Nouri A, Martin AR, Kato S, et al. The relationship between MRI signal intensity changes, clinical presentation, and surgical outcome in degenerative cervical myelopathy: Analysis of a global cohort. Spine. 2017 Dec 15;42(24):1851-8. doi: 10.1097/BRS.0000000000002234. PMID: 28498290.
122. Yin LQ, Zhang J, Wu YG, et al. Increased signal intensity of spinal cord on T2W magnetic resonance imaging for cervical spondylotic myelopathy patients: Risk factors and prognosis (a STROBE-compliant article). Medicine (Baltimore). 2020 Dec 04;99(49):e23098. doi: 10.1097/MD.0000000000023098. PMID: 33285685.
123. Kim TH, Ha Y, Shin JJ, et al. Signal intensity ratio on magnetic resonance imaging as a prognostic factor in patients with cervical compressive myelopathy. Medicine (Baltimore). 2016 Sep;95(39):e4649. doi: 10.1097/MD.0000000000004649. PMID: 27684796.
124. Uchida K, Nakajima H, Takeura N, et al. Prognostic value of changes in spinal cord signal intensity on magnetic resonance imaging in patients with cervical compressive myelopathy. Spine J. 2014 Aug 01;14(8):1601-10. doi: 10.1016/j.spinee.2013.09.038. PMID: 24411833.
125. Zhang JT, Meng FT, Wang S, et al. Predictors of surgical outcome in cervical spondylotic myelopathy: focusing on the quantitative signal intensity. Eur Spine J. 2015 Dec;24(12):2941-5. doi: 10.1007/s00586-015-4109-5. PMID: 26155898.
126. Baker JD, Harada GK, Tao Y, et al. The impact of modic changes on preoperative symptoms and clinical outcomes in anterior cervical discectomy and fusion patients. Neurospine. 2020 Mar;17(1):190-203. doi: 10.14245/ns.2040062.031. PMID: 32252168.
127. Harada GK, Alter K, Nguyen AQ, et al. Cervical spine endplate abnormalities and association with pain, disability, and adjacent segment

degeneration after anterior cervical discectomy and fusion. Spine. 2020 Aug 01;45(15):E917-E26. doi: 10.1097/BRS.0000000000003460. PMID: 32675603.
128. Sharma R, Borkar S, Katiyar V, et al. Interplay of dynamic extension reserve and T1 slope in determining the loss of cervical lordosis following laminoplasty: a novel classification system. World Neurosurg. 2020 Apr;136:e33-e40. doi: 10.1016/j.wneu.2019.08.212. PMID: 31493608.
129. Wang K, Chen Z, Zhang F, et al. Evaluation of DTI parameter ratios and diffusion tensor tractography grading in the diagnosis and prognosis prediction of cervical spondylotic myelopathy. Spine (Phila Pa 1976). 2017 Feb 15;42(4):E202-e10. doi: 10.1097/brs.0000000000001784. PMID: 28207659.
130. Zhang JK, Sun P, Jayasekera D, et al. Utility of diffusion basis spectrum imaging in quantifying baseline disease severity and prognosis of cervical spondylotic myelopathy. Spine (Phila Pa 1976). 2022 Dec 15;47(24):1687-93. doi: 10.1097/BRS.0000000000004456. PMID: 35969006.
131. Zhang JK, Jayasekera D, Javeed S, et al. Diffusion basis spectrum imaging predicts long-term clinical outcomes following surgery in cervical spondylotic myelopathy. Spine J. 2022 Apr;23(4):504-12. doi: 10.1016/j.spinee.2022.12.003. PMID: 36509379.
132. Zhang MZ, Ou-Yang HQ, Liu JF, et al. Predicting postoperative recovery in cervical spondylotic myelopathy: construction and interpretation of T2*-weighted radiomic-based extra trees models. Eur Radiol. 2022 May;32(5):3565-75. doi: 10.1007/s00330-021-08383-x. PMID: 35024949.
133. Lambrechts MJ, D'Antonio ND, Karamian BA, et al. What is the role of dynamic cervical spine radiographs in predicting pseudarthrosis revision following anterior cervical discectomy and fusion? Spine J. 2022 May 12;12(10):12. doi: 10.1016/j.spinee.2022.04.020. PMID: 35568109.
134. Song KS, Piyaskulkaew C, Chuntarapas T, et al. Dynamic radiographic criteria for detecting pseudarthrosis following anterior cervical arthrodesis. J Bone Joint Surg Am. 2014 Apr 02;96(7):557-63. doi: 10.2106/JBJS.M.00167. PMID: 24695922.
135. Balouch E, Burapachaisri A, Woo D, et al. Assessing postoperative pseudarthrosis in Anterior Cervical Discectomy and Fusion (ACDF) on dynamic radiographs using novel angular measurements. Spine (Phila Pa 1976). 2022 Aug 15;47(16):1151-6. doi: 10.1097/BRS.0000000000004375. PMID: 35853174.
136. Ajiboye RM, D'Oro A, Ashana AO, et al. Routine use of intraoperative neuromonitoring during ACDFs for the treatment of spondylotic myelopathy and radiculopathy is questionable: a review of 15,395 cases. Spine. 2017 Jan 01;42(1):14-9. doi: 10.1097/BRS.0000000000001662. PMID: 27120059.
137. Badhiwala JH, Nassiri F, Witiw CD, et al. Investigating the utility of intraoperative neurophysiological monitoring for anterior cervical discectomy and fusion: analysis of over 140,000 cases from the National (Nationwide) Inpatient Sample data set. J Neurosurg Spine. 2019 03 29;31(1):76-86. doi: 10.3171/2019.1.SPINE181110. PMID: 30925481.