

Appendix D – Clinical evidence tables

Full citation	Abbas A, Hansrani V, Sedgwick N, Ghosh J, and McCollum C N (2014) 3D contrast enhanced ultrasound for detecting endoleak following endovascular aneurysm repair (EVAR). European Journal of Vascular and Endovascular Surgery 47, 487-492																															
Study type	Cross sectional study																															
Aim	Compare 3D CEUS with CTA for the detection of endoleak and aneurysm expansion following EVAR.																															
Patient Characteristics	<p>Inclusion criteria: Consecutive subjects attending for CTA and 3D CEUS imaging who were thought to possibly have an endoleak following an EVAR</p> <p>Exclusion criteria: Subjects who did not have paired CTA imaging.</p> <table border="1"> <thead> <tr> <th colspan="3">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Age (years; mean \pm SD)</td> <td colspan="2">77.4 \pm 6</td> </tr> <tr> <td>Males (%)</td> <td colspan="2">88%</td> </tr> <tr> <td>BMI (kg/m²; mean \pm SD)</td> <td colspan="2">29 \pm 4</td> </tr> <tr> <td>Creatinine (mmol/L; mean \pm SD)</td> <td colspan="2">101 \pm 35</td> </tr> <tr> <td>Stent-graft: bifurcated</td> <td colspan="2">80%</td> </tr> <tr> <td>Stent-graft: Uniliac</td> <td colspan="2">20%</td> </tr> <tr> <td>Elective EVAR</td> <td colspan="2">96%</td> </tr> <tr> <td>Emergency EVAR</td> <td colspan="2">4%</td> </tr> <tr> <td>Aneurysm Size</td> <td colspan="2">Not reported</td> </tr> </tbody> </table>		Study Characteristics			Age (years; mean \pm SD)	77.4 \pm 6		Males (%)	88%		BMI (kg/m ² ; mean \pm SD)	29 \pm 4		Creatinine (mmol/L; mean \pm SD)	101 \pm 35		Stent-graft: bifurcated	80%		Stent-graft: Uniliac	20%		Elective EVAR	96%		Emergency EVAR	4%		Aneurysm Size	Not reported	
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Emergency EVAR	4%																															
Aneurysm Size	Not reported																															
Sample Size	23 patients																															
Index test(s)	<p>2D CEUS and 3D CEUS</p> <p>With patients supine, the AAA and stent-graft were visualised and traced to the proximal neck, with was measured in cross-section and interrogated for potential endoleak using low colour flow velocity or power Doppler colour flow settings. After administration of SonoVue (contrast agent) into a peripheral vein (2-5mL), the aorta was scanned methodically in transverse section from the neck of the graft to the distal stent-graft in the iliac arteries. The image acquisition for 2D and 3D CEUS is simultaneous and takes 10-15 minutes, with subsequent analysis of the 3D images taking a further 5-10 minutes. The images were analysed independently by two fully trained vascular laboratory technologist.</p>																															

Full citation	Abbas A, Hansrani V, Sedgwick N, Ghosh J, and McCollum C N (2014) 3D contrast enhanced ultrasound for detecting endoleak following endovascular aneurysm repair (EVAR). European Journal of Vascular and Endovascular Surgery 47, 487-492
Reference standard(s)	CTA All patients had paired CTA images as part of their routine EVAR surveillance
Study Details	Study location: Manchester, UK Study setting: Tertiary referral vascular centre Study dates: May 2012 to May 2013 Loss to follow-up: Not specified. Time between testing & Treatment: The interval between paired images was an average of 3.9 weeks (range: same day to 8 weeks) Source of funding: Manchester Surgical Research Trust (MSRT)
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Unclear risk of bias. Unclear if index results were interpreted without knowledge of the reference standard. Definition of endoleak not provided Reference standard: Unclear risk of bias. Unclear if reference standard results were interpreted without knowledge of the index test. Flow and timing: High risk of bias. Inadequate time interval between index test and reference standard. Overall risk of bias: High risk of bias Directness: Directly applicable

Full citation	AbuRahma Ali F, Welch Christine A, Mullins Bandy B, and Dyer Benjamin (2005) Computed tomography versus color duplex ultrasound for surveillance of abdominal aortic stent-grafts. Journal of endovascular therapy: an official journal of the International Society of Endovascular Specialists 12, 568-73																					
Study type	Cross sectional																					
Aim	Compare the ability of computed tomography (CT) and colour duplex ultrasound (CDUS) to detect endoleak and accurately measure aortic aneurysm diameters after endovascular repair.																					
Patient Characteristics	<p>Inclusion criteria: Patients undergoing endovascular AAA repair using 3 commercially available devices Exclusion criteria: Not specified. Patient characteristics:</p> <table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Age (years; range)</td> <td>74 years (49-89)</td> </tr> <tr> <td>Males (%)</td> <td>88%</td> </tr> <tr> <td>BMI (kg/m²; mean± SD)</td> <td>29± 4</td> </tr> <tr> <td>Creatinine (mmol/L; mean± SD)</td> <td>101±35</td> </tr> <tr> <td>Stent-graft: bifurcated</td> <td>80%</td> </tr> <tr> <td>Stent-graft: Uniliac</td> <td>20%</td> </tr> <tr> <td>Elective EVAR</td> <td>96%</td> </tr> <tr> <td>Emergency EVAR</td> <td>4%</td> </tr> <tr> <td>Aneurysm Size</td> <td>Not reported</td> </tr> </tbody> </table>		Study Characteristics		Age (years; range)	74 years (49-89)	Males (%)	88%	BMI (kg/m ² ; mean± SD)	29± 4	Creatinine (mmol/L; mean± SD)	101±35	Stent-graft: bifurcated	80%	Stent-graft: Uniliac	20%	Elective EVAR	96%	Emergency EVAR	4%	Aneurysm Size	Not reported
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Stent-graft: Uniliac	20%																					
Elective EVAR	96%																					
Emergency EVAR	4%																					
Aneurysm Size	Not reported																					
Sample Size	178 patients																					
Index test(s)	CDUS The follow-up protocol called for serial CT and CDUS scans at 1 month and every 6 months thereafter. Transverse and anteroposterior (AP) images were obtained from the level of the suprarenal aorta above the graft to the distal iliac or femoral arteries. These studies were reviewed by a board certified vascular surgeon and registered vascular technologist. Neither the registered vascular technologist nor the reviewing surgeon was aware of the CT results during any portion of the CDUS examination. An endoleak was indicated by flow and spectral signals outside the prosthesis.																					
Reference standard(s)	CTA																					

Full citation	AbuRahma Ali F, Welch Christine A, Mullins Bandy B, and Dyer Benjamin (2005) Computed tomography versus color duplex ultrasound for surveillance of abdominal aortic stent-grafts. Journal of endovascular therapy: an official journal of the International Society of Endovascular Specialists 12, 568-73
	Helical CT imaging was performed to acquire non-contrasted and contrasted axial images of the abdominal aorta. All CT scans were reviewed by one vascular surgeon. An endoleak was determined using CT scans based on extravasation of contrast between the prosthesis and the aneurysm wall
Study Details	Study location: East Virginia, USA Study setting: Department of Surgery Study dates: February 2000 and October 2004 Loss to follow-up: Not specified Time between testing & Treatment: 7 days Source of funding: Not specified
Quality Assessment (QUADAS 2)	Patient selection: Unclear risk of bias. Exclusion criteria not specified. Index test: Low risk of bias Reference standard: Low risk of bias Flow and timing: Low risk of bias Overall risk of bias: Low risk of bias Directness: Directly applicable

Full citation	Badri Hassan, El Haddad, Mohammed, Ashour Hamdy, Nice Colin, Timmons Grace, and Bhattacharya Vish (2010) Duplex ultrasound scanning (DUS) versus computed tomography angiography (CTA) in the follow-up after EVAR. Angiology 61, 131-6									
Study type	Cross sectional study (retrospective)									
Aim	Assess the reliability of DUS compared with CTA for surveillance following EVAR.									
Patient Characteristics	Inclusion criteria: Patients undergoing EVAR. Exclusion criteria: Not reported									
	<table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Mean Age (range)</td> <td>79 years (56-94 years)</td> </tr> <tr> <td>Males (%)</td> <td>85%</td> </tr> <tr> <td>Aneurysm Size</td> <td>Not reported</td> </tr> </tbody> </table>		Study Characteristics		Mean Age (range)	79 years (56-94 years)	Males (%)	85%	Aneurysm Size	Not reported
Study Characteristics										
Mean Age (range)	79 years (56-94 years)									
Males (%)	85%									
Aneurysm Size	Not reported									
Sample Size	59 patients									
Index test(s)	<p>CDUS</p> <p>Follow-up protocol for patients undergoing EVAR was to perform both CDUS and CTA at 1 month, 3 months, 6 months, 12 months, 18 months, and then yearly thereafter. All patients were scanned with a 2- to 5-MHz transducer. Pulsed Doppler was used to evaluate any colour Doppler signals exterior to the graft. This was to help differentiate between genuine higher velocity endoleak and 'pseudo-endoleak' reflecting the movement of liquefied thrombus within the aneurysm sac. Reporting radiologists and ultrasonographers referred to previous scans to assess significant change in maximum sac diameter. 3 specialist vascular ultrasonographers performed and reported the CDUS.</p>									
Reference standard(s)	<p>CTA</p> <p>All patients underwent dual phase Multi-Detector CT on a Philips MX80000 IDT or GE Prospeed SX. Two consultant interventional radiologists reported the CTA.</p>									
Study Details	<p>Study location: Gateshead, UK</p> <p>Study setting: Department of Vascular Surgery</p> <p>Study dates: April 1998 and December 2007</p> <p>Loss to follow-up: Not reported</p> <p>Time between testing & Treatment: Paired scans conducted within 2 weeks of each other, and almost all scans took place on the same day</p> <p>Source of funding: Not specified</p>									

Full citation	Badri Hassan, El Haddad, Mohammed, Ashour Hamdy, Nice Colin, Timmons Grace, and Bhattacharya Vish (2010) Duplex ultrasound scanning (DUS) versus computed tomography angiography (CTA) in the follow-up after EVAR. <i>Angiology</i> 61, 131-6
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Unclear risk of bias. Unclear if index test results were interpreted without knowledge of reference standard results. Reference standard: Unclear risk of bias. Unclear if reference standard results were interpreted without knowledge of index test. Flow and timing: Low risk of bias Overall risk of bias: High risk of bias Directness: Directly applicable

Full citation	Bargellini Irene, Cioni Roberto, Napoli Vinicio, Petruzzi Pasquale, Vignali Claudio, Cicorelli Antonio, Sardella Savino, Ferrari Mauro, and Bartolozzi Carlo (2009) Ultrasonographic surveillance with selective CTA after endovascular repair of abdominal aortic aneurysm. Journal of endovascular therapy: an official journal of the International Society of Endovascular Specialists 16, 93-104									
Study type	Cross sectional study									
Aim	Evaluate the agreement between CDUS and CTA in monitoring aneurysm diameter and detecting endoleaks after EVAR.									
Patient Characteristics	<p>Inclusion criteria: Patients who underwent EVAR for elective treatment of infrarenal AAAs with a mean maximum transverse diameter of 52.4±9.7mm.</p> <p>Exclusion criteria: Not specified</p> <table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Mean Age (range)</td> <td>72.4 years (52-88)</td> </tr> <tr> <td>Males (%)</td> <td>97%</td> </tr> <tr> <td>Aneurysm Size (±SD)</td> <td>52.4 ± 9.7 mm</td> </tr> </tbody> </table>		Study Characteristics		Mean Age (range)	72.4 years (52-88)	Males (%)	97%	Aneurysm Size (±SD)	52.4 ± 9.7 mm
Study Characteristics										
Mean Age (range)	72.4 years (52-88)									
Males (%)	97%									
Aneurysm Size (±SD)	52.4 ± 9.7 mm									
Sample Size	198 patients									
Index test(s)	<p>CDUS</p> <p>All patients underwent strict clinical and imaging follow-up by CDUS at 1 month and every 6 months. When complications were suspected (such as endoleak, stent-graft migration, or increased AAA diameter), closer surveillance was performed. A single radiologist masked to the CTA findings performed CDUS. A change (≥10%) in the maximum transverse sac diameter at follow up compared to the pre-procedural value was considered significant.</p>									
Reference standard(s)	<p>CTA</p> <p>CTA was performed at 1 and 6 months and annually thereafter. Surveillance CTA included an unenhanced scan, followed by acquisitions in the arterial phase and delayed phases.</p>									
Study Details	<p>Study location: Italy</p> <p>Study setting: Department of Diagnostic and Interventional Radiology</p> <p>Study dates: November 1998 to January 2007</p> <p>Loss to follow-up:</p> <p>5 cases of surgical conversion due to severe kinking of the stent-graft, rupture and stent-graft occlusion</p> <p>2 deaths due to myocardial infarction</p> <p>Aneurysm- related death due to rupture</p>									

Full citation	Bargellini Irene, Cioni Roberto, Napoli Vinicio, Petruzzi Pasquale, Vignali Claudio, Cicorelli Antonio, Sardella Savino, Ferrari Mauro, and Bartolozzi Carlo (2009) Ultrasonographic surveillance with selective CTA after endovascular repair of abdominal aortic aneurysm. Journal of endovascular therapy: an official journal of the International Society of Endovascular Specialists 16, 93-104
	Time between testing & Treatment: CDUS and CTA conducted within 30 days of each other Source of funding: Not reported
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Low risk of bias Reference standard: Unclear risk of bias- unclear blinding between reference standard results and index test results Flow and timing: Low risk of bias Overall risk of bias: Moderate risk of bias Directness: Directly applicable

Full citation	Bendick Phillip J, Bove Paul G, Long Graham W, Zelenock Gerald B, Brown O William, and Shanley Charles J (2003) Efficacy of ultrasound scan contrast agents in the noninvasive follow-up of aortic stent grafts. Journal of vascular surgery 37, 381-5									
Study type	Cross sectional study									
Aim	Evaluate the efficacy of duplex ultrasound scan with the addition of an ultrasound scan contrast agent in documenting endoleaks and compare results with CTA									
Patient Characteristics	<p>Inclusion criteria: Patients who had a percutaneously placed aortoiliac stent graft for infrarenal aortic aneurysmal disease. 10 patients selected because of the technical difficulty of the conventional duplex ultrasound scan from patient body habitus or presence of bowel gas.</p> <p>Exclusion criteria: Not reported</p> <table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Mean Age</td> <td>74.5 ±7.6 years</td> </tr> <tr> <td>Males (%)</td> <td>95%</td> </tr> <tr> <td>Aneurysm Size (±SD)</td> <td>5.6 ± 0.9 cm</td> </tr> </tbody> </table>		Study Characteristics		Mean Age	74.5 ±7.6 years	Males (%)	95%	Aneurysm Size (±SD)	5.6 ± 0.9 cm
Study Characteristics										
Mean Age	74.5 ±7.6 years									
Males (%)	95%									
Aneurysm Size (±SD)	5.6 ± 0.9 cm									
Sample Size	20 patients									
Index test(s)	<p>CDUS and CEUS</p> <p>As part of routine postoperative surveillance at 1, 3, 6 and 12 months, a standard aortic duplex ultrasound scan examination, with CDI and spectral Doppler velocity measurements. The operator was blinded to the results of any previous ultrasound scans and of any prior angiographic or CTA studies. After completion of the standard aortic postoperative scanning protocol, a 1-mL bolus of ultrasound scan contrast agent was given. The contrast was allowed to circulate in the blood pool for approximately 1 minute, and then the aortic stent graft and aneurysm sac were again scanned.</p> <p>Any endoleaks that were seen with CDUS were classified as being related to stent graft itself (group I), at either the proximal or distal attachment sites or at any graft module junctions or secondary to patent aortic branch vessels (group II), such as the inferior mesenteric artery or lumbar arteries, which showed collateral filled and back bleeding into the aneurysm sac.</p>									
Reference standard(s)	<p>CTA</p> <p>CTA was conducted after a standard stent graft protocol. All CTA studies were done within a 2 week period of duplex ultrasound scan.</p>									
Study Details	<p>Study location: USA</p> <p>Study setting: Department of Surgery</p> <p>Study dates: January to December 2001</p>									

Full citation	Bendick Phillip J, Bove Paul G, Long Graham W, Zelenock Gerald B, Brown O William, and Shanley Charles J (2003) Efficacy of ultrasound scan contrast agents in the noninvasive follow-up of aortic stent grafts. Journal of vascular surgery 37, 381-5
	Loss to follow-up: Not specified Time between testing & Treatment: within 2 weeks Source of funding: Not specified
Quality Assessment (QUADAS 2)	Patient selection: High risk of bias. Consecutive patients not selected. Index test: Low risk of bias Reference standard: Low risk of bias Flow and timing: Low risk of bias Overall risk of bias: Moderate risk of bias Directness: Directly applicable

Full citation	Cantador Alex Aparecido, Siqueira Daniel Emilio Dalledone, Jacobsen Octavio Barcellos, Baracat Jamal, Pereira Ines Minniti Rodrigues, Menezes Fabio Husemann, and Guillaumon Ana Terezinha (2016) Duplex ultrasound and computed tomography angiography in the follow-up of endovascular abdominal aortic aneurysm repair: a comparative study. Radiologia brasileira 49(4), 229-233																			
Study type	Cross sectional study																			
Aim	Compare duplex ultrasound and CTA in terms of their performance in detecting endoleaks, as well as in determining the diameter of the aneurysm sac, in the post-operative follow-up of EVAR																			
Patient Characteristics	<p>Inclusion criteria: Patients undergoing EVAR</p> <p>Exclusion criteria:</p> <p>Patients allergic to iodinated contrast</p> <p>Patients with creatinine level >2.0 mg/dL</p> <table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Age (range)</td> <td>75 years (58-85 years)</td> </tr> <tr> <td>Males (%)</td> <td>83%</td> </tr> <tr> <td>Smoking (%)</td> <td>80%</td> </tr> <tr> <td>Arterial hypertension (%)</td> <td>73%</td> </tr> <tr> <td>Diabetes mellitus (%)</td> <td>30%</td> </tr> <tr> <td>Dyslipidemia (%)</td> <td>23%</td> </tr> <tr> <td>Myocardial infarction (%)</td> <td>16%</td> </tr> <tr> <td>Aneurysm Size (range)</td> <td>6.5 cm (3.5-8.8 cm)</td> </tr> </tbody> </table>		Study Characteristics		Age (range)	75 years (58-85 years)	Males (%)	83%	Smoking (%)	80%	Arterial hypertension (%)	73%	Diabetes mellitus (%)	30%	Dyslipidemia (%)	23%	Myocardial infarction (%)	16%	Aneurysm Size (range)	6.5 cm (3.5-8.8 cm)
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Myocardial infarction (%)	16%																			
Aneurysm Size (range)	6.5 cm (3.5-8.8 cm)																			
Sample Size	30 patients																			
Index test(s)	<p>CDUS</p> <p>One ultrasound and one CT angiography per patient, with a maximum interval of two weeks between examinations were evaluated. Endoleaks were initially evaluated through the acquisition of good-quality B-mode ultrasound images, the aneurysm sac and stent being inspected in cross-sectional and longitudinal views. Thereafter, Doppler was used to identify any flow between the stent and aneurysm sac. Endoleaks were evaluated in spectral Doppler, in order to confirm the findings of the colour Doppler ultrasound examinations. One radiologist performed all ultrasounds.</p>																			

Full citation	Cantador Alex Aparecido, Siqueira Daniel Emilio Dalledone, Jacobsen Octavio Barcellos, Baracat Jamal, Pereira Ines Minniti Rodrigues, Menezes Fabio Husemann, and Guillaumon Ana Terezinha (2016) Duplex ultrasound and computed tomography angiography in the follow-up of endovascular abdominal aortic aneurysm repair: a comparative study. Radiologia brasileira 49(4), 229-233
Reference standard(s)	CTA One radiologist performed all CT angiographies. Reports were generated independently, without data sharing between the examiners.
Study Details	Study location: Brazil Study setting: Not specified Study dates: Not specified Loss to follow-up: Not specified Time between testing & Treatment: Maximum of 14 days Source of funding: Not specified
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Low risk of bias Reference standard: Low risk of bias Flow and timing: low risk of bias Overall risk of bias: Low risk of bias Directness: Directly applicable

Full citation	Clevert D A, Minaifar N, Weckbach S, Kopp R, Meimarakis G, Clevert D A, and Reiser M (2008) Color duplex ultrasound and contrast-enhanced ultrasound in comparison to MS-CT in the detection of endoleak following endovascular aneurysm repair. <i>Clinical hemorheology and microcirculation</i> 39, 121-32							
Study type	Cross sectional study							
Aim	Compare colour duplex ultrasound (CDU), contrast enhanced ultrasound (CEUS) and multislice computed tomography (MS-CT) angiography in the routine follow-up of patients following EVAR.							
Patient Characteristics	Inclusion criteria: consecutive patients who had undergone EVAR. Exclusion criteria: Not specified							
	<table border="1"> <tr> <td colspan="2">Study Characteristics</td> </tr> <tr> <td>Mean Age</td> <td>63 years</td> </tr> <tr> <td>Aneurysm Size (\pmSD)</td> <td>Not reported</td> </tr> </table>		Study Characteristics		Mean Age	63 years	Aneurysm Size (\pm SD)	Not reported
Study Characteristics								
Mean Age	63 years							
Aneurysm Size (\pm SD)	Not reported							
Sample Size	43 patients							
Index test(s)	<p>CDUS and CEUS</p> <p>Two experienced sonographers performed ultrasound examinations of the abdominal aorta. An internally standardised duplex scanning protocol was used for assessing the abdominal aorta followed by CUES. In CDUS, the colour gain was selected just as high as it is necessary to avoid overwriting artefacts. The sonographer was not aware of the CT scan results during the examination and reading of CDUS and CEUS examination. Endoleaks were defined as the persistence of blood flow outside the lumen of the endoluminal graft but within an aneurysm sac or adjacent vascular segment being treated by the graft. Type I endoleak were defined as flow into aneurysm sac originating from around a stent graft attachment site. Type II endoleak were defined as retrograde blood flow through aortic branch vessels into the aneurysm sac. Type III endoleak was defined as structural failure within the stent graft such as stent-graft fractures or holes that develop in the fabric of the device.</p>							
Reference standard(s)	<p>CTA</p> <p>The patients were examined using a standard protocol for an arterial and venous phase exam with a 16 or 64 detector CT scanner. CT examinations were performed within 1 day before CEUS. CT examinations were performed and read by experienced radiologists who were blinded to the results of both sonography and contrast-enhanced sonography.</p>							
Study Details	<p>Study location: Munich, Germany</p> <p>Study setting: Department of Clinical Radiology</p> <p>Study dates: September 2006 to December 2006</p> <p>Loss to follow-up: No loss to follow-up</p>							

Full citation	Clevert D A, Minaifar N, Weckbach S, Kopp R, Meimarakis G, Clevert D A, and Reiser M (2008) Color duplex ultrasound and contrast-enhanced ultrasound in comparison to MS-CT in the detection of endoleak following endovascular aneurysm repair. <i>Clinical hemorheology and microcirculation</i> 39, 121-32
	Time between testing & Treatment: CTA examinations conducted within 1 day before CEUS. Source of funding: Not specified
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Low risk of bias Reference standard: Low risk of bias Flow and timing: Low risk of bias Overall risk of bias: Low risk of bias Directness: Directly applicable

Full citation	Clevert D A, Helck A, D'Anastasi M, Gurtler V, Sommer W H, Meimarakis G, Weidenhagen R, and Reiser M (2011) Improving the follow up after EVAR by using ultrasound image fusion of CEUS and MS-CT. Clinical hemorheology and microcirculation 49, 91-104									
Study type	Cross sectional study (retrospective)									
Aim	To evaluate whether the image fusion with CEUS and CT affects the diagnosis of endoleaks in unclear cases.									
Patient Characteristics	<p>Inclusion criteria: Only patients undergoing follow-up after EVAR</p> <p>Exclusion criteria:</p> <p>Patients with heart pacemaker or neurostimulator</p> <p>Patients with acute heart failure, myocardial infarction, known allergy to Sonovue, extensive subcutaneous emphysema</p> <p>Patient non-compliance</p> <table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Mean Age</td> <td>73 years</td> </tr> <tr> <td>Males (%)</td> <td>94%</td> </tr> <tr> <td>Aneurysm Size (\pmSD)</td> <td>Not reported</td> </tr> </tbody> </table>		Study Characteristics		Mean Age	73 years	Males (%)	94%	Aneurysm Size (\pm SD)	Not reported
Study Characteristics										
Mean Age	73 years									
Males (%)	94%									
Aneurysm Size (\pm SD)	Not reported									
Sample Size	35 patients									
Index test(s)	<p>CDUS and CEUS</p> <p>Ultrasound examinations were performed by an experienced sonographer and were later read by two blinded unbiased investigators. Both conventional ultrasound including CDUS and CEUS were performed. For CEUS, an intravenous bolus injection of 1.0 ml of a second generation blood pool contrast agent consisting of stabilised microbubbles of sulphur hexafluoride was administered.</p>									
Reference standard(s)	<p>CTA</p> <p>All special ultrasound techniques like CDUS, power-Doppler or CEUS were integrated in the image fusion examination. Standard DICOM data sets of all cross-sectional CT examinations were used for image fusion.</p>									
Study Details	<p>Study location: Germany</p> <p>Study setting: Interdisciplinary Ultrasound Centre</p> <p>Study dates: Not reported</p> <p>Loss to follow-up: No adverse reactions to the ultrasound contrast medium were observed</p> <p>Time between testing & Treatment: Not reported</p> <p>Source of funding: Not reported</p>									

Full citation	Clevert D A, Helck A, D'Anastasi M, Gurtler V, Sommer W H, Meimarakis G, Weidenhagen R, and Reiser M (2011) Improving the follow up after EVAR by using ultrasound image fusion of CEUS and MS-CT. Clinical hemorheology and microcirculation 49, 91-104
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Unclear- definition of endoleak not provided Reference standard: Unclear risk of bias- Inadequate information on reference standard and unclear blinding between reference standard results and index test Flow and timing: Unclear risk of bias- interval between reference standard and index test not reported. Overall risk of bias: High risk of bias Directness: Directly applicable

Full citation	D'Audiffret A, Desgranges P, Kobeiter D H, and Becquemin J P (2001) Follow-up evaluation of endoluminally treated abdominal aortic aneurysms with duplex ultrasonography: validation with computed tomography. Journal of vascular surgery 33, 42-50																											
Study type	Cross sectional study																											
Aim	Compare CDUS and CTA for the follow-up of endoluminally treated aortic aneurysms.																											
Patient Characteristics	Inclusion criteria: Patients who underwent AAA exclusion with commercially available endoprosthesis Exclusion criteria: Patients who did not have a minimum follow-up of 6 months																											
	<table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Mean Age</td> <td>70 ± 5</td> </tr> <tr> <td>Males (%)</td> <td>93%</td> </tr> <tr> <td>Ischemic Heart disease</td> <td>56.2%</td> </tr> <tr> <td>Previous myocardial infraction</td> <td>19.2%</td> </tr> <tr> <td>Obesity</td> <td>31.3%</td> </tr> <tr> <td>Smoking</td> <td>49%</td> </tr> <tr> <td>Hypertension</td> <td>59.4%</td> </tr> <tr> <td>Pulmonary disease</td> <td>29%</td> </tr> <tr> <td>Diabetes mellitus</td> <td>9%</td> </tr> <tr> <td>Renal impairment</td> <td>11%</td> </tr> <tr> <td>Hyperlipidemia</td> <td>30.3%</td> </tr> <tr> <td>Aneurysm Size (range)</td> <td>53.2 mm (48-80 mm)</td> </tr> </tbody> </table>		Study Characteristics		Mean Age	70 ± 5	Males (%)	93%	Ischemic Heart disease	56.2%	Previous myocardial infraction	19.2%	Obesity	31.3%	Smoking	49%	Hypertension	59.4%	Pulmonary disease	29%	Diabetes mellitus	9%	Renal impairment	11%	Hyperlipidemia	30.3%	Aneurysm Size (range)	53.2 mm (48-80 mm)
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Aneurysm Size (range)	53.2 mm (48-80 mm)																											
Sample Size	89 patients																											
Index test(s)	CDUS CDUS examinations were performed by 1 or 4 physicians. No contrast agent was used. Colour flow sampling within the aneurysm sac, outside the endoprosthesis, was used to detect endoleaks. When flow was detected, a Doppler waveform analysis completed the investigation.																											
Reference standard(s)	CTA																											

Full citation	D'Audiffret A, Desgranges P, Kobeiter D H, and Becquemin J P (2001) Follow-up evaluation of endoluminally treated abdominal aortic aneurysms with duplex ultrasonography: validation with computed tomography. Journal of vascular surgery 33, 42-50
	Helical CTA performed. Endoleaks were defined by the presence of contrast between the graft the arterial wall of the aneurysm. Comparison with non-enhanced CT images enabled the differentiation of small type II endoleak from calcification. All images were reviewed by an experienced radiologist and vascular surgeon.
Study Details	<p>Study location: France</p> <p>Study setting: Department of Vascular surgery</p> <p>Study dates: January 1995 to March 2000</p> <p>Loss to follow-up: Not specified</p> <p>Time between testing & Treatment: Between a one month interval</p> <p>Source of funding: Not specified</p>
Quality Assessment (QUADAS 2)	<p>Patient selection: Low risk of bias</p> <p>Index test: High risk of bias. Inadequate blinding between index and reference standard</p> <p>Reference standard: High risk of bias. Inadequate blinding between reference standard and index test.</p> <p>Flow and timing: Low risk of bias</p> <p>Overall risk of bias: High risk of bias</p> <p>Directness: Directly applicable</p>

Full citation	Demirpolat Gulgun, Ozturk Nur, Parildar Mustafa, Posacioglu Hakan, and Tamsel Sadik (2011) Duplex ultrasound evaluation of endoluminally treated aortic aneurysms with emphasis on diameter measurement: A comparison with computed tomography. Journal of clinical ultrasound: JCU 39, 263-9									
Study type	Cross sectional study (retrospective)									
Aim	Determine accuracy of CDUS for endoleak detection and measurement of the aneurysm diameter after EVAR.									
Patient Characteristics	Inclusion criteria: Patients treated with endovascular stent grafts for AAA Exclusion criteria: Not specified									
	<table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Mean Age (range)</td> <td>72.2 years (47 to 90 years)</td> </tr> <tr> <td>Males (%)</td> <td>89%</td> </tr> <tr> <td>Aneurysm Size (\pmSD)</td> <td>64 \pm18.4 mm</td> </tr> </tbody> </table>		Study Characteristics		Mean Age (range)	72.2 years (47 to 90 years)	Males (%)	89%	Aneurysm Size (\pm SD)	64 \pm 18.4 mm
Study Characteristics										
Mean Age (range)	72.2 years (47 to 90 years)									
Males (%)	89%									
Aneurysm Size (\pm SD)	64 \pm 18.4 mm									
Sample Size	29 patients									
Index test(s)	CDUS CDUS was performed by a radiologist experience in Doppler ultrasonography. Endoleaks were suspected when reproducible, pulsatile colour flow images could be seen outside the graft. If present, spectral analysis of pulsed Doppler signal was performed and the relation of this flow with the graft lumen or with branches of the aorta was evaluated.									
Reference standard(s)	CTA Routine follow-up were performed first, sixth and twelfth months, and yearly thereafter. No pre-contrast or delayed images were obtained.									
Study Details	Study location: Turkey Study setting: Department of Radiology Study dates: September 2007 and May 2009 Loss to follow-up: Not specified Time between testing & Treatment: Same day Source of funding: Not specified.									
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Low risk of bias									

Full citation	Demirpolat Gulgun, Ozturk Nur, Parildar Mustafa, Posacioglu Hakan, and Tamsel Sadik (2011) Duplex ultrasound evaluation of endoluminally treated aortic aneurysms with emphasis on diameter measurement: A comparison with computed tomography. Journal of clinical ultrasound: JCU 39, 263-9
	Reference standard: Low risk of bias Flow and timing: Low risk Overall risk of bias: Low risk of bias Directness: Directly applicable

Full citation	Franca G J, Baroncini L A. V, de Oliveira , A , Vidal E A, Miyamoto M, Toregeani J F, Coelho L O. M, and Timi J R. R (2013) Evaluation with Doppler vascular ultrasound in postoperative endovascular treatment of abdominal aortic aneurysm: A prospective comparative study with angiotomography. Jornal Vascular Brasileiro 12, 102-109									
Study type	Cross sectional									
Aim	Determine validity indices of Doppler vascular ultrasound and to correlate findings with CTA results in postoperative evaluation of patients who had undergone elective endovascular treatment of AAAs.									
Patient Characteristics	Inclusion criteria: Not specified Exclusion criteria: Not specified									
	<table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Mean Age</td> <td>73±6.9 years</td> </tr> <tr> <td>Males (%)</td> <td>90%</td> </tr> <tr> <td>Aneurysm Size (±SD)</td> <td>54.5 ±12.6 mm</td> </tr> </tbody> </table>		Study Characteristics		Mean Age	73±6.9 years	Males (%)	90%	Aneurysm Size (±SD)	54.5 ±12.6 mm
Study Characteristics										
Mean Age	73±6.9 years									
Males (%)	90%									
Aneurysm Size (±SD)	54.5 ±12.6 mm									
Sample Size	33 patients									
Index test(s)	CDUS Doppler vascular exams were performed by 3 experienced vascular ultrasonographers. Exam interpretation was blinded for test information, even in patients with more than one test pair. Endoleak was defined as the transmission of flow and pressure into the aneurysm sac.									
Reference standard(s)	CTA 3 radiologists performed CTA examinations									
Study Details	Study location: Brazil Study setting: Vascular Ultrasonography units Study dates: not specified Loss to follow-up: Not specified Time between testing & Treatment: interval between two examinations could not exceed 90 days Source of funding: Not specified									
Quality Assessment (QUADAS 2)	Patient selection: Unclear risk of bias. Inclusion and exclusion criteria not specified. Index test: Low risk of bias									

Full citation	Franca G J, Baroncini L A. V, de Oliveira , A , Vidal E A, Miyamoto M, Toregeani J F, Coelho L O. M, and Timi J R. R (2013) Evaluation with Doppler vascular ultrasound in postoperative endovascular treatment of abdominal aortic aneurysm: A prospective comparative study with angiotomography. Jornal Vascular Brasileiro 12, 102-109
	Reference standard: Low risk of bias Flow and timing: High risk of bias. Inadequate interval between index test and reference test. Overall risk of bias: High risk of bias Directness: Directly applicable

Full citation	Gargiulo M, Gallitto E, Serra C, Freyrie A, Mascoli C, Bianchini Massoni, C , De Matteis , M , De Molo , C , and Stella A (2014) Could four-dimensional contrast-enhanced ultrasound replace computed tomography angiography during follow up of fenestrated endografts? Results of a preliminary experience. European journal of vascular and endovascular surgery : the official journal of the European Society for Vascular Surgery 48, 536-42									
Study type	Cross sectional study									
Aim	Evaluate 4D CEUS as an alternative imaging method to CTA during follow-up of fenestrated EVAR for juxta- and para-renal AAA.									
Patient Characteristics	Inclusion criteria: All consecutive patients who underwent FEVAR follow-up for juxta- and para- AAA Exclusion criteria: Not specified									
	<table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Mean Age</td> <td>74±7 years</td> </tr> <tr> <td>Males (%)</td> <td>96%</td> </tr> <tr> <td>Aneurysm Size (±SD)</td> <td>55 ± 7 mm</td> </tr> </tbody> </table>		Study Characteristics		Mean Age	74±7 years	Males (%)	96%	Aneurysm Size (±SD)	55 ± 7 mm
Study Characteristics										
Mean Age	74±7 years									
Males (%)	96%									
Aneurysm Size (±SD)	55 ± 7 mm									
Sample Size	22 patients									
Index test(s)	4DCEUS All US examinations, including baseline US, CEUS, and 4D CEUS, were performed with the same machine. A sulphur hexafluoride-filled microbubble contrast agent (SonoVue) was used for contrast examinations. To avoid inter-observer variability, all US scanning was performed by one investigator who was blinded to the CTA. Endoleaks were detected and classified according the White and May classification									
Reference standard(s)	CTA CTA was performed by a radiologist with experience in vascular CTA evaluations. Triple phase CTA was acquired on a 64-slice CT scanner. Endoleaks were detected and classified according to the White and May classification.									
Study Details	Study location: Italy Study setting: Ultrasound Unit Study dates: October 2011 to March 2012 Loss to follow-up: No loss to follow-up Time between testing & Treatment: ≤30 days Source of funding: Not specified									

Full citation	Gargiulo M, Gallitto E, Serra C, Freyrie A, Mascoli C, Bianchini Massoni, C , De Matteis , M , De Molo , C , and Stella A (2014) Could four-dimensional contrast-enhanced ultrasound replace computed tomography angiography during follow up of fenestrated endografts? Results of a preliminary experience. European journal of vascular and endovascular surgery : the official journal of the European Society for Vascular Surgery 48, 536-42
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Low risk of bias Reference standard: Unclear risk of bias- unclear blinding between reference standard and index test Flow and timing: Low risk of bias Overall risk of bias: Moderate risk of bias Directness: Directly applicable

Full citation	Giannoni Maria Fabrizia, Fanelli Fabrizio, Citone Michele, Cristina Acconcia, Maria , Speziale Francesco, and Gossetti Bruno (2007) Contrast ultrasound imaging: the best method to detect type II endoleak during endovascular aneurysm repair follow-up. Interactive cardiovascular and thoracic surgery 6, 359-62						
Study type	Cross sectional study						
Aim	Evaluate if ultrasound investigation with Cadence Contrast Pulse Sequencing technique and Sonovue is a possible alternative method to CTA in detecting endoleaks.						
Patient Characteristics	Inclusion criteria: Consecutive patients with endovascular grafts for infrarenal aortic aneurysms.						
	Exclusion criteria: Not specified						
	<table border="1"> <tr> <td colspan="2">Study Characteristics</td> </tr> <tr> <td>Mean Age</td> <td>74.4±5.4 years</td> </tr> <tr> <td>Aneurysm Size (±SD)</td> <td>Not reported</td> </tr> </table>		Study Characteristics		Mean Age	74.4±5.4 years	Aneurysm Size (±SD)
Study Characteristics							
Mean Age	74.4±5.4 years						
Aneurysm Size (±SD)	Not reported						
Sample Size	30 patients						
Index test(s)	<p>CEUS</p> <p>Ultrasound investigation (Sequoia Acuson Siemens) was performed with convex probe, equipped for Cadence CPS software. The echo-contrast solution was injected in bolus. The US examination were performed by vascular doctors, blinded to the results of CTA. Particular attention was reserved in order to detect type II endoleak, defined as persisting flow from patent lumbar or mesenteric arteries within aneurysm sac and outside the endograft.</p>						
Reference standard(s)	<p>CTA</p> <p>CTA was performed with delayed triphasic sequences (Siemens Somatom Sensation Cardia 64).</p>						
Study Details	<p>Study location: Rome, Italy</p> <p>Study setting: Division of Vascular Surgery</p> <p>Study dates: Not specified</p> <p>Loss to follow-up: One patient dropped out because a stroke occurred in the time interval between the two investigations</p> <p>Time between testing & Treatment: No more than 15 days between the two examinations.</p> <p>Source of funding: Not specified</p>						
Quality Assessment (QUADAS 2)	<p>Patient selection: Low risk of bias</p> <p>Index test: Low risk of bias</p>						

Full citation	Giannoni Maria Fabrizia, Fanelli Fabrizio, Citone Michele, Cristina Acconcia, Maria , Speziale Francesco, and Gossetti Bruno (2007) Contrast ultrasound imaging: the best method to detect type II endoleak during endovascular aneurysm repair follow-up. Interactive cardiovascular and thoracic surgery 6, 359-62
	Reference standard: Unclear risk of bias- unclear if reference standard results were interpreted without knowledge of index test results Flow and timing: Low risk of bias Overall risk of bias: Moderate risk of bias Directness: Directly applicable

Full citation	Gilabert Rosa, Bunesch Laura, Real Maria Isabel, Garcia-Criado Angeles, Burrel Marta, Ayuso Juan Ramon, Barrufet Marta, Montana Xavier, and Riambau Vicenc (2012) Evaluation of abdominal aortic aneurysm after endovascular repair: prospective validation of contrast-enhanced US with a second-generation US contrast agent. Radiology 264, 269-77									
Study type	Cross sectional study									
Aim	Assess the accuracy of contrast agent enhanced ultrasonography with a second generation US contrast agent in the detection and classification of endoleaks after EVAR.									
Patient Characteristics	<p>Inclusion criteria: Patients undergoing EVAR at institution</p> <p>Exclusion criteria:</p> <p>Patients with inadequate renal function (calculated creatinine clearance <30 mL/<50mL/min in patients with diabetes)</p> <p>Patients with contraindications to US contrast agent administration, such as heart failure, a right-to-left shunt, severe chronic bronchopulmonary disorder, severe pulmonary hypertension, or uncontrolled hypertension.</p> <table border="1" data-bbox="448 699 1697 858"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Mean Age (range)</td> <td>71.6 years (51-83 years)</td> </tr> <tr> <td>Males (%)</td> <td>97%</td> </tr> <tr> <td>Aneurysm Size (\pmSD)</td> <td>Not reported</td> </tr> </tbody> </table>		Study Characteristics		Mean Age (range)	71.6 years (51-83 years)	Males (%)	97%	Aneurysm Size (\pm SD)	Not reported
Study Characteristics										
Mean Age (range)	71.6 years (51-83 years)									
Males (%)	97%									
Aneurysm Size (\pm SD)	Not reported									
Sample Size	35 patients									
Index test(s)	<p>CEUS</p> <p>All US studies were performed by two radiologists. CDUS was performed prior to CEUS. The CEUS study was performed after injection of 2.4 mL of sulphur hexafluoride (SonoVue) followed by a 5 mL saline bolus flush. Endoleaks were diagnosed when the observation consisted of a hyperchogenic flowing region (localised or diffuse) that was absent on the baseline unenhanced images obtained outside the endograft lumen but within the aneurysm sac.</p>									
Reference standard(s)	<p>CTA</p> <p>CTA images were obtained either with a helical CT scanner or multi-detector CT scanner. Triple-phase image acquisitions were performed that included abdominal aorta from the celiac trunk to the external iliac arteries 2-4 cm below the endoprotheses or the common femoral arteries. CTAS were analysed by two radiologists who were not involved in CDUS or CEUS image acquisitions and analysis and who had knowledge of previous CT angiographic findings. Endoleaks were diagnosed when the observation consisted of an increase in the attenuation coefficient at CTA</p>									
Study Details	Study location: Spain									

Full citation	Gilabert Rosa, Bunesch Laura, Real Maria Isabel, Garcia-Criado Angeles, Burrel Marta, Ayuso Juan Ramon, Barrufet Marta, Montana Xavier, and Riambau Vicenc (2012) Evaluation of abdominal aortic aneurysm after endovascular repair: prospective validation of contrast-enhanced US with a second-generation US contrast agent. Radiology 264, 269-77					
	<p>Study setting: Diagnostic imaging centre</p> <p>Study dates: January 2004 and December 2006</p> <p>Loss to follow-up: Not reported</p> <p>Time between testing & Treatment: 52 CTA and CEUS studies performed on the same day, 31 CEUS studies performed before CTA (mean, 10.77 days \pm8.32) and 43 CEUS studies were performed after CTA (mean, 8.6 days\pm4.7)</p> <p>Source of funding: Not reported</p>					
Quality Assessment (QUADAS 2)	<p>Patient selection: Low risk of bias</p> <p>Index test: Low risk of bias</p> <p>Reference standard: Low risk of bias</p> <p>Flow and timing: Low risk of bias</p> <p>Overall risk of bias: Low risk of bias</p> <p>Directness: Directly applicable</p>					
Full citation	Golzarian Jafar, Murgo Salvatore, Dussaussois Luc, Guyot Sophie, Said Kamel Ait, Wautrecht Jean Claude, and Struyven Julien (2002) Evaluation of abdominal aortic aneurysm after endoluminal treatment: comparison of color Doppler sonography with biphasic helical CT. AJR. American journal of roentgenology 178, 623-8					
Study type	Cross sectional study					
Aim	Compare colour Doppler sonography with biphasic helical CT in the evaluation of abdominal aneurysms after endovascular repair.					
Patient Characteristics	<p>Inclusion criteria: Patients who underwent transfemoral insertion of stent-grafts for abdominal aortic aneurysm</p> <p>Exclusion criteria: Only the examinations obtained within 7 days after implantation were compared.</p> <table border="1" data-bbox="448 1209 1697 1289"> <tr> <td colspan="2">Study Characteristics</td> </tr> <tr> <td>Mean Age (range)</td> <td>73 years (61-87 years)</td> </tr> </table>		Study Characteristics		Mean Age (range)	73 years (61-87 years)
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Mean Age (range)	73 years (61-87 years)					

Full citation	Golzarian Jafar, Murgo Salvatore, Dussaussois Luc, Guyot Sophie, Said Kamel Ait, Wautrecht Jean Claude, and Struyven Julien (2002) Evaluation of abdominal aortic aneurysm after endoluminal treatment: comparison of color Doppler sonography with biphasic helical CT. AJR. American journal of roentgenology 178, 623-8	
	Males (%)	93%
	Aneurysm Size (range)	5.1-7.8 cm
Sample Size	55 patients	
Index test(s)	<p>CDUS</p> <p>All patients prospectively underwent CDUS and biphasic CTA within 7 days after stent-graft implantation. CDUS and CTA were used as follow-up modalities in patients at 3, 6 and 12 months and every 6 months thereafter. CDUS was performed by 2 experienced operators (one angiologist and one radiologist). Each patient was evaluated by one physician. Patients were studied in the supine and lateral positions after an overnight fast. The aorta was first scanned transversally from the top of the stent-graft to the femoral arteries, and the maximal transversal diameter was measured. A leak was considered present when a signal associated with a spectral Doppler signal was observed outside the aorta. In case of a perigraft leak, an attempt was made to identify the origin and the direction of the flow. Operators were unaware of the helical CT results.</p>	
Reference standard(s)	<p>CTA</p> <p>All helical CT examinations were performed by 2 experience radiologists. A leak was considered present if contrast material was noted outside the stent-graft in either acquisition. All images were reviewed on radiologists and a workstation in conference with 2 radiologists who were unaware of the colour Doppler sonographic results.</p>	
Study Details	<p>Study location: Brussels, Belgium</p> <p>Study setting: Department of Radiology</p> <p>Study dates: April 1996 to April 1997</p> <p>Loss to follow-up: No loss to follow up</p> <p>Time between testing & Treatment: The maximum time interval between helical CT and CDUS was 48 hours, however, 33 patients had both examinations on the same day.</p> <p>Source of funding: Not specified</p>	
Quality Assessment (QUADAS 2)	<p>Patient selection: Low risk of bias</p> <p>Index test: Low risk of bias</p> <p>Reference standard: Low risk of bias</p> <p>Flow and timing: Low risk of bias</p>	

Full citation	Golzarian Jafar, Murgo Salvatore, Dussaussois Luc, Guyot Sophie, Said Kamel Ait, Wautrecht Jean Claude, and Struyven Julien (2002) Evaluation of abdominal aortic aneurysm after endoluminal treatment: comparison of color Doppler sonography with biphasic helical CT. AJR. American journal of roentgenology 178, 623-8
	Overall risk of bias: Low risk of bias Directness: Partially indirect. Although the protocol specifies that studies published after 2000 should be included, the committee were interested in studies in which patients received scans before this cut-off. As this study was conducted between 1996 and 1997, the study was downgraded for partial indirectness.

Full citation	Gray C, Goodman P, Herron C C, Lawler L P, O'Malley M K, O'Donohoe M K, and McDonnell C O (2012) Use of colour duplex ultrasound as a first line surveillance tool following EVAR is associated with a reduction in cost without compromising accuracy. European Journal of Vascular and Endovascular Surgery 44, 145-150									
Study type	Cross sectional study (retrospective)									
Aim	Evaluate the cost saving obtained if CDUS was employed as a first line surveillance tool following EVAR, as well as comparing the two entities in terms of efficacy.									
Patient Characteristics	Inclusion criteria: All patients who underwent EVAR at the Mater Hospital from 1st June 2003 to 1st July 2010 Exclusion criteria: Not specified									
	<table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Age</td> <td>77.1 ±7.9 years</td> </tr> <tr> <td>Male (%)</td> <td>84.1 %</td> </tr> <tr> <td>Aneurysm Size (±SD)</td> <td>Not reported</td> </tr> </tbody> </table>		Study Characteristics		Age	77.1 ±7.9 years	Male (%)	84.1 %	Aneurysm Size (±SD)	Not reported
Study Characteristics										
Age	77.1 ±7.9 years									
Male (%)	84.1 %									
Aneurysm Size (±SD)	Not reported									
Sample Size	145									
Index test(s)	<p>CDUS</p> <p>Following graft implantation all patients underwent regular post-operative surveillance, including CDUS and CT scans of the aorta within 7 days of surgery. After discharge, all patients underwent a CDUS scan and abdominal x ray at 1 month, a CDUS and CT scan at 6 months, 12 months, and annually thereafter provided. All scans were performed by the same accredited vascular technologist, blinded to CT results. Any examination that did not achieve complete visualisation of the entire aneurysm sac was considered limited. Contrast was not used in any patient. The stent and residual aneurysm sac were assessed using colour flow and spectral Doppler to rule out the presence of an endoleak. This required the use of very sensitive colour flow scale settings to determine the presence of low velocity leaks which may have been present within the residual aneurysm sac. Proximal and distal sealing zones were assessed to ensure that there was no evidence of high jet flow indicating type I endoleak or low velocity flow within the old aneurysm sac demonstrating forward and reversed flow indicating the presence of Type II endoleak.</p>									
Reference standard(s)	<p>CTA</p> <p>All CT scans were carried out on a Siemens Somatom Definition AS 128 slice scanner. Under the follow-up protocol following EVAR, patients underwent 3 CTs in the initial year post graft implantation (post-surgery, at 6 months and 1 year) and annually thereafter, provided there has been no documented endoleak or residual sac increase on either CDUS or CT.</p>									
Study Details	<p>Study location: Dublin, Ireland</p> <p>Study setting: Department of Vascular Radiology, Mater Misericordiae University Hospital</p>									

Full citation	Gray C, Goodman P, Herron C C, Lawler L P, O'Malley M K, O'Donohoe M K, and McDonnell C O (2012) Use of colour duplex ultrasound as a first line surveillance tool following EVAR is associated with a reduction in cost without compromising accuracy. European Journal of Vascular and Endovascular Surgery 44, 145-150
	Study dates: June 2003 to July 2010 Loss to follow-up: Patients who missed scheduled appointments were contacted directly by phone and asked to re-attend Time between testing & Treatment: Unclear. However scans performed greater than 90 days apart were excluded. Source of funding: Not specified
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Low risk of bias Reference standard: Unclear risk of bias- unclear blinding between reference and index test Flow and timing: Unclear risk of bias – interval between index test and reference standard not specified Overall risk of bias: High risk of bias Directness: Direct

Full citation	Gurtler Verena M, Sommer Wieland H, Meimarakis Georgios, Kopp Reinhard, Weidenhagen Rolf, Reiser Maximilian F, and Clevert Dirk-Andre (2013) A comparison between contrast-enhanced ultrasound imaging and multislice computed tomography in detecting and classifying endoleaks in the follow-up after endovascular aneurysm repair. Journal of vascular surgery 58, 340-5									
Study type	Cross-sectional study (retrospective)									
Aim	Compare contrast-enhanced ultrasound imaging and multislice computed tomography (MS-CT) angiography in detecting and classifying endoleaks in the follow-up of patients after EVAR.									
Patient Characteristics	<p>Inclusion criteria: Only patients undergoing follow-up after EVAR who had received at least one CEUS examination after the stent implantation Examinations that were performed on the same day or ≤ 30 days.</p> <p>Exclusion criteria: Patients with an abdominal tube stent Patients with acute heart failure and acute myocardial infarction Allergy to contrast agent Patient noncompliance</p> <table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Age</td> <td>70.4 \pm 8.6 years</td> </tr> <tr> <td>Males (%)</td> <td>84.4 (%)</td> </tr> <tr> <td>Aneurysm Size (\pmSD)</td> <td>Not reported</td> </tr> </tbody> </table>		Study Characteristics		Age	70.4 \pm 8.6 years	Males (%)	84.4 (%)	Aneurysm Size (\pm SD)	Not reported
Study Characteristics										
Age	70.4 \pm 8.6 years									
Males (%)	84.4 (%)									
Aneurysm Size (\pm SD)	Not reported									
Sample Size	171 patients									
Index test(s)	<p>CEUS An experienced sonographer performed the US examinations in the follow-up after EVAR. An internally standardised scanning protocol was used in assessing the abdominal aneurysm. The protocol included transverse and sagittal imaging. An endoleak was defined as an extravasation of contrast between the aneurysm well and the prosthesis. CEUS and MS-CT images were assessed by consensus reading by 2 experienced radiologists. Radiologists reading one test did not have access to the results of the other test. CEUS findings were considered true positive if the MS-CT revealed evidence of an endoleak, if the findings were not confirmed in MS-CT, they were considered false positive.</p>									

Full citation	Gurtler Verena M, Sommer Wieland H, Meimarakis Georgios, Kopp Reinhard, Weidenhagen Rolf, Reiser Maximilian F, and Clevert Dirk-Andre (2013) A comparison between contrast-enhanced ultrasound imaging and multislice computed tomography in detecting and classifying endoleaks in the follow-up after endovascular aneurysm repair. Journal of vascular surgery 58, 340-5
Reference standard(s)	CTA Patients were examined using a standard protocol for an arterial and a venous phase examination with a Somaton Sensation 16-,64-, or 128-slice detector MS-CT scanner. Because of the retrospective nature of the study, the image resolution was performed with the latest state-of-the-art equipment available at that time. All images were stored in the picture archiving and communications system and were examined by two experienced radiologists in a consensus reading.
Study Details	Study location: Munich, Germany Study setting: Department for Clinical Radiology and Department of Surgery Study dates: February 2006 to February 2011 Loss to follow-up: All examinations were performed successfully and without complication or adverse effects Time between testing & Treatment: Same day or ≤ 30 days Source of funding: Not specified
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Low risk of bias Reference standard: Low risk of bias Flow and timing: Low risk of bias Overall risk of bias: Low risk of bias Directness: Directly applicable

Full citation	Henao Esteban A, Hodge Megan D, Felkai Deborah D, McCollum Charles H, Noon George P, Lin Peter H, Lumsden Alan B, and Bush Ruth L (2006) Contrast-enhanced Duplex surveillance after endovascular abdominal aortic aneurysm repair: improved efficacy using a continuous infusion technique. Journal of vascular surgery 43, 259-264							
Study type	Cross sectional study							
Aim	Prospectively evaluate the use of continuous infusion method of ultrasound contrast in the surveillance of abdominal aortic endografts in detecting endoleaks compared with CT.							
Patient Characteristics	<p>Inclusion criteria: All men and postmenopausal women seen at follow-up intervals were asked to participate</p> <p>Exclusion criteria:</p> <p>Patients with a known endoleak from previous examinations</p> <p>Severe iodinated contrast allergy</p> <p>Evidence of renal insufficiency marked by a serum creatinine level >1.5 mg/dL</p> <p>Evidence of a right-to-left cardiac shunt or severe pulmonary or hepatic disease</p> <table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Mean Age</td> <td>70.4 years</td> </tr> <tr> <td>Aneurysm Size</td> <td>5.27 cm</td> </tr> </tbody> </table>		Study Characteristics		Mean Age	70.4 years	Aneurysm Size	5.27 cm
Study Characteristics								
Mean Age	70.4 years							
Aneurysm Size	5.27 cm							
Sample Size	20 patients							
Index test(s)	<p>CDUS and CEUS</p> <p>Patient were typically followed after a successful endovascular aneurysm repair at 1,6,12 and 24 months, and annually thereafter. Endoleaks were defined as the presence of persistent intrasac flow outside the stent-raft. The endoleaks were characterised in relation to the endograft, aneurysm wall, and aortic side branches, and recorded in accordance to the White-May classification.</p> <p>Four experienced vascular sonographers performed all the ultrasound studies using a 3.5-MHz probe on a Philips lu22 UNIT. Ultrasonographers were blinded to the results of pervious angiographic or CT angiographic results. Measurements of the aneurysm were recorded, and grey scale, colour Duplex, and CEUS were used to identify leaks.</p>							
Reference standard(s)	<p>CTA</p> <p>CTA were performed on the same day, before CEUS. The protocol called for the intravenous injection of 150 mL of a contrast agent at a rate of 2.5 mL/s.</p>							
Study Details	<p>Study location: USA</p> <p>Study setting: Unclear</p>							

Full citation	Henao Esteban A, Hodge Megan D, Felkai Deborah D, McCollum Charles H, Noon George P, Lin Peter H, Lumsden Alan B, and Bush Ruth L (2006) Contrast-enhanced Duplex surveillance after endovascular abdominal aortic aneurysm repair: improved efficacy using a continuous infusion technique. Journal of vascular surgery 43, 259-264
	<p>Study dates: July 2004 to May 2005</p> <p>Loss to follow-up: None reported</p> <p>Time between testing & Treatment: Both tests performed on the same day</p> <p>Source of funding: Not specified</p>
Quality Assessment (QUADAS 2)	<p>Patient selection: Low risk of bias</p> <p>Index test: Low risk of bias</p> <p>Reference standard: Low risk of bias</p> <p>Flow and timing: Low risk of bias</p> <p>Overall risk of bias: Low risk of bias</p> <p>Directness: Directly applicable</p>
Full citation	Iezzi Roberto, Basilico Raffaella, Giancristofaro Daniela, Pascali Danilo, Cotroneo Antonio Raffaele, and Storto Maria Luigia (2009) Contrast-enhanced ultrasound versus color duplex ultrasound imaging in the follow-up of patients after endovascular abdominal aortic aneurysm repair. Journal of vascular surgery 49, 552-60
Study type	Cross sectional study
Aim	Assess the negative predictive value, sensitivity, specificity, and diagnostic accuracy of real-time contrast enhanced ultrasound (CEUS) in the detection of endoleaks in patients with AAA who underwent EVAR compared with unenhanced ultrasound imaging.
Patient Characteristics	<p>Inclusion criteria:</p> <p>All patients treated with EVAR who underwent CTA as part of a routine surveillance program at 1, 6, and 12 months after the procedure and annually thereafter.</p> <p>To avoid selection bias in favour of patients who were 'easy to scan' patients were recruited before undergoing a baseline US scan. No patient was excluded on the basis of poor technical quality of the baseline US study.</p> <p>Exclusion criteria:</p>

Full citation	Iezzi Roberto, Basilico Raffaella, Giancristofaro Daniela, Pascali Danilo, Cotroneo Antonio Raffaele, and Storto Maria Luigia (2009) Contrast-enhanced ultrasound versus color duplex ultrasound imaging in the follow-up of patients after endovascular abdominal aortic aneurysm repair. Journal of vascular surgery 49, 552-60									
	Patients with unstable general conditions such as heart failure, severe chronic bronchopulmonary disorders, severe pulmonary hypertension, or uncontrolled hypertension									
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Study Characteristics										
Mean Age	79.6 ±5.2 years									
Males (%)	82.1%									
Aneurysm Size	Not reported									
Sample Size	84 patients									
Index test(s)	<p>CDUS and CEUS</p> <p>Patients underwent CTA, CDUS and CEUS on the same day. The precontrast and postcontrast US scans were performed by a single radiologist who blinded to all other imaging findings at the time of examinations. All US scans were performed with a Philips HDI 5000 scanner. CEUS was performed after administration of a second-generation contrast agent (SnoVue). Cine loop sweeps from the US examinations were randomly reviewed independently by two radiologists not involved in the imaging, and neither were aware of the CTA outcomes or dose of contrast used for CEUS. The tapes were viewed at an interval of at least 1 week to reduce their memory of previous images. The readers were blinded to image session sequence; furthermore, names, ages, and identifications were hidden during the review. During the reading session that included the baseline unenhanced US images, the presence of endoleak was considered probable if a colour duplex signal was present beyond the graft. During the reading session of CEUS imaging, the presence of endoleak was considered probable or certain if high attenuation area, absent on the baseline unenhanced-phase images, due to the presence of contrast enhancement, was present beyond the graft but within the aneurysm sac.</p>									
Reference standard(s)	<p>CTA</p> <p>Triple-phase acquisition (unenhanced and contrast enhanced transverse imaging, in arterial and delayed phases) was performed using a multidetector row helical scanner at each follow-up CT study. CT acquisition assessed in consensus by two experienced vascular radiologists not involved in US image analysis, who knew previous CT findings. They were asked to classify a detected leak according to its aetiology as described by White et al.</p>									
Study Details	<p>Study location: Italy</p> <p>Study setting: Department of Radiology</p> <p>Study dates: Not reported</p> <p>Loss to follow-up: All patients completed the protocol, and no adverse events were recorded during CEUS or CT examinations</p>									

Full citation	lezzi Roberto, Basilico Raffaella, Giancristofaro Daniela, Pascali Danilo, Cotroneo Antonio Raffaele, and Storto Maria Luigia (2009) Contrast-enhanced ultrasound versus color duplex ultrasound imaging in the follow-up of patients after endovascular abdominal aortic aneurysm repair. Journal of vascular surgery 49, 552-60
	Time between testing & Treatment: All tests conducted on the same day Source of funding: Not reported
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Low risk of bias Reference standard: Low risk of bias Flow and timing: Low risk of bias Overall risk of bias: Low risk of bias Directness: Directly applicable

Full citation	Kamal D M, Steinmetz O K, and Obrand D I (2008) The value of duplex ultrasound versus contrast enhanced CT scan in the follow-up of endoluminally repaired abdominal aortic aneurysm: A blinded comparison. Bahrain Medical Bulletin 30, 101-107																													
Study type	Cross sectional (retrospective)																													
Aim	To compare the accuracy of Duplex ultrasound to contrast- enhanced CT scan with respect to aneurysm sac diameter measurement and endoleak detection in patients with EVAR.																													
Patient Characteristics	<p>Inclusion criteria: Patients evaluated by contrast enhanced computed tomography scan and duplex ultrasound examinations in their postoperative follow-up.</p> <p>Exclusion criteria:</p> <p>Patients who were followed-up elsewhere</p> <p>Patients who were followed-up by CT scan only (no Duplex performed)</p> <p>If the concurrent (paired) study was done more than one month apart</p> <p>If the CT scan was done without contrast, it was excluded from endoleak detection comparison.</p> <table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Mean Age</td> <td>76.6 ±7.6 years</td> </tr> <tr> <td>Males (%)</td> <td>88.2%</td> </tr> <tr> <td>Obesity (%)</td> <td>17.6%</td> </tr> <tr> <td>Coronary Artery Disease (%)</td> <td>64.7%</td> </tr> <tr> <td>Congestive Heart Failure (%)</td> <td>7.8%</td> </tr> <tr> <td>Hypertension (%)</td> <td>58.8%</td> </tr> <tr> <td>Diabetes Mellitus (%)</td> <td>7.8%</td> </tr> <tr> <td>Chronic Obstructive Pulmonary Disease (%)</td> <td>27.5%</td> </tr> <tr> <td>Dyslipidemia (%)</td> <td>25.5%</td> </tr> <tr> <td>Remote Cerebro-vascular accident (%)</td> <td>15.7%</td> </tr> <tr> <td>Cigarette smoking (%)</td> <td>33.3%</td> </tr> <tr> <td>Chronic Renal Failure</td> <td>7.8%</td> </tr> <tr> <td>Aneurysm Size (±SD)</td> <td>Not reported</td> </tr> </tbody> </table>		Study Characteristics		Mean Age	76.6 ±7.6 years	Males (%)	88.2%	Obesity (%)	17.6%	Coronary Artery Disease (%)	64.7%	Congestive Heart Failure (%)	7.8%	Hypertension (%)	58.8%	Diabetes Mellitus (%)	7.8%	Chronic Obstructive Pulmonary Disease (%)	27.5%	Dyslipidemia (%)	25.5%	Remote Cerebro-vascular accident (%)	15.7%	Cigarette smoking (%)	33.3%	Chronic Renal Failure	7.8%	Aneurysm Size (±SD)	Not reported
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Full citation	Kamal D M, Steinmetz O K, and Obrand D I (2008) The value of duplex ultrasound versus contrast enhanced CT scan in the follow-up of endoluminally repaired abdominal aortic aneurysm: A blinded comparison. Bahrain Medical Bulletin 30, 101-107
Sample Size	63 patients
Index test(s)	CDUS A colour Doppler (Duplex) was used for detection of endoleaks, characterised by detection of a colour and spectral signal outside the limits of the prosthesis.
Reference standard(s)	CTA There was a slight difference in the CT scan and ultrasound protocol in the two hospitals. At one hospital, the contrast enhanced CT was performed using a Picker CT, Twin Flash Spiral Helical Unit. At second hospital, CT scan was performed using a Siemens Plus4 machine. An endoleak was defined as persistent blow flow between the tenet graft and the wall of the aneurysm. Radiologist performing the CT was blinded to the ultrasound results and vice versa.
Study Details	Study location: Bahrain Study setting: Two McGill University Teaching Hospitals Study dates: February 1998 and December 2000 Loss to follow-up: Not reported Time between testing & Treatment: CT and CDUS conducted within a 1 month period Source of funding: Not specified.
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Low risk of bias Reference standard: Low risk of bias Flow and timing: High risk of bias- Two hospitals followed different protocols for CT scan Overall risk of bias: Moderate risk of bias Directness: Directly applicable

Full citation	Lowe Christopher, Abbas Abeera, Rogers Steven, Smith Lee, Ghosh Jonathan, and McCollum Charles (2017) Three-dimensional contrast-enhanced ultrasound improves endoleak detection and classification after endovascular aneurysm repair. Journal of vascular surgery 65(5), 1453-1459									
Study type	Cross sectional study									
Aim	Comparing standard CEUS, 3D-CEUS and CTA for the detection and classification of endoleaks in EVAR surveillance.									
Patient Characteristics	Inclusion criteria: Consecutive patients undergoing CTA for EVAR surveillance Exclusion criteria: Studies with poor image quality due to bowel gas or obesity									
	<table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Mean Age</td> <td>76 years</td> </tr> <tr> <td>Males (%)</td> <td>86%</td> </tr> <tr> <td>Aneurysm Size (\pmSD)</td> <td>Not reported</td> </tr> </tbody> </table>		Study Characteristics		Mean Age	76 years	Males (%)	86%	Aneurysm Size (\pm SD)	Not reported
Study Characteristics										
Mean Age	76 years									
Males (%)	86%									
Aneurysm Size (\pm SD)	Not reported									
Sample Size	100 patients									
Index test(s)	CEUS and 3D CEUS Standard CEUS and 3D-CEUS images were acquired by the same vascular scientist for all patients in the study and reported independently by 2 vascular scientists blinded to each other and CTA result. Standard CEUS was performed using the same Philips iU22 duplex ultrasound machine. A 1-mL of SonoVue contrast agent was given. 3D CEUS system used was a prototype magnetically tracked freehand system attached to the same Philip iU22 ultrasound unit.									
Reference standard(s)	CTA CTA was reported by the consultant vascular interventional radiologists.									
Study Details	Study location: Manchester, UK Study setting: Not specified Study dates: May 2012 and March 2015 Loss to follow-up: 57 patients lost due to patient compliance Patients lost due to instrument failure Time between testing & Treatment: CTA and ultrasound imaging were conducted on the same day in 52 studies and never more than 4 weeks apart in other studies									

Full citation	Lowe Christopher, Abbas Abeera, Rogers Steven, Smith Lee, Ghosh Jonathan, and McCollum Charles (2017) Three-dimensional contrast-enhanced ultrasound improves endoleak detection and classification after endovascular aneurysm repair. Journal of vascular surgery 65(5), 1453-1459
	Source of funding: Not specified
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Unclear risk of bias. Definition of endoleak not provided Reference standard: Low risk of bias Flow and timing: Low risk of bias Overall risk of bias: Moderate risk of bias Directness: Directly applicable

Full citation	McWilliams Richard G, Martin Janis, White Donagh, Gould Derek A, Rowlands Peter C, Haycox Alan, Brennan John, Gilling-Smith Geoffrey L, and Harris Peter L (2002) Detection of endoleak with enhanced ultrasound imaging: comparison with biphasic computed tomography. Journal of endovascular therapy : an official journal of the International Society of Endovascular Specialists 9, 170-9								
Study type	Cross sectional study								
Aim	To compare unenhanced and enhanced ultrasound imaging to biphasic computed tomography (CT) in the detection after EVAR.								
Patient Characteristics	<p>Inclusion criteria: Patients who underwent EVAR. Exclusion criteria: All patients seen at follow-up intervals were asked to participate unless there was documented contraindication to the use of Levovist.</p> <table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Mean Age</td> <td>70 years</td> </tr> <tr> <td>Males (%)</td> <td>83%</td> </tr> <tr> <td>Aneurysm Size (\pmSD)</td> <td>Not reported</td> </tr> </tbody> </table>	Study Characteristics		Mean Age	70 years	Males (%)	83%	Aneurysm Size (\pm SD)	Not reported
Study Characteristics									
Mean Age	70 years								
Males (%)	83%								
Aneurysm Size (\pm SD)	Not reported								
Sample Size	53 patients								
Index test(s)	<p>CDUS and CEUS</p> <p>Endograft patients are followed according to the intervals recommended by the EUROSTAR registry at 1,3,6,12, 18 and 24 months and annually thereafter. One experienced vascular sonographer performed all the ultrasound studies. Patients were scanned with colour and power Doppler before and after the intravenous administration of Levovist, an ultrasound contrast. Endoleak was indicated by colour flow within the aneurysm sac outside the stent graft.</p>								
Reference standard(s)	<p>CTA</p> <p>Endoleak was defined as the presence of intrasac flow outside the stent graft. It was defined by its relationship to the endograft, aneurysm wall, and aortic side branches and categorised using the White/May classification. Biphasic enhanced CT was performed on the same day using the same protocol and imager. Either of two radiologists, who were blinded to the ultrasound results, recorded all the CT studies.</p>								
Study Details	<p>Study location: Liverpool, UK</p> <p>Study setting: Departments of Radiology and Vascular Surgery</p> <p>Study dates: March 1999 to May 2000</p> <p>Loss to follow-up: 2 participants excluded because radiology staff failed to follow protocol.</p> <p>Time between testing & Treatment: Same day</p>								

Full citation	McWilliams Richard G, Martin Janis, White Donagh, Gould Derek A, Rowlands Peter C, Haycox Alan, Brennan John, Gilling-Smith Geoffrey L, and Harris Peter L (2002) Detection of endoleak with enhanced ultrasound imaging: comparison with biphasic computed tomography. Journal of endovascular therapy : an official journal of the International Society of Endovascular Specialists 9, 170-9
	Source of funding: Not specified
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Low risk of bias Reference standard: Low risk of bias Flow and timing: Low risk of bias Overall risk of bias: Low risk of bias Directness: Directly applicable

Full citation	Mauro R, Maioli F, Freyrie A, Testi G, Palumbo N, Serra C, and Stella A (2010) Is CEUS a valid alternative to CTA in endoleak's detection? Italian Journal of Vascular and Endovascular Surgery 17, 253-258							
Study type	Cross sectional study							
Aim	Evaluate the diagnostic accuracy of section generation enhancement ultrasound (CEUS) in comparison with CTA to detect endoleaks in patients submitted to EVAR.							
Patient Characteristics	<p>Inclusion criteria: Patients undergoing EVAR Exclusion criteria: Renal insufficiency One patient who died seven days after procedure Patients who refused the follow-up program</p> <table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Mean Age (years)</td> <td>74.3 ± 7.2 years</td> </tr> <tr> <td>Aneurysm Size (±SD)</td> <td>Not reported</td> </tr> </tbody> </table>		Study Characteristics		Mean Age (years)	74.3 ± 7.2 years	Aneurysm Size (±SD)	Not reported
Study Characteristics								
Mean Age (years)	74.3 ± 7.2 years							
Aneurysm Size (±SD)	Not reported							
Sample Size	122 patients							
Index test(s)	CEUS Program consisted of CEUS and CTA examinations at 1,6,12 and 24 months after EVAR. All exams were performed within 14 days by different blinded operators. The second generation echo-contrast agent SonoVue was employed. Presence of endoleaks was defined as contrast enhancement into the residual aneurysm sac. The physician who performed CEUS did not know the results of CTA examinations.							
Reference standard(s)	CTA CTA was performed with arterial phase and 3 minutes delayed phase, using a CTA multislice 16 slice GE light Speed scanner. The images were reviewed by a radiologist.							
Study Details	Study location: Bologna, Italy Study setting: Department of Vascular Surgery Study dates: January 2005 to May 2007 Loss to follow-up: No adverse events were noted Time between testing & Treatment: 14 days							

Full citation	Mauro R, Maioli F, Freyrie A, Testi G, Palumbo N, Serra C, and Stella A (2010) Is CEUS a valid alternative to CTA in endoleak's detection? Italian Journal of Vascular and Endovascular Surgery 17, 253-258
	Source of funding: Not specified
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Low risk of bias Reference standard: Low risk of bias Flow and timing: Low risk of bias Overall risk of bias: Low risk of bias Directness: Directly applicable

Full citation	Mori Kensaku, Saida Tsukasa, Sato Fujio, Uchikawa Yoko, Konishi Takahiro, Ishiguro Toshitaka, Hiyama Takashi, Hoshiai Sodai, Okamoto Yoshikazu, Nasu Katsuhiko, and Minami Manabu (2017) Endoleak detection after endovascular aneurysm repair using unenhanced MRI with flow suppression technique: Feasibility study in comparison with contrast-enhanced CT. European radiology 27(1), 336-344									
Study type	Cross sectional study									
Aim	Evaluate the feasibility of unenhanced motion sensitized-driven equilibrium (MSDE) - prepared balanced turbo filed echo (BTFE) sequences for detecting endoleaks after EVAR.									
Patient Characteristics	<p>Inclusion criteria: Consecutive patients who underwent EVAR for aortic and/or iliac aneurysms aged between 46 and 90 years Written informed consent obtained</p> <p>Exclusion criteria: Contraindication to contrast enhanced CT Predialysis renal failure Severe bronchial asthma Contraindication to unenhanced MR imaging: MR-incompatible stent graft Patient with pacemaker</p> <table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Mean Age (range)</td> <td>73.2 years (47-87 years)</td> </tr> <tr> <td>Males (%)</td> <td>71.7%</td> </tr> <tr> <td>Aneurysm Size (\pmSD)</td> <td>Not reported</td> </tr> </tbody> </table>		Study Characteristics		Mean Age (range)	73.2 years (47-87 years)	Males (%)	71.7%	Aneurysm Size (\pm SD)	Not reported
Study Characteristics										
Mean Age (range)	73.2 years (47-87 years)									
Males (%)	71.7%									
Aneurysm Size (\pm SD)	Not reported									
Sample Size	46 patients									
Index test(s)	MR imaging All patients underwent unenhanced MR imaging with 1.5 – Tesla MR system. Unenhanced MR imaging was performed just after CTA on the same day in all but two patients, who underwent MR imaging two days after CTA. Unenhanced 2D MSDE- prepared BTFE sequences with and without flow suppression were acquired in the axial, coronal and sagittal planes. Endoleaks were diagnosed as follows: first, the observers detected all hyperintense areas in the aneurysms, other than flow blood in the stent grafts. Endoleaks were distinguished from misregistration artefacts by reviewing adjacent images in the same plan and/ or images in different planes. When									

Full citation	Mori Kensaku, Saida Tsukasa, Sato Fujio, Uchikawa Yoko, Konishi Takahiro, Ishiguro Toshitaka, Hiyama Takashi, Hoshiai Sodai, Okamoto Yoshikazu, Nasu Katsuhiko, and Minami Manabu (2017) Endoleak detection after endovascular aneurysm repair using unenhanced MRI with flow suppression technique: Feasibility study in comparison with contrast-enhanced CT. European radiology 27(1), 336-344
	hyperintense areas were located in compatible positions on adjacent images in the same plane and/ or on images in different planes, they were diagnosed as endoleaks.
Reference standard(s)	CTA In all patients, biphasic contrast enhanced CT was performed within 28 days after EVAR.
Study Details	Study location: Japan Study setting: Department of Radiology Study dates: September 2012 to August 2014 Loss to follow-up: All patients tolerated contrast enhanced CT and unenhanced MR imaging Time between testing & Treatment: Same day for all patients apart from 2 who had MR done 2 days after CTA Source of funding: Grant received from Grant in Aid for Scientific Research from Japan Society for Promotion of Science. Philips Medical Systems provided authors with MSDE preparation pulse before selling on the market as a clinical science key.
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Low risk of bias Reference standard: High risk of bias – Observers involved in interpreting reference standard and index test Flow and timing: Low risk of bias Overall risk of bias: Moderate risk of bias Directness: Indirectly applicable. MSDE-BTFE sequence utilised in study is not routinely used in practice.

Full citation	Motta R, Rubaltelli L, Vezzaro R, Vida V, Marchesi P, Stramare R, Zanon A, Battistel M, Somnavilla M, and Miotto D (2012) Role of multidetector CT angiography and contrast-enhanced ultrasound in redefining follow-up protocols after endovascular abdominal aortic aneurysm repair. La Radiologia medica 117, 1079-92
Study type	Cross sectional study
Aim	Evaluate the accuracy of CEUS compared with a particularly tailored protocol of CTA performed with a 64-row multidetector CT.
Patient Characteristics	Inclusion criteria: Consecutive patients who underwent CTA Exclusion criteria: Severe allergy to iodinated contrast Severe renal failure Study Characteristics: Not reported
Sample Size	88 patients
Index test(s)	CEUS CEUS examinations and evaluations were performed by two other senior radiologists in consensus reading, masked to CTA findings, with an Esatune (26 patients) or a MyLab25 (62 patients).
Reference standard(s)	CTA CTA scans were obtained from the coeliac to the femoral arteries before and after the i.v. injection of contrast medium. CTA examinations were performed by two senior radiologists, in consensus reading and blinded to CEUS results. Endoleaks were identified and characterised according to the classification of standard guidelines.
Study Details	Study location: Padua, Italy Study setting: Department of Radiology Study dates: January 2008 and December 2010 Loss to follow-up: No adverse events were recorded during the examinations. Time between testing & Treatment: CTA and CEUS conducted within a few hours Source of funding: Not specified
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Low risk of bias Reference standard: Low risk of bias Flow and timing: Low risk of bias

Full citation	Motta R, Rubaltelli L, Vezzaro R, Vida V, Marchesi P, Stramare R, Zanon A, Battistel M, Sommovilla M, and Miotto D (2012) Role of multidetector CT angiography and contrast-enhanced ultrasound in redefining follow-up protocols after endovascular abdominal aortic aneurysm repair. La Radiologia medica 117, 1079-92
	Overall risk of bias: Low risk of bias
	Directness: Directly applicable

Full citation	Nagre Shardul B, Taylor Steven M, Passman Marc A, Patterson Mark A, Combs Bart R, Lowman Bruce G, Jordan William D, and Jr (2011) Evaluating outcomes of endoleak discrepancies between computed tomography scan and ultrasound imaging after endovascular abdominal aneurysm repair. Annals of vascular surgery 25, 94-100																							
Study type	Cross sectional study (retrospective)																							
Aim	Determine discrepancies in endoleak detection between CTA and CDUS.																							
Patient Characteristics	Inclusion criteria: Patients who had undergone both CTA and CDUS at the same visit or within 7 days of each other Exclusion criteria: Not specified																							
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End stage renal disease on dialysis (%)	2.7%																							
Aneurysm Size (±SD)	Not reported																							
Sample Size	455 patients																							
Index test(s)	CDUS Patients were evaluated with CTA and CDUS imaging within 30 days after the procedure. Both studies were recorded within 7 days of each other. Abdominal X-ray was performed at the discretion of the physician. After the initial study, patients were followed up at 6-12 months intervals, depending on multiple risk factors, including clinical signs and symptoms, abnormal findings in previous studies, and renal function. All CDUS scans were performed by a registered vascular technician.																							
Reference standard(s)	CTA Both contrast enhanced and non-contrast images were obtained by performing helical scans from the diaphragm to the upper thigh using a thin section of CT angiography protocol. CT without contrast and DUS were obtained in patients with abnormal renal function (creatinine: >1.4mg/dL).																							

Full citation	Nagre Shardul B, Taylor Steven M, Passman Marc A, Patterson Mark A, Combs Bart R, Lowman Bruce G, Jordan William D, and Jr (2011) Evaluating outcomes of endoleak discrepancies between computed tomography scan and ultrasound imaging after endovascular abdominal aneurysm repair. Annals of vascular surgery 25, 94-100
Study Details	Study location: USA Study setting: University of Alabama Study dates: October 1999 and June 2009 Loss to follow-up: National death indices were reviewed of patients lost to follow-up. Time between testing & Treatment: CTA and CDUS conducted on the same day or within 7 days of each other Source of funding: Not specified.
Quality Assessment (QUADAS 2)	Patient selection: Unclear risk of bias- Unclear if consecutive patients were selected Index test: Unclear risk of bias- Unclear binding between index test and reference standard. Definition of endoleak not provided Reference standard: Unclear risk of bias- unclear blinding between reference standard and index test Flow and timing: Low risk of bias Overall risk of bias: High risk of bias Directness: Directly applicable

Full citation	Nerlekar R, Warriar R, De Ryke, R , Miller R, Hewitt P M, and Scott A (2006) A comparative study of ultrasound and computed tomography scan for the follow-up of abdominal aortic aneurysms after endovascular repair. Journal for Vascular Ultrasound 30, 81-85							
Study type	Cross sectional study							
Aim	To compare ultrasound and CT scan in our practice to ascertain whether ultrasound alone would be sufficient for follow-up of AAA after EVAR.							
Patient Characteristics	<p>Inclusion criteria: All patients who underwent EVAR for an AAA and had CDUS and CT on the same day or within 1 month</p> <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Patients with modified device configuration Pre-existing grafts Graft deployment failure Patients who died before 1 month follow up from the study US and CT scans performed in isolation <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th colspan="2" style="text-align: left;">Study Characteristics</th> </tr> <tr> <td style="width: 50%;">Mean Age (range)</td> <td>73 years (52-93 years)</td> </tr> <tr> <td>Aneurysm Size (range)</td> <td>52 mm (21-75 mm)</td> </tr> </table>		Study Characteristics		Mean Age (range)	73 years (52-93 years)	Aneurysm Size (range)	52 mm (21-75 mm)
Study Characteristics								
Mean Age (range)	73 years (52-93 years)							
Aneurysm Size (range)	52 mm (21-75 mm)							
Sample Size	121 patients							
Index test(s)	<p>CDUS</p> <p>Patients were followed up with contrast-enhanced spiral CT scanning and duplex ultrasound at 1 and 6 months after EVAR and annually thereafter. All US examinations were performed by a single experienced ultrasonographer using a Sonoline Elegra Ultrasound Imaging System with colour flow Doppler.</p>							
Reference standard(s)	<p>CTA</p> <p>CT scans were obtained using a High Speed Advanced 2X spiral CT scanner with administration of 140 mL of intravenous contrast. All US and CT scan films were reviewed by two blinded reviewers.</p>							
Study Details	<p>Study location: Australia</p> <p>Study setting: Department of Surgery</p> <p>Study dates: 1995 and 2003</p> <p>Loss to follow-up: 3 participants died before the 1 month follow-up from study</p>							

Full citation	Nerlekar R, Warriar R, De Ryke, R , Miller R, Hewitt P M, and Scott A (2006) A comparative study of ultrasound and computed tomography scan for the follow-up of abdominal aortic aneurysms after endovascular repair. Journal for Vascular Ultrasound 30, 81-85
	Time between testing & Treatment: Both tests done of the same day or within 1 month Source of funding: Not reported
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Unclear risk of bias - Definition of endoleak not provided Reference standard: Low risk of bias Flow and timing: Low risk of bias Overall risk of bias: Moderate risk of bias Directness: Directly applicable

Full citation	Oikonomou K, Ventin F C, Paraskevas K I, Geisselsoder P, Ritter W, and Verhoeven E L (2012) Early follow-up after endovascular aneurysm repair: Is the first postoperative computed tomographic angiography scan necessary?. Journal of Endovascular Therapy 19, 151-156									
Study type	Cross sectional study									
Aim	Examine whether initial postoperative computed tomographic angiography (CTA) is needed in all patients undergoing EVAR.									
Patient Characteristics	<p>Inclusion criteria: Consecutive patients who underwent EVAR for infrarenal AAA Exclusion criteria: Patients unsuitable for a postoperative CTA due to severely impaired renal function</p> <table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Mean Age (range)</td> <td>73 years (range 46-91)</td> </tr> <tr> <td>Male (%)</td> <td>85%</td> </tr> <tr> <td>Aneurysm Size (range)</td> <td>55 mm (48-110 mm)</td> </tr> </tbody> </table>		Study Characteristics		Mean Age (range)	73 years (range 46-91)	Male (%)	85%	Aneurysm Size (range)	55 mm (48-110 mm)
Study Characteristics										
Mean Age (range)	73 years (range 46-91)									
Male (%)	85%									
Aneurysm Size (range)	55 mm (48-110 mm)									
Sample Size	100 patients									
Index test(s)	CDUS Patients were prospectively enrolled for a triple-modality early follow-up imaging protocol consisting an intraoperative completion angiogram, a DUS, and a plain abdominal radiograph prior to hospital discharge. These data were compared with the results of a CTA performed within 1 month after the procedure. CDUS examinations were performed by experienced vascular surgeons. An endoleak on CDUS was defined as the presence of persistent blood flow and spectral signal outside the graft wall.									
Reference standard(s)	CTA CTAs were performed on a Siemens Somatom scanner. Patients with known history of contrast agent allergy received oral corticosteroids and antihistamines prior to the examinations. Patients with GFR < 60 mL/min and 2 additional risk factors, including age > 75 years, diabetes mellitus, and established cardiac insufficiency, were given 24 hours of intravenous hydration and acetylcysteine before the CTA.									
Study Details	Study location: Germany Study setting: Department of Radiology Study dates: November 2009 to May 2011 Loss to follow-up: Not specified. Time between testing & Treatment: Median interval between CDUS and CTA was 9 days (range from 0-25) Source of funding: Not specified									

Full citation	Oikonomou K, Ventin F C, Paraskevas K I, Geisselsoder P, Ritter W, and Verhoeven E L (2012) Early follow-up after endovascular aneurysm repair: Is the first postoperative computed tomographic angiography scan necessary?. Journal of Endovascular Therapy 19, 151-156
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Unclear risk of bias- unclear if index test results were interpreted without knowledge of the result of the reference standard Reference standard: Unclear risk of bias- unclear if reference standard results were interpreted without knowledge of the result of the index test Flow and timing: Low risk of bias Overall risk of bias: High risk of bias Directness: Directly applicable

Full citation	Pages S, Favre J P, Cerisier A, Pyneeandee S, Boissier C, and Veyret C (2001) Comparison of color duplex ultrasound and computed tomography scan for surveillance after aortic endografting. Annals of vascular surgery 15, 155-62									
Study type	Cross sectional study									
Aim	Compare CDUS and CT scanning for follow-up of patients treated by EVAR.									
Patient Characteristics	Inclusion criteria: Patients referred for elective treatment. Exclusion criteria: Not specified									
	<table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Mean Age (Range)</td> <td>71 years (50-83 years)</td> </tr> <tr> <td>Males (%)</td> <td>95%</td> </tr> <tr> <td>Aneurysm Size (\pmSD)</td> <td>55 \pm 9 mm</td> </tr> </tbody> </table>		Study Characteristics		Mean Age (Range)	71 years (50-83 years)	Males (%)	95%	Aneurysm Size (\pm SD)	55 \pm 9 mm
Study Characteristics										
Mean Age (Range)	71 years (50-83 years)									
Males (%)	95%									
Aneurysm Size (\pm SD)	55 \pm 9 mm									
Sample Size	41 participants									
Index test(s)	CDUS Postoperative surveillance included plain abdominal roentgenography, CT scan and CDUS. These procedures were performed prior to discharge, and at 3, 6, 12, 24 and 30 months. CT and CDUS examinations were performed by different operators at different locations. The second operator had no knowledge of the results of the first examination. On CDUS, the characteristic feature was detection of a colour and spectral signal outside the limits of the prosthesis. On CDUS, the largest anteroposterior or transverse diameter was used for the detection of diameter changes.									
Reference standard(s)	CTA Three consecutive spiral CT scan acquisitions were performed. On CT scans, endoleaks were characterised by extravasation of contrast dye between the prosthesis and aneurysmal wall. On CT scan, the maximum diameter of the aneurysm was defined as the largest diameter measured regardless of the position of the aortic axis, including the thickness of the wall.									
Study Details	Study location: France Study setting: University Hospital Centre Study dates: November 1996 to September 1999 Loss to follow-up: No loss to follow-up Time between testing & Treatment: Not specified Source of funding: Not reported									

Full citation	Pages S, Favre J P, Cerisier A, Pyneeandee S, Boissier C, and Veyret C (2001) Comparison of color duplex ultrasound and computed tomography scan for surveillance after aortic endografting. Annals of vascular surgery 15, 155-62
Quality Assessment (QUADAS 2)	<p>Patient selection: Low risk of bias Index test: Low risk of bias Reference standard: Low risk of bias Flow and timing: High risk of bias- interval between index test and reference test not specified</p> <p>Overall risk of bias: Moderate risk of bias</p> <p>Directness: Partially indirect. Although the protocol specifies that studies published after 2000 should be included, the committee were interested in studies in which patients received scans before this cut-off. As this study was conducted between 1996 and 1999, the study was downgraded for partial indirectness.</p>

Full citation	Parent F Noel, 3rd, Godziachvili Vasso, Meier George H, 3rd , Parker Frank M, Carter Kathleen, Gayle Robert G, Demasi Richard J, and Gregory Roger T (2002) Endograft limb occlusion and stenosis after ANCURE endovascular abdominal aneurysm repair. Journal of vascular surgery 35, 686-90
Study type	Cross sectional study (retrospective)
Aim	Demonstration of the value of CDUS in the detection of Type I and Type II endoleak
Patient Characteristics	Inclusion criteria: Patients who underwent treatment before September 1999 Exclusion criteria: Not specified Study Characteristics: Not specified
Sample Size	83 patients
Index test(s)	CDUS CDUS and CTA scans were scheduled within 30 days and at 3,6 and 12 months after surgery and annually thereafter. A Type I endoleak was defined as an incompetent seal at one of the graft attachment sites, and a Type II was defined as continuance of liquefied blood within the AAA sac because of a patent branch vessel. Type I and Type III were not observed. CDUS scan evidence of an endoleak required the identification of perigraft Doppler scan signals with colour flow and was confirmed with spectral analysis and mapping of the blood flow pattern.
Reference standard(s)	CTA CT scan protocol consisted of a 3 mm slice thickness and a pitch of 2 mm, with a single detector helical scanner. CT scan was diagnostic for endoleak in contrast was visualised exterior to the endograft but within the aneurysm sac.
Study Details	Study location: USA Study setting: Department of Surgery Study dates: February 1996 to July 2000 Loss to follow-up: Not specified Time between testing & Treatment: Not specified Source of funding: Not specified
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Unclear risk of bias- unclear blinding between index test and reference standard

Full citation	Parent F Noel, 3rd, Godziachvili Vasso, Meier George H, 3rd , Parker Frank M, Carter Kathleen, Gayle Robert G, Demasi Richard J, and Gregory Roger T (2002) Endograft limb occlusion and stenosis after ANCURE endovascular abdominal aneurysm repair. Journal of vascular surgery 35, 686-90
	Reference standard: Unclear risk of bias- unclear blinding between reference standard and index test Flow and timing: Unclear risk of bias- unclear time interval between index test and reference standard Overall risk of bias: High risk of bias Directness: Directly applicable

Full citation	Perini P, Sediri I, Midulla M, Delsart P, Mouton S, Gautier C, Pruvo J P, and Haulon S (2011) Single-centre prospective comparison between contrast-enhanced ultrasound and computed tomography angiography after EVAR. European journal of vascular and endovascular surgery : the official journal of the European Society for Vascular Surgery 42, 797-802
Study type	Cross-sectional study
Aim	To evaluate contrast enhanced ultrasound (CEUS) as an effective alternative to CT-angiography (CTA) for endoleak detection and aneurismal sac diameter measurement in the follow-up after EVAR.
Patient Characteristics	Inclusion criteria: All patients who underwent EVAR for AAA and for whom a follow-up with CTA and CEUS was undertaken. Exclusion criteria: Patients who underwent thoracic endografting Patients with severe contrast media allergy Patients with severe renal insufficiency Study Characteristics: Not specified
Sample Size	395 patients
Index test(s)	CEUS All US scans were performed by 3 angiologists experienced in vascular ultrasonography and in the use of ultrasound contrast material who were blinded to CTA findings at the time of examination. Endoleak detection was performed at a low mechanical index (0.2-0.3) and with the focus positioned behind the aorta to delay bubble destruction. Endoleaks were classified according to that 'Reporting standards for endovascular aortic aneurysm repair' published in 2002. Paired imaging was performed less than 1 month after procedure (typically before discharge) and during follow up (median 18.55 months)
Reference standard(s)	CTA All CTAs were performed with a 640 slice CT scanner. Triple-phase acquisition with unenhanced and contrast enhanced in arterial (with bolus tracking) and delayed phases (at 70 s) was carried out from the thorax to the femoral bifurcations. CTAs were analysed on an independent dedicated workstation by both vascular surgeons and vascular radiologists (who were blinded to the results of CEUS, if already performed) to determine the maximal aortic diameter by centreline measurements and to depict and characterise endoleaks.
Study Details	Study location: France Study setting: Not specified Study dates: January 2006 to December 2010 Loss to follow-up: All patients completed the follow-up, and no adverse events were recorded during these examinations.

Full citation	Perini P, Sediri I, Midulla M, Delsart P, Mouton S, Gautier C, Pruvo J P, and Haulon S (2011) Single-centre prospective comparison between contrast-enhanced ultrasound and computed tomography angiography after EVAR. European journal of vascular and endovascular surgery : the official journal of the European Society for Vascular Surgery 42, 797-802
	Time between testing & Treatment: <15 days Source of funding: No source of funding
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Low Risk of bias Reference standard: Low Risk of Bias Flow and timing: Low risk of bias Overall risk of bias: Low risk of bias Directness: Directly applicable

Full citation	Perini P, Sediri I, Midulla M, Delsart P, Gautier C, and Haulon S (2012) Contrast-Enhanced ultrasound vs. CT angiography in fenestrated EVAR surveillance: A single-Center comparison. Journal of Endovascular Therapy 19, 648-655							
Study type	Cross sectional study (retrospective)							
Aim	To evaluate CEUS as an effective alternative to CTA during follow-up after fenestrated EVAR of juxtarenal aortic aneurysms.							
Patient Characteristics	<p>Inclusion criteria: All patients who received a fenestrated stent-graft for juxtarenal abdominal aortic who had both CTA and CEUS imaging studies. Only fenestrated endografts with up to 3 fenestrations with or without a scallop for the celiac trunk or the superior mesenteric artery (SMA) were eligible so that entire implant could be visualised with standard abdominal ultrasound</p> <p>Exclusion criteria: Patients who received endografts with >3 fenestrations Patients who died in the early postoperative period Patients who underwent a CT without contrast because of severe renal insufficiency Inadequate CEUS due to intervening bowel gas or ascites</p> <table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Mean Age</td> <td>72 years</td> </tr> <tr> <td>Aneurysm Size (±SD)</td> <td>57.70 ±8.59 mm</td> </tr> </tbody> </table>		Study Characteristics		Mean Age	72 years	Aneurysm Size (±SD)	57.70 ±8.59 mm
Study Characteristics								
Mean Age	72 years							
Aneurysm Size (±SD)	57.70 ±8.59 mm							
Sample Size	62 patients							
Index test(s)	CEUS The timing of the first postoperative investigation was no more than 30 days after procedure (preferably 1 week), and the interval between the 2 examinations was <7 days. All CEUS scans were performed by 3 angiologists. Ultrasound examinations were performed with any of 3 machines: a Vivid 7 or a Vivid 9 or a Philips iE33 equipped with a convex 3.5- MHz probe. All physicians were blinded to the findings of the other study if already performed. Endoleaks were identified and classified according to established reporting standards.							
Reference standard(s)	CTA CTA analysis were performed by both vascular surgeons and vascular radiologists. Triple-phase CTAs [unenhanced and contrast-enhanced in arterial (with bolus tracking) and delayed (70 seconds) phases] were acquired on a 64 slice CT scanner from the thorax to the femoral bifurcations. Iodinated contrast or Omnipaque 350 was injected intravenously at a flow rate of 4.5mL/s, followed by 40mL of saline solution injected at the same time. The CTAs were processed on an independent dedicated workstation to generate all conventional reconstructions following a standardised pattern.							

Full citation	Perini P, Sediri I, Midulla M, Delsart P, Gautier C, and Haulon S (2012) Contrast-Enhanced ultrasound vs. CT angiography in fenestrated EVAR surveillance: A single-Center comparison. Journal of Endovascular Therapy 19, 648-655
Study Details	Study location: France Study setting: University Hospital Study dates: January 2008 and April 2011 Loss to follow-up: Not reported Time between testing & Treatment: Interval between the 2 examinations was <7 days. Source of funding: Not reported
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Low risk of bias Reference standard: low risk of bias Flow and timing: Low risk of bias Overall risk of bias: Low risk of bias Directness: Directly applicable

Full citation	Raman Kathleen G, Missig-Carroll Nita, Richardson Tracey, Muluk Satish C, and Makaroun Michel S (2003) Color-flow duplex ultrasound scan versus computed tomographic scan in the surveillance of endovascular aneurysm repair. Journal of vascular surgery 38, 645-51								
Study type	Cross sectional study (retrospective)								
Aim	Compare both computed tomography scan (CT) and colour flow duplex ultrasound scanning as surveillance modalities for clinically significant endoleaks and to evaluate concordance in AAA diameter measurements in patients after EVAR in a busy hospital vascular laboratory.								
Patient Characteristics	<p>Inclusion criteria: Patients who underwent EVAR with Ancure or AneuRX at the University of Pittsburgh Medical Centre. Exclusion criteria: Not specified</p> <table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Age</td> <td>73 ± 7 years</td> </tr> <tr> <td>Males (%)</td> <td>87.5%</td> </tr> <tr> <td>Aneurysm Size (±SD)</td> <td>Not reported</td> </tr> </tbody> </table>	Study Characteristics		Age	73 ± 7 years	Males (%)	87.5%	Aneurysm Size (±SD)	Not reported
Study Characteristics									
Age	73 ± 7 years								
Males (%)	87.5%								
Aneurysm Size (±SD)	Not reported								
Sample Size	281								
Index test(s)	<p>CDUS</p> <p>Follow-up of these patients included same day ultrasound, CT, and abdominal radiograph in the first postoperative month, then at 6 months, 12 months, and yearly thereafter. Patients who underwent routine endovascular aneurysm repair with commercial endografts under same day studies only 30 days postoperatively. All duplex scans were performed by a registered vascular technologist in a fully accredited hospital vascular laboratory. A protocol standardised for the vascular laboratory was used for assessing the abdominal aorta, aortic bifurcation, and iliac vessels. Colour flow duplex scanning and Doppler interrogation of the sac was used to rule out the presence of perigraft flow. Endoleak detection was based on direct visualisation and spectral confirmation of perigraft flow into an aneurysm sac. All CDUS were reviewed by a vascular surgeon. The ultrasound scanning technologists and the surgeon reviewing the tapes were both unaware of the results of the CT scan during any portion of the ultrasound scan examination or review.</p>								
Reference standard(s)	<p>CTA</p> <p>Contrast CT scans were performed. All CT scans were reviewed by a single vascular surgeon.</p>								
Study Details	<p>Study location: Pittsburgh, USA</p> <p>Study setting: University of Pittsburgh Medical Centre</p> <p>Study dates: February 1996 to November 2002</p>								

Full citation	Raman Kathleen G, Missig-Carroll Nita, Richardson Tracey, Muluk Satish C, and Makaroun Michel S (2003) Color-flow duplex ultrasound scan versus computed tomographic scan in the surveillance of endovascular aneurysm repair. Journal of vascular surgery 38, 645-51
	Loss to follow-up: Not specified Time between testing & Treatment: CDUS and CTA carried out on the same day Source of funding: Not specified
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Low risk of bias Reference standard: Unclear risk of bias - unclear if reference standard results were interpreted without knowledge of index test Flow and timing: Low risk of bias Overall risk of bias: Moderate risk of bias Directness: Direct

Full citation	Schmieder Greg C, Stout Christopher L, Stokes Gordon K, Parent F Noel, and Panneton Jean M (2009) Endoleak after endovascular aneurysm repair: duplex ultrasound imaging is better than computed tomography at determining the need for intervention. Journal of vascular surgery 50, 1012-8									
Study type	Cross sectional study (retrospective)									
Aim	Retrospectively compare CT and CDUS imaging in the detection of endoleaks requiring intervention after EVAR.									
Patient Characteristics	Inclusion criteria: Only patients with paired imaging studies \leq 3 months of each other were included. Exclusion criteria: Patients with symptomatic or ruptured AAA and isolated iliac aneurysms.									
	<table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Mean Age (range)</td> <td>72 years (51-90 years)</td> </tr> <tr> <td>Males (%)</td> <td>86%</td> </tr> <tr> <td>Aneurysm Size (\pmSD)</td> <td>Not reported</td> </tr> </tbody> </table>		Study Characteristics		Mean Age (range)	72 years (51-90 years)	Males (%)	86%	Aneurysm Size (\pm SD)	Not reported
Study Characteristics										
Mean Age (range)	72 years (51-90 years)									
Males (%)	86%									
Aneurysm Size (\pm SD)	Not reported									
Sample Size	236 patients									
Index test(s)	CDUS CDUS or CT examinations were scheduled at 1, 3, 6 and 12 months and annually thereafter. The CDUS was performed in sagittal and transverse views to evaluate the AAA sac for the presence of flow outside the graft. CDUS scan evidence of an endoleak required the identification of perigraft Doppler scan signal with colour flow and was confirmed with spectral analysis and mapping of blood flow pattern. All CDUS examinations occurred in a peripheral vascular laboratory and were performed by vascular technicians. Vascular surgeons read the results. The CDUS examination was considered inadequate if the endograft graft was poorly or incompletely seen secondary to patient habitus or obscured by bowel gas.									
Reference standard(s)	CTA CT scan surveillance was performed using a GE Lightspeed plus 16 slice scanner. Interpretation of CT scan was performed by radiology, whereas vascular surgery interpreted CDU results. Vascular surgeons made clinical decisions by reviewing both imaging modalities and the patient's clinical findings.									
Study Details	Study location: USA Study setting: Not specified Study dates: July 1996 to March 2007 Loss to follow-up: Not specified Time between testing & Treatment: Mean interval between CDU and CT was 18 days (range, 0-90 days)									

Full citation	Schmieder Greg C, Stout Christopher L, Stokes Gordon K, Parent F Noel, and Panneton Jean M (2009) Endoleak after endovascular aneurysm repair: duplex ultrasound imaging is better than computed tomography at determining the need for intervention. Journal of vascular surgery 50, 1012-8
	Source of funding: Not specified
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Low risk of bias Reference standard: Low risk of bias Flow and timing: High risk of bias. Inadequate interval between index and reference test. Overall risk of bias: Moderate Directness: Direct

Full citation	Ten Bosch, Jan A, Rouwet Ellen V, Peters Cecile T. H, Jansen Linda, Verhagen Hence J. M, Prins Martin H, and Teijink Joep A. W (2010) Contrast-enhanced ultrasound versus computed tomographic angiography for surveillance of endovascular abdominal aortic aneurysm repair. Journal of vascular and interventional radiology: JVIR 21, 638-43								
Study type	Cross – sectional study								
Aim	Compare diagnostic accuracy between contrast-enhanced ultrasound and computed tomographic angiography to detect changes in AA size and endoleaks during follow-up after EVAR.								
Patient Characteristics	<p>Inclusion criteria: All patients who underwent EVAR for infrarenal AAA Exclusion criteria: Patients who could not undergo CT angiography as a result of severe iodinated contrast allergy or severe renal insufficiency</p> <table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Age</td> <td>71 years \pm 9</td> </tr> <tr> <td>Males (%)</td> <td>92%</td> </tr> <tr> <td>Aneurysm Size (\pmSD)</td> <td>Not reported</td> </tr> </tbody> </table>	Study Characteristics		Age	71 years \pm 9	Males (%)	92%	Aneurysm Size (\pm SD)	Not reported
Study Characteristics									
Age	71 years \pm 9								
Males (%)	92%								
Aneurysm Size (\pm SD)	Not reported								
Sample Size	83 patients								
Index test(s)	<p>CUES</p> <p>The routine surveillance regiment consisted of intravenous contrast enhanced CT scans at 3 and 12 months after procedure and yearly thereafter. During the study period, contrast enhanced US examinations were added to this regimen. US investigations were performed with an abdominal 3.5- MHz curved-array transducer. The examinations were performed by 3 well trained vascular technicians dedicated to US imaging, who were blinded to each other's findings and to the findings on CTA. An endoleak was identified on CEUS by flow and spectral signals within the aneurysm sac during infusion of sonographic contrast.</p>								
Reference standard(s)	<p>CTA</p> <p>Triple phase CTA was performed from the diaphragm to the common femoral arteries after continuous intravenous administration of iodinated contrast agent.</p>								
Study Details	<p>Study location: Netherlands Study setting: Department of Vascular Surgery Study dates: May 2006 and December 2008 Loss to follow-up: Not reported Time between testing & Treatment: 30 days</p>								

Full citation	Ten Bosch, Jan A, Rouwet Ellen V, Peters Cecile T. H, Jansen Linda, Verhagen Hence J. M, Prins Martin H, and Teijink Joep A. W (2010) Contrast-enhanced ultrasound versus computed tomographic angiography for surveillance of endovascular abdominal aortic aneurysm repair. Journal of vascular and interventional radiology: JVIR 21, 638-43
	Source of funding: Not specified
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Low risk of bias Reference standard: Unclear risk of bias. – Unclear if CTA results were interpreted without knowledge of CEUS. Flow and timing: Low risk of bias Overall risk of bias: Moderate risk of bias Directness: directly applicable

Full citation	Wolf Y G, Johnson B L, Hill B B, Rubin G D, Fogarty T J, and Zarins C K (2000) Duplex ultrasound scanning versus computed tomographic angiography for postoperative evaluation of endovascular abdominal aortic aneurysm repair. Journal of vascular surgery 32, 1142-8
Study type	Cross-sectional study
Aim	Compare duplex ultrasound scanning and computed tomography (CT) angiography for postoperative imaging and surveillance after endovascular repair of AAA.
Patient Characteristics	Inclusion criteria: Patients who underwent endovascular repair of AAA with the AneuRx (Medtronic) bifurcated endograft. Exclusion criteria: Not reported Patient characteristics: Not reported
Sample Size	100
Index test(s)	CDUS Follow-up protocol included CT angiography before discharge, duplex scan at 1 month, and CT angiography at 6 months, 1 year and yearly thereafter. All duplex scans were obtained after the patients fasted for 6 hours and were performed by a registered vascular technologist proficient in both vascular and abdominal imaging. Vascular technologist was not aware of CT scan results. An internally standardised duplex scanning protocol was used for assessing the abdominal aorta. All duplex scans were reviewed by a vascular surgeon.
Reference standard(s)	CTA Helical CT was performed with either a CTi single detector-row or a Lightspeed QXi multi detector-row CT scanner. In addition to a formal reading by a radiologist who was unaware of the duplex scans result, CT angiograms were reviewed by a panel of radiologists and vascular surgeons to confirm the presence or absence of an endoleak.
Study Details	Study location: Stanford, USA Study setting: Stanford University Hospital Study dates: October 1996 to May 1999 Loss to follow-up: Not reported Time between testing & Treatment: Where possible, CT and duplex scans were conducted within 7 days from each other. Source of funding: Not specified
Quality Assessment (QUADAS 2)	Patient selection: Low risk of bias Index test: Unclear risk of bias – Definition of endoleak not stated

Full citation	Wolf Y G, Johnson B L, Hill B B, Rubin G D, Fogarty T J, and Zarins C K (2000) Duplex ultrasound scanning versus computed tomographic angiography for postoperative evaluation of endovascular abdominal aortic aneurysm repair. Journal of vascular surgery 32, 1142-8
	Reference standard: Low risk of bias Flow and timing: Unclear – CT and CDUS performed within 7 days in only 76 patients. Overall risk of bias: Moderate risk of bias Directness: Partially indirect. Although the protocol specifies that studies published after 2000 should be included, the committee were interested in studies in which patients received scans before this cut-off. As this study was conducted between 1996 and 1999, the study was downgraded for partial indirectness.

Full citation	Zannetti S, De Rango, P , Parente B, Parlani G, Verzini F, Maselli A, Nardelli L, and Cao P (2000) Role of duplex scan in endoleak detection after endoluminal abdominal aortic aneurysm repair. European journal of vascular and endovascular surgery : the official journal of the European Society for Vascular Surgery 19, 531-5									
Study type	Cross sectional study									
Aim	To validate the role of Duplex scan in endoleak detection in postoperative surveillance of endoluminal abdominal aneurysm repair.									
Patient Characteristics	<p>Inclusion criteria: Patients undergoing EVAR Exclusion criteria: Conversion to open repair Duplex scan performed in a different centre in patients from out of town Patient refusal Patients with renal insufficiency Patients in need of a different imaging technique (I.e. angiography in patients subjected to adjunctive peripheral revascularisation) Inadequate duplex visualisation of the AAA sac due to obesity or intestinal gas.</p> <table border="1"> <thead> <tr> <th colspan="2">Study Characteristics</th> </tr> </thead> <tbody> <tr> <td>Mean Age</td> <td>70.1 ±6.7 years</td> </tr> <tr> <td>Males (%)</td> <td>91%</td> </tr> <tr> <td>Aneurysm Size (±SD)</td> <td>50.2 ± 8.3 mm</td> </tr> </tbody> </table>		Study Characteristics		Mean Age	70.1 ±6.7 years	Males (%)	91%	Aneurysm Size (±SD)	50.2 ± 8.3 mm
Study Characteristics										
Mean Age	70.1 ±6.7 years									
Males (%)	91%									
Aneurysm Size (±SD)	50.2 ± 8.3 mm									
Sample Size	103 patients									
Index test(s)	CDUS CDUS was performed with an ATL 3000 HDI system (Advanced Technology Laboratory) with a C4-2 MHz curved array transducer. Low frequencies were used and colour Doppler settings were optimised to avoid excessive overgain (i.e. colour artefacts to may fill the colour box) or undergain (i.e. absence of colour flow within the aortic graft). The entire AAA sac, proximal and distal necks, the aorta, iliac and femoral arteries were systematically imaged and measurements were performed on both sagittal and transverse views. The presence of perigraft endoleaks was suspected when a reproducible colour signal outside the endograft and within the aneurysmal sac was visualised. All suspected endoleaks were further evaluated with the Doppler signal to avoid colour artefacts. When the presence of both the Doppler and colour signal outside the endograft and within the aneurysmal sac were observed, the location, flow direction, and extent of AAA sac involvement were recorded. Two vascular surgeons performed all duplex-scan examinations.									
Reference standard(s)	CTA									

Full citation	Zannetti S, De Rango, P , Parente B, Parlani G, Verzini F, Maselli A, Nardelli L, and Cao P (2000) Role of duplex scan in endoleak detection after endoluminal abdominal aortic aneurysm repair. European journal of vascular and endovascular surgery : the official journal of the European Society for Vascular Surgery 19, 531-5
	Contrast enhanced CT scan was considered the gold standard in endoleak detection and classification. All CT scans were centrally reviewed by the same vascular surgeon who established the presence or absence of endoleak. Endoleak was diagnosed in the presence, in the axial reconstruction, of contrast outside the lumen of the endoluminal graft and within aneurysmal sac. Medium contrast within the aneurysmal sac that appeared in continuity with the proximal or distal implant zones were interpreted as a graft-related endoleak, whereas a small amount of contrast medium near the entry of a patent inferior mesenteric or lumbar artery, implying retrograde flow, was interpreted as a non-graft related endoleak. The interpretation of all colour duplex and CT scans was blinded to all concurrent and prior studies.
Study Details	<p>Study location: Perugia, Italy</p> <p>Study setting: Unit of Vascular Surgery</p> <p>Study dates: April 1997 and March 1999</p> <p>Loss to follow-up: Major complication occurred in six patients and included a non-disabling stroke during a secondary endovascular procedure, occlusion of the endograft limb, renal infarction due to covering of the right renal artery by the endograft treated with nephrectomy, asymptomatic occlusion of a renal artery, and intraoperative rupture of a common iliac artery. Late death occurred in 3 patients and was caused by pulmonary embolism in a patient undergoing hip replacement, by cancer and by myocardial infarction.</p> <p>Time between testing & Treatment: Not specified</p> <p>Source of funding: Not specified</p>
Quality Assessment (QUADAS 2)	<p>Patient selection: Low risk of bias</p> <p>Index test: Low risk of bias</p> <p>Reference standard: Low risk of bias</p> <p>Flow and timing: Unclear risk of bias- interval between index test and reference standard not specified</p> <p>Overall risk of bias: Moderate risk of bias</p> <p>Directness: Partially indirect. Although the protocol specifies that studies published after 2000 should be included, the committee were interested in studies in which patients received scans before this cut-off. As this study was conducted between 1997 and 1999, the study was downgraded for partial indirectness.</p>