

1. Invest Radiol. 2011 Apr 11. [Epub ahead of print]

Dynamic Contrast-Enhanced Ultrasound for Assessment of Skeletal Muscle Microcirculation in Peripheral Arterial Disease.

Amarteifio E, Weber MA, Wormsbecher S, Demirel S, Krakowski-Roosen H, Jöres A, Braun S, Delorme S, Böckler D, Kauczor HU, Krix M.

2. Int Angiol. 2011 Apr;30(2):135-9.

The clinical role of contrast-enhanced ultrasound in the evaluation of renal artery stenosis and diagnostic superiority as compared to traditional echo-color-Doppler flow imaging.

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Identification of carotid 'vulnerable plaque' by contrast-enhanced ultrasonography: correlation with plaque histology, symptoms and cerebral computed tomography.

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Prospective comparative analysis of colour-Doppler ultrasound, contrast-enhanced ultrasound, computed tomography and magnetic resonance in detecting endoleak after endovascular abdominal aortic aneurysm repair.

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Long-term follow-up after endovascular aneurysm repair: is ultrasound alone enough?

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1. Invest Radiol. 2011 Apr 11. [Epub ahead of print]

Dynamic Contrast-Enhanced Ultrasound for Assessment of Skeletal Muscle Microcirculation in Peripheral Arterial Disease.

Amarteifio E, Weber MA, Wormsbecher S, Demirel S, Krakowski-Roosen H, Jöres A, Braun S, Delorme S, Böckler D, Kauczor HU, Krix M.

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OBJECTIVE: This feasibility study was performed to assess whether dynamic contrast-enhanced ultrasound (CEUS) and transient arterial occlusion are able to detect alterations in the microvascular perfusion and arterial perfusion reserve in patients suffering from peripheral arterial disease (PAD) in comparison with healthy volunteers.

MATERIALS AND METHODS: Twenty patients with PAD, Rutherford classification grade I, category III (mean age, 64 years; mean height, 173 cm; mean weight, 81.8 kg), and 20 volunteers (mean age, 50 years; mean height, 174 cm; mean weight, 77.8 kg) participated in the study. Low-mechanical index CEUS (7 MHz; MI, 0.28) was performed to the dominant lower leg after start of a continuous automatic intravenous injection of 4.8 mL suspension with microbubbles containing sulfur hexafluoride (SonoVue) within 5 minutes. Perfusion of the calf muscle was monitored by CEUS before, during, and after release of arterial occlusion at the thigh level lasting for 60 seconds. Several parameters, especially the time to maximum enhancement after release of occlusion (tmax), the maximum enhancement after release of occlusion (maxenh), the total vascular response after release of occlusion (AUCpost), and the resulting slope (m2) to maximum enhancement were calculated. **RESULTS:** After release of the occlusion, a significantly delayed increase of the CEUS signal to maxenh was observed in the patients with PAD (32 ± 17 seconds) compared with volunteers (17 ± 8 seconds, $P = 0.0009$). maxenh was 66.5 ± 36.6 (~mL) in PAD versus 135.6 ± 75.1 (~mL) in volunteers ($P = 0.0016$). AUCpost was 3016.5 ± 1825.8 (~mL·s) in PAD versus 5906.4 ± 3173.1 (~mL·s) in volunteers ($P = 0.0013$), and m2 was significantly lower in PAD (3.8 ± 5.2 vs. 14.8 ± 9.7 [~mL/s], $P = 0.0001$).

CONCLUSIONS: Microvascular perfusion deficits and reduced arterial perfusion reserve in patients with PAD are clearly detectable with dynamic CEUS after transient arterial occlusion.

2. *Int Angiol.* 2011 Apr;30(2):135-9.

The clinical role of contrast-enhanced ultrasound in the evaluation of renal artery stenosis and diagnostic superiority as compared to traditional echo-color-Doppler flow imaging.

Cicccone MM, Cortese F, Fiorella A, Scicchitano P, Cito F, Quistelli G, Pertosa G, D'agostino R, Guida P, Favale S.

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AIM: The purpose of this study was to investigate the feasibility of contrast-enhanced ultrasound (CEUS) in the evaluation of renal artery stenosis as compared with traditional techniques: echo color Doppler (ECD) investigation and selective angiography. CEUS is a technique based on the injection of an intravascular biocompatible tracer, namely an intravenous contrast galactose microparticle suspension containing microbubbles (Levovist), that has a similar rheology to that of red blood cells, allowing quantification of renal tissue perfusion. **METHODS:** A population of 120 hypertensive patients (82 men, mean age 55) with a systolic abdominal murmur and/or a diagnosis of poly-distinct atherosclerosis was studied by ECD and CEUS (Levovist). Selective angiography was performed in patients with renal artery stenosis demonstrated by one of the two ultrasonographic techniques. **RESULTS:** Forty of the 120 patients in the study population showed renal artery stenosis at one of the two ultrasound techniques: ECD identified renal artery stenosis in 33 cases and CEUS in 38. Instead, selective angiography had detected renal artery stenosis in 38 patients, the same with renal artery stenosis diagnosed by CEUS. Thus, CEUS sensitivity, specificity and accuracy were similar to those of angiography while six false negatives and two false positives were obtained with ECD. **CONCLUSION:** Our results suggest that this renal CEUS is a promising, new, non-invasive method for screening patients with suspected renal artery stenosis. This technique appears to be superior to traditional ECD flow imaging for diagnosing renal artery stenosis and so may be an important aid in cardiovascular diagnostics.

3. *J Cardiovasc Surg (Torino)*. 2011 Apr;52(2):193-8.

Is it time to eliminate CT after EVAR as routine follow-up?

Verhoeven EL, Oikonomou K, Ventin FC, Lerut P, Fernandes E, Fernandes R, Mendes Pedro L.

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Growing concerns regarding radiation exposure, contrast induced nephropathy and

increasing costs lead us to reconsider the necessity of CTA for all EVAR patients. The purpose of this study is to compare the results of different follow-up imaging modalities with the aim of finding a rationale to the optimal follow-up imaging protocol. We reviewed recent literature regarding post EVAR imaging modalities and compared it to our experience with different follow-up protocols. Modalities compared were CTA, DUS, CEUS, and plain abdominal X-ray with regard to detection of complications, cost, overall impact to the patient, and on decision making regarding reintervention. CTA is related to increased follow-up costs and a much higher exposure to radiation compared to other modalities. The cumulative radiation dose can have a significant impact on the attributable lifetime cancer risk of patients. Renal function deterioration during post EVAR follow-up is higher compared to open repair. Plain abdominal X-ray is the best manageable modality and a well established tool in documenting migration kinking and stent fracture. Plain X-Ray cannot be used as a standalone imaging modality since it doesn't allow direct detection of endoleaks. As far as detection of endoleaks is concerned recent meta-analyses show a sensitivity of 66-77% for DUS and 81-98% for CEUS, respectively. Most endoleaks missed by DUS and CEUS are type II endoleaks with no need for reintervention. Our data in a cohort of 62 patients do show a sensitivity of 66.7% for DUS, and do correlate with current literature. No endoleaks requiring reintervention were missed. A follow-up protocol comprising of DUS/CEUS and plain abdominal X-ray gives a wide range of information covering EVAR related risks and is associated with less radiation exposure, avoidance of renal function deterioration due to repeated contrast agent application and an important decrease in the cost of EVAR follow-up. CTA should be reserved for cases of inconclusive ultrasound, signs of complications and unfavourable anatomy.

4. Eur J Radiol. 2011 Feb 26. [Epub ahead of print]

Imaging of carotid arterial diseases with contrast-enhanced ultrasound (CEUS).

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Carotid duplex ultrasound is the standard of care for the initial diagnosis of carotid artery bifurcation diseases. But in difficult examinations, carotid abnormalities are commonly encountered and may represent a diagnostic challenge in patients with clinical symptoms as well as in the follow up after carotid endarterectomy or carotid artery stenting. Contrast enhanced ultrasound (CEUS) with low mechanical index (low MI) is a promising new method in the diagnosis and follow up of pathological carotid diseases. Unlike most contrast agents used for magnetic resonance imaging or computed tomography, the microbubbles used in CEUS with SonoVue[®] remain within the vascular space and hence can be used to study vascular disease. In addition to improving current carotid structural scans, CEUS has potential to improve or add extra information on carotid arterial diseases. This review describes the current carotid duplex ultrasound examination and compares the pathological findings with CEUS.

5. Eur J Vasc Endovasc Surg. 2011 Feb;41(2):238-48. Epub 2010 Dec 8.

Identification of carotid 'vulnerable plaque' by contrast-enhanced ultrasonography: correlation with plaque histology, symptoms and cerebral computed tomography.

Faggioli GL, Pini R, Mauro R, Pasquinelli G, Fittipaldi S, Freyrie A, Serra C, Stella A.

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INTRODUCTION: Indication to carotid revascularisation is commonly determined by percent of stenosis as well as neurological symptoms and clinical conditions. High plaque embolic potential is defined as 'vulnerability'; however, its characterisation is not universally used for carotid revascularisation. We investigated the role of contrast-enhanced ultrasonography (CEUS) to identify carotid vulnerable plaque. **METHODS:** Patients undergoing carotid endarterectomy were preoperatively evaluated by cerebral computed tomography (CT) scan and CEUS. Contrast microbubbles detected within the plaque indicated neovascularisation and were quantified by decibel enhancement (dB-E). Plaques were histologically evaluated for five features: (microvessel density, fibrous cap thickness, extension of calcification, inflammatory infiltrate and lipid core) and blindly scored 1-5 to assess plaque vulnerability. Analysis of variance (ANOVA), Fisher's and Student's t-test were used to correlate patients' characteristics, histological features and dB-E. **RESULTS:** In 22 patients, dB-E (range 2-7.8, mean 4.85 ± 1.9 SD) was significantly greater in symptomatic (7.40 ± 0.5) vs. asymptomatic (3.5 ± 1.4) patients ($p = 0.002$). A higher dB-E was significantly associated with thinner fibrous cap ($<200 \mu\text{m}$, 5.96 ± 1.5 vs. 3 ± 1 , $p = 0.01$) and greater inflammatory infiltrate (3.2 ± 0.9 vs. 6.4 ± 1.2 , $p = 0.03$). Plaques with vulnerability score of 5 had significantly higher dB-E compared with those with vulnerability score of 1 (7.6 ± 0.2 vs. 2.5 ± 0.6 , respectively, $p = 0.001$). Preoperative ipsilateral embolic lesions at CT were correlated with higher dB-E (5.96 ± 1.5 vs. 3.0 ± 1.0 , $p = 0.01$). **CONCLUSION:** CEUS with dB-E is indicative of the extent of plaque neovascularisation. It can be used therefore as a marker for vulnerable plaque.

6. Eur J Vasc Endovasc Surg. 2011 Feb;41(2):186-92. Epub 2010 Nov 20.

Prospective comparative analysis of colour-Doppler ultrasound, contrast-enhanced ultrasound, computed tomography and magnetic resonance in detecting endoleak after endovascular abdominal aortic aneurysm repair.

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OBJECTIVES: To assess the accuracy of colour-Doppler ultrasound (CDUS), contrast-enhanced ultrasonography (CEUS), computed tomography angiography (CTA) and magnetic resonance angiography (MRA) in detecting endoleaks after endovascular abdominal aortic aneurysm repair (EVAR). **DESIGN:** Prospective, observational study.

MATERIALS AND METHODS: From December 2007 to April 2009, 108 consecutive patients who underwent EVAR were evaluated with CDUS, CEUS, CTA and MRA as well as angiography, if further treatment was necessary. Sensitivity, specificity, accuracy and negative predictive value of ultrasound examinations were compared with CTA and MRA as the reference standards, or with angiography when available. **RESULTS:** Twenty-four endoleaks (22%, type II: 22 cases, type III: two cases) were documented. Sensitivity and specificity of CDUS, CEUS, CTA, and MRA were 58% and 93%, 96% and 100%, 83% and 100% and 96% and 100% respectively. CEUS allowed better classification of endoleaks in 10, two and one patients compared with CDUS, CTA and MRA, respectively. **CONCLUSIONS:** The accuracy of CEUS in detecting endoleaks after EVAR is markedly better than CDUS and is similar to CTA and MRA. CEUS seems to be a feasible tool in the long-term surveillance after EVAR, and it may better classify endoleaks missed by other imaging techniques.

7. Expert Rev Neurother. 2011 Feb;11(2):265-73.

Sonothrombolysis for the treatment of acute stroke: current concepts and future directions.

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Achieving rapid reperfusion transcranial color-coded duplex is the critical issue in acute stroke treatment. Ultrasound (US) generates negative pressure waves that are associated with an increase in either intrinsic or intravenous tissue plasminogen activator (tPA)-induced fibrinolytic activity. Higher rates of tPA-induced arterial recanalization, associated with a trend towards better functional outcome, have been safely achieved by using high-frequency US. By contrast, the use of low-frequency US and transcranial color-coded duplex has been linked to significant hemorrhagic complications. US-accelerated thrombolysis has been safely enhanced by lowering the amount of energy needed for acoustic cavitation with the administration of microbubbles. Other applications of US are being studied, including its intra-arterial use. Operator-independent devices, which will spread the use of these US techniques further, are also being developed. This article reviews the present status of sonothrombolysis in acute stroke treatment, highlighting both experimental and clinical studies addressing this issue, and discusses its future regarding both efficacy and safety.

8. J Vasc Surg. 2010 Dec;52(6):1531-6. Epub 2010 Sep 16.

Success of arterial revascularization determined by contrast ultrasound muscle perfusion imaging.

Duerschmied D, Maletzki P, Freund G, Olschewski M, Bode C, Hehrlein C.

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BACKGROUND: In the early postoperative evaluation of the success of arterial revascularization, ankle-brachial index (ABI) and other noninvasive tests lack reliability, especially in patients with incompressible arteries or local edema. Contrast-enhanced ultrasound (CEUS) imaging of limb muscle perfusion may be an alternative to standard tests if it detects treatment success reliably. **METHODS:** We compared a simplified CEUS method with clinical staging, pulse volume recording (PVR), and ABI in patients with lifestyle-limiting peripheral arterial disease undergoing revascularization by percutaneous transluminal angioplasty (PTA) or bypass surgery. Patients underwent staging, PVR, ABI, and CEUS before, directly after, and 3 to 5 months after successful PTA (n = 20) or successful bypass grafting (n = 14). For CEUS, contrast agent was injected into an antecubital vein, and the time from beginning to peak intensity of contrast enhancement (TTP) in the calf muscle was measured. **RESULTS:** Successful revascularization by both PTA and bypass was associated with a significant improvement in staging, PVR, ABI, and TTP directly after intervention and at follow-up. Median ABI increased from 0.60 to 0.85 (P = .001) after PTA and from 0.36 to 0.76 (P = .003) after bypass surgery. Median TTP decreased from 45 seconds to 24 seconds (P = .015) and from 30 seconds to 27 seconds (P = .041), respectively. McNemar analysis revealed unidirectional changes in both ABI and TTP (P = .625 after PTA and P = 1.000 after bypass surgery), and equivalence analysis showed 95% confidence intervals within clinical indifference, indicating that TTP was equivalent to standard tests in detecting successful revascularization. **CONCLUSIONS:** Contrast ultrasound perfusion imaging of calf muscle after arterial revascularization may be a valuable alternative to standard noninvasive tests such as ABI or PVR to determine the success of an arterial revascularization.

9. J Cereb Blood Flow Metab. 2010 Oct;30(10):1712-20. Epub 2010 Jun 9.

Combined contrast-enhanced ultrasound and rt-PA treatment is safe and improves impaired microcirculation after reperfusion of middle cerebral artery occlusion.

Nedelmann M, Ritschel N, Doenges S, Langheinrich AC, Acker T, Reuter P, Yeniguen M, Pukropski J, Kaps M, Mueller C, Bachmann G, Gerriets T.

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In monitoring of recanalization and in sonothrombolysis, contrast-enhanced ultrasound (CEUS) is applied in extended time protocols. As extended use may increase the probability of unwanted effects, careful safety evaluation is required. We investigated the safety profile and beneficial effects of CEUS in a reperfusion model. Wistar rats were subjected to filament occlusion of the right middle cerebral artery (MCA). Reperfusion was established after 90 minutes, followed by recombinant tissue-type plasminogen activator (rt-PA) treatment and randomization to additional CEUS (contrast agent: SonoVue; 60 minutes). Blinded outcome evaluation consisted of magnetic resonance imaging (MRI), neurologic assessment, and histology and, in separate experiments, quantitative 3D nano-computed tomography (CT) angiography (900 nm(3) voxel size). Nano-CT revealed severely compromised microcirculation in untreated animals after MCA reperfusion. The rt-PA partially improved hemispheric perfusion. Impairment was completely reversed in animals receiving rt-PA and CEUS. This combination was more effective than treatment with either CEUS without rt-PA or rt-PA and ultrasound or ultrasound alone. In MRI experiments, CEUS and rt-PA treatment resulted in a significantly reduced ischemic lesion volume and edema formation. No unwanted effects were detected on MRI, histology, and intracranial temperature assessment. This study shows that CEUS and rt-PA is safe in the situation of reperfusion and displays beneficial effects on the level of the microvasculature.

10. *Perspect Vasc Surg Endovasc Ther.* 2010 Sep;22(3):145-51.

Long-term follow-up after endovascular aneurysm repair: is ultrasound alone enough?

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In the last decade, endovascular aneurysm repair (EVAR) has become the preferred method for infrarenal abdominal aortic aneurysm repair in patients with suitable anatomy. EVAR offers the advantage of lower perioperative morbidity and mortality but carries the cost of device-related complications such as endoleak, graft migration, graft thrombosis, and structural graft failure. These complications mandate a lifelong surveillance of EVAR patients and their endografts. Since the advent of EVAR, this has largely been accomplished with serial computed tomography (CT). There is, however, increasing awareness of the risks and costs of a lifelong CT imaging mandate, which has led to several cohort analyses comparing CT with color duplex ultrasonography (CDU) with contrast-enhanced ultrasound (CEUS) for the evaluation of the endograft and aneurysm sac post-EVAR. This review will summarize the findings of these reports and highlight the results of recent ultrasound-based surveillance strategies.

11. JACC Cardiovasc Imaging. 2010 Jul;3(7):761-71.

Contrast-enhanced ultrasound imaging of the vasa vasorum: from early atherosclerosis to the identification of unstable plaques.

Staub D, Schinkel AF, Coll B, Coli S, van der Steen AF, Reed JD, Krueger C, Thomenius KE, Adam D, Sijbrands EJ, ten Cate FJ, Feinstein SB.

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Proliferation of the adventitial vasa vasorum (VV) is inherently linked with early atherosclerotic plaque development and vulnerability. Recently, direct visualization of arterial VV and intraplaque neovascularization has emerged as a new surrogate marker for the early detection of atherosclerotic disease. This clinical review focuses on contrast-enhanced ultrasound (CEUS) as a noninvasive application for identifying and quantifying carotid and coronary artery VV and intraplaque neovascularization. These novel approaches could potentially impact the clinician's ability to identify individuals with premature cardiovascular disease who are at high risk. Once clinically validated, the uses of CEUS may provide a method to noninvasively monitor therapeutic interventions. In the future, the therapeutic use of CEUS may include ultrasound-directed, site-specific therapies using microbubbles as vehicles for drug and gene delivery systems. The combined applications for diagnosis and therapy provide unique opportunities for clinicians to image and direct therapy for individuals with vulnerable lesions.

12. Abdom Imaging. 2010 Jun;35(3):376-80. Epub 2009 Mar 25.

Contrast enhanced ultrasonography versus MR angiography in aortocaval fistula: case report.

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Aortocaval fistula (ACF) is a rare, life threatening complication of abdominal aortic aneurysms. Time to diagnosis is crucial as preoperative diagnosis and early surgical intervention significantly improve the outcome. The clinical spectrum being varied, the challenge of prompt and reliable diagnosis rests on emergency radiology. While the gold standard for detecting ACF today is CT angiography (CTA), frequently complicating renal insufficiency discourages the use of iodinated contrast making MR angiography (MRA) a useful alternative. Contrast enhanced ultrasound (CEUS) provides a promising new diagnostic option allowing rapid, non invasive and bedside diagnosis, especially in hemodynamically unstable patients. We present a case of prompt diagnosis of ACF by CEUS in comparison to modern MRA, thus establishing the new potential role of CEUS.

13. J Vasc Interv Radiol. 2010 May;21(5):638-43. Epub 2010 Apr 2.

Contrast-enhanced ultrasound versus computed tomographic angiography for surveillance of endovascular abdominal aortic aneurysm repair.

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PURPOSE: To compare diagnostic accuracy between contrast-enhanced ultrasound (US) and computed tomographic (CT) angiography to detect changes in abdominal aortic aneurysm (AAA) size and endoleaks during follow-up after endovascular aneurysm repair (EVAR). **MATERIALS AND METHODS:** Between May 2006 and December 2008, 83 patients were consecutively enrolled for contrast-enhanced US and CT angiography imaging during surveillance after EVAR, yielding 127 paired examinations. Comparative analysis was performed for the anteroposterior and transverse maximal diameters of the aneurysm sac and for the presence or absence of endoleak, as determined by US and CT angiography. **RESULTS:** Contrast-enhanced US demonstrated significantly more endoleaks, predominantly of type II, compared with CT angiography (53% vs 22% of cases). The number of observed agreements was 77 of 127 (61%), indicating a low level of agreement (kappa value of 0.237). US was as accurate as CT angiography in the assessment of maximal aneurysm sac diameters, as shown by Bland-Altman analyses and low coefficients of variation (8.0% and 8.6%, respectively). The interobserver variability for AAA size measurement by US was low, given the interclass correlation coefficients of 0.99 and 0.98 for anteroposterior and transverse maximal diameters, respectively. **CONCLUSIONS:** Contrast-enhanced US may be an alternative to CT angiography in the follow-up of patients after EVAR. As US reduces exposure to the biologic hazards associated with lifelong annual CT angiography, including cumulative radiation dose and nephrotoxic contrast agent load, contrast-enhanced US might be considered as a substitute for CT angiography in the surveillance of patients after EVAR.

14. J Vasc Surg. 2010 May;51(5):1103-10.

First experience using intraoperative contrast-enhanced ultrasound during endovascular aneurysm repair for infrarenal aortic aneurysms.

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BACKGROUND: Endovascular aortic repair (EVAR) has become an additional treatment option for patients with infrarenal aortic aneurysms and suitable aortic morphology. However, endoleaks are commonly encountered and represent a relevant risk for secondary treatment failure. In addition, impaired renal function or allergic reactions

to intravascular iodine application might represent exclusion criteria for conventional infrarenal endovascular aortic repair using intraoperative angiography with iodine contrast media. Real-time contrast-enhanced ultrasound (CEUS) with a low mechanical index (MI) is a promising method recently introduced for follow up after endovascular infrarenal aortic repair. **METHODS:** In this study, intraoperative CEUS using SonoVue as ultrasound contrast agent was evaluated in 17 patients for localization of the proximal infrarenal landing zone, the distal iliac fixation area, and identification of endoleaks in patients suitable for endovascular aortic repair with an infrarenal aortic neck $>$ or $=$ 10 mm and non-aneurysmal common iliac arteries. For comparison, 20 patients were treated by conventional EVAR using intraoperative fluoroscopy and iodine contrast media. **RESULTS:** Intraoperative application of contrast-enhanced ultrasound (iCEUS) for identification of the infrarenal landing zone and proximal stent graft release was achieved in 14 out of 17 patients (82.4%), as verified by intraoperative angiography or postinterventional imaging. Intraoperative CEUS-assisted visualization of the distal fixation area proximal to the level of the iliac bifurcation was achieved in 89.3% (25 out of 28 iliac arteries examined) in comparison to intraoperative angiography or postinterventional CEUS, computed tomography (CT), or magnetic resonance (MR) angiography. Three selected patients having contraindications for iodine-based contrast media were treated by iCEUS-assisted EVAR without the use of any iodine contrast during fluoroscopy. Time for exposure to intraoperative radiation, volume of contrast medium used, and the number of intraoperative angiographies and postinterventional CT or MR angiographies were significantly reduced in the iCEUS-assisted EVAR group in comparison to conventional endovascular aortic treatment ($P < .002$ or less for all parameters). Intraoperative application of CEUS detected more endoleaks than conventional EVAR (8/17 vs 4/20; $P = .08$) treated by proximal stent graft extension in one symptomatic patient with a type Ia endoleak. **CONCLUSIONS:** Intraoperative CEUS-assisted EVAR in patients with infrarenal aortic aneurysms represents a new option for intraoperative visualization of aortoiliac segments required as proximal or distal fixation zones and identification of endoleaks, especially in those patients with contraindications for usage of iodine-containing contrast agents, in association with a reduction of iodine contrast media used and radiation exposure during fluoroscopy.

15. Eur J Vasc Endovasc Surg. 2010 Apr;39(4):429-30. Epub 2010 Feb 18.

Comments regarding 'duplex ultrasound and contrast-enhanced ultrasound versus computed tomography for the detection of endoleak after EVAR'.

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Comment on

Eur J Vasc Endovasc Surg. 2010 Apr;39(4):418-28.

16. Eur J Vasc Endovasc Surg. 2010 Apr;39(4):418-28. Epub 2010 Feb 1.

Duplex ultrasound and contrast-enhanced ultrasound versus computed tomography for the detection of endoleak after EVAR: systematic review and bivariate meta-analysis.

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Comment in

Eur J Vasc Endovasc Surg. 2010 Apr;39(4):429-30.

INTRODUCTION: Contrast-enhanced computed tomography (CT) has become the 'gold-standard' imaging modality for surveillance following EVAR. However repeated CT causes cumulative contrast related renal injury. Duplex ultrasound (USS) and contrast-enhanced (non-nephrotoxic) duplex scanning (CEUS) are less invasive but considered less accurate than CT. The aim of this study was to determine the diagnostic accuracy of imaging modalities used to detect endoleak. Accordingly, we undertook a systematic review and meta-analysis of the evidence base for USS and CEUS compared to CT following EVAR. **METHODS:** Medline, Embase, trial registries, conference proceedings and article reference lists were searched to identify trials comparing USS or CEUS with CT following EVAR. Contrast-enhanced computed tomography was taken as the 'gold-standard' investigation. USS and CEUS were compared to CT in separate meta-analyses. **RESULTS:** Twenty-one studies in 2601 patients compared USS with CT. The sensitivity of USS at detecting endoleak was 0.77 (95% CI 0.64-0.86; I(2)=0.82) and pooled specificity 0.94 (95% CI 0.88-0.97; I(2)=0.90). Seven studies (288 patients) compared CEUS vs CT. The pooled sensitivity was 0.98 (95% CI 0.90-0.99; I(2)=0.32) and specificity 0.88 (95% CI 0.78-0.94; I(2)=0.67). **CONCLUSION:** This study confirms that unenhanced USS has poor sensitivity for endoleak detection; however CEUS is a highly sensitive modality. These results should be interpreted with some caution due to heterogeneity in analysed trials and further research is needed to evaluate the efficacy of CEUS before it can be utilised as the primary imaging modality for EVAR surveillance.

17. Eur J Vasc Endovasc Surg. 2010 Apr;39(4):381-7. Epub 2010 Jan 8.

The use of contrast enhanced ultrasound in carotid arterial disease.

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Traditionally, stroke risk stratification has centred on the degree of internal carotid artery stenosis, and the presence of focal neurological symptoms. However, degree of stenosis alone is a relatively poor predictor of future stroke in asymptomatic patients; the Asymptomatic Carotid Surgery Trial highlighting the need to identify a subgroup of asymptomatics that may benefit from intervention. Attempting to define this subgroup has inspired imaging research to identify, in vivo, high-risk plaques. In addition to pre-operative risk stratification of carotid stenosis, contrast enhanced ultrasound (CEUS) may be employed in monitoring response to plaque-stabilising therapies. Unlike most contrast agents used for computed tomography and magnetic resonance imaging, microbubbles used in CEUS remain within the vascular space and can hence be used to study the vasculature. In addition to improving current carotid structural scans, CEUS has potential to add extra information on plaque characteristics. Furthermore, by targeting microbubbles to specific ligands expressed on vascular endothelium, CEUS may have the ability to probe plaque biology. This review describes the current carotid ultrasound examination and the need to improve it, rationale for imaging neovascularisation, use of CEUS to image neovascularisation, microbubbles in improving the structural imaging of plaque, potential problems with CEUS, and future directions.

18. Abdom Imaging. 2010 Feb;35(1):106-14. Epub 2009 May 15.

Endoleaks after endovascular repair of abdominal aortic aneurysm: value of CEUS.

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Endovascular repair (EVAR) is playing an increasingly role in the treatment of abdominal aortic aneurysm. A successful procedure depends on the complete sealing of the aneurysm sac from blood flow to achieve general pressure relief and avoid aneurysm rupture, with a shrinkage of the aneurysm sac. The most common complication of EVAR is endoleak that is the persistence of perigraft flow within the aneurysm sac, which has to be considered the major cause of enlargement and rupture of the aneurysm, and the main indication for surgical late conversion. For this reason, strict surveillance of these patients is mandatory for the early detection of endoleaks and the preferred method of follow-up is represented by CT angiography. However, CTA has limitations. The investigation is repeated several times, making radiation exposure a necessary concern. Therefore, it would be useful to have another reliable diagnostic examination during follow-up. Color duplex ultrasound is non-invasive, does not use radiation or contrast medium, is less expensive, easy to perform and widely available. However, this technique obtained poor results in terms of sensitivity in the detection of endoleaks. In the last years, the introduction of ultrasound contrast agents and contrast-specific imaging has, however, rekindled interest in this modality and its potential for replacing of CTA in routine surveillance. The purpose of this

review is to highlight the diagnostic value of CEUS in the post-EVAR endoleaks detection.

19. Clin Hemorheol Microcirc. 2010;46(2-3):127-37.

Diagnosis, therapy monitoring and follow up of renal artery pseudoaneurysm with contrast-enhanced ultrasound in three cases.

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PURPOSE: We describe the presentation of renal artery pseudoaneurysm (RAP) in different imaging modalities (CT, DSA, standard US, contrast enhanced ultrasound (CEUS)). In particular the benefit of CEUS with regards to therapy monitoring and follow up care shall be highlighted. MATERIALS AND METHODS: Three patients with renal artery pseudoaneurysm after renal surgery were investigated with CT and/or US (grey-scaled US, color duplex US, CEUS), respectively. The therapy (angiography-coiling) was monitored using contrast-enhanced ultrasound. RESULTS: Accurate diagnosis of RAP in our study was yielded using color duplex US and CEUS. CEUS was very practical for therapy monitoring of coil embolization with the potential of shortening the invasive DSA. Thus, CEUS has potential of radiation dose reduction and the potential of saving coils with the result of cost reduction. CONCLUSION: CEUS is an appropriate approach for monitoring coil embolization of RAP.

20. Clin Hemorheol Microcirc. 2010;45(1):19-25.

Comparison of time-resolved CT-angiography, contrast-enhanced ultrasound and digital subtraction angiography in a patient with a small type II endoleak after endovascular aneurysm repair.

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We report discordant imaging findings of a small persistent type II endoleak in a 72-year-old man who had undergone endovascular aneurysm repair (EVAR) of an abdominal aortic aneurysm. Although the aneurysm was growing in size digital subtraction angiography could not detect an endoleak, but time-resolved CT-angiography and contrast enhanced ultrasound did detect a small type II endoleak.

21. Eur J Radiol.. [Epub ahead of print]

Comparison of transient arterial occlusion and muscle exercise provocation for assessment of perfusion reserve in skeletal muscle with real-time contrast-enhanced ultrasound.

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OBJECTIVE: Contrast-enhanced ultrasound (CEUS) is able to quantify muscle perfusion and changes in perfusion due to muscle exercise in real-time. However, reliable measurement of standardized muscle exercise is difficult to perform in clinical examinations. We compared perfusion reserve assessed by CEUS after transient arterial occlusion and exercise to find the most suitable measurement for clinical application. **METHODS:** Contrast pulse sequencing (7MHz) during continuous IV infusion of SonoVue((R)) (4.8mL/300s) was used in 8 healthy volunteers to monitor muscle perfusion of the gastrocnemius muscle during transient (1min) arterial occlusion produced by a thigh cuff of a venous occlusion plethysmograph. Isometric muscle exercise (50% of individual maximum strength for 20s) was subsequently performed during the same examination, and several CEUS parameters obtained from ultrasound-signal-intensity-time curves and its calculation errors were compared. **RESULTS:** The mean maximum local blood volume after occlusion was 13.9 [approximately mL] (range, 4.5-28.8 [approximately mL]), and similar values were measured after sub-maximum exercise 13.8 [approximately mL], (range, 4.6-22.2 [approximately mL]). The areas under the curve during reperfusion vs. recovery were also similar (515.2+/-257.5 compared to 482.2+/-187.5 [approximately mLs]) with a strong correlation ($r=0.65$), as were the times to maximum (15.3s vs. 15.9s), with a significantly smaller variation for the occlusion method (+/-2.1s vs. +/-9.0s, $p=0.03$). The mean errors for all calculated CEUS parameters were lower for the occlusion method than for the exercise test. **CONCLUSIONS:** CEUS muscle perfusion measurements can be easily performed after transient arterial occlusion. It delivers data which are comparable to CEUS measurements after muscle exercise but with a higher robustness. This method can be easily applied in clinical examination of patients with e.g. PAOD or diabetic microvessel diseases to assess perfusion reserve.

22. Radiologe. 2009 Nov;49(11):1033-9.

[Imaging of endoleaks after endovascular aneurysm repair (EVAR) with contrast-enhanced ultrasound (CEUS)].

[Article in German]

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Endoleaks following endovascular aneurysm repair (EVAR) are common and present a diagnostic challenge in the follow-up after EVAR. Contrast-enhanced ultrasound (CEUS) is a promising new method for the diagnosis and follow-up of endoleaks. CEUS with SonoVue allows a rapid and non-invasive diagnosis in the follow-up after EVAR. The sensitivity and specificity of conventional ultrasound compared to the multislice CT angiography is estimated to be 33-63% and 63-93%, respectively. These values can be increased through the use of CEUS in up to 98-100% (sensitivity) and 82-93% (specificity). This article describes the etiology, classification and importance of different types of endoleaks. The value of CEUS in this clinical scenario will be discussed.

23. Stroke. 2009 Oct;40(10):3238-44. Epub 2009 Aug 6.

Consensus recommendations for transcranial color-coded duplex sonography for the assessment of intracranial arteries in clinical trials on acute stroke.

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BACKGROUND AND PURPOSE: Transcranial color-coded duplex sonography has become a standard diagnostic technique to assess the intracranial arterial status in acute stroke. It is increasingly used for the evaluation of prognosis and the success of revascularization in multicenter trials. The aim of this international consensus procedure was to develop recommendations on the methodology and documentation to be used for assessment of intracranial occlusion and for monitoring of recanalization. **METHODS:** Thirty-five experts participated in the consensus process. The presented recommendations were approved during a meeting of the consensus group in October 2008 in Giessen, Germany. The project was an initiative of the German Competence Network Stroke and performed under the auspices of the Neurosonology Research Group of the World Federation of Neurology.

RESULTS: Recommendations are given on how examinations should be performed in the time-limited situation of acute stroke, including criteria to assess the quality of the acoustic bone window, the use of echo contrast agents, and the evaluation of intracranial vessel status. The important issues of the examiners' training and experience, the documentation, and analysis of study results are addressed. One central aspect was the development of standardized criteria for diagnosis of arterial occlusion. A transcranial color-coded duplex sonography recanalization score based on objective hemodynamic criteria is introduced (consensus on grading intracranial flow obstruction [COGIF] score). **CONCLUSIONS:** This work presents consensus statements in an attempt to standardize the application of transcranial color-coded duplex sonography in the setting of acute stroke research, aiming to improve the reliability and reproducibility of the results of future stroke studies.

24. Ultrasound Med Biol. 2009 Oct;35(10):1587-95. Epub 2009 Aug 13.

Real-time contrast-enhanced ultrasound for the assessment of perfusion dynamics in skeletal muscle.

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We developed a real-time low-MI contrast-enhanced ultrasound method (CEUS), compared it with venous occlusion plethysmography (VOP) and evaluated its robustness in the quantification of skeletal muscle perfusion during exercise. Contrast pulse sequencing (7 MHz) during continuous intravenous infusion of SonoVue (4.8 mL/300 s) was used repeatedly in eight healthy volunteers to monitor changes of the muscle perfusion before, during and after isometric exercises (10 to 50% of individual maximum strength for 20 to 30 s) of the gastrocnemius muscle in real time. CEUS was correlated with VOP at different time points, and the exactness of several CEUS parameters obtained from ultrasound-signal-intensity-time curves was evaluated. Real-time CEUS depicted a large variability of the skeletal muscle blood volume at rest (mean, 3.48; range, 0.60 to 9.92 [approximately mL]), with a significant reproducibility ($r=0.72$, $p<0.05$) and correlation with VOP ($r=0.59$, $p<0.001$). Mean blood volume during exercise was 1.58 (approximately mL), increased to a mean maximum after exercise of 8.88 (approximately mL), the mean change of the local blood volume during and directly after the exercise was -0.10 and +1.57 (approximately mL/s). The average CEUS signal during exercise decreased (mean area under the curve, -50.4 [approximately mL.s]) and subsequently increased post exercise (mean 118.6 [approximately mL.s]). CEUS parameters could be calculated with mean relative errors between 6 and 36%. Continuous assessment of local muscle microcirculation during exercise is possible with real-time CEUS with an acceptable robustness. Its application may be of particular interest in a better understanding of the role of perfusion during muscle training, and the monitoring of pathological vascular response, such as in diabetic microvessel diseases.

25. J Vasc Surg. 2009 Mar;49(3):552-60. Epub 2009 Jan 9.

Contrast-enhanced ultrasound versus color duplex ultrasound imaging in the follow-up of patients after endovascular abdominal aortic aneurysm repair.

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PURPOSE: This study assessed the negative predictive value, sensitivity, specificity, and diagnostic accuracy of real-time contrast-enhanced ultrasound imaging (CEUS) in the detection of endoleaks in patients with abdominal aortic aneurysm (AAA) who underwent endovascular repair (EVAR) compared with unenhanced ultrasound imaging. Computed tomography angiography (CTA) was the gold standard. The secondary objective was to define the optimal dose of the second-generation contrast agent to routinely use in the CEUS examinations for endoleak detection. **METHODS:** The study enrolled 84 patients with unruptured AAA who were treated with EVAR and underwent CTA follow-up. In the same day, CTA (4- x 1-mm collimation, 1.25-mm slice width), unenhanced US imaging and CEUS imaging was performed in all patients. The CEUS studies were performed after an intravenous bolus injection of 1.2 mL and 2.4 mL of a second-generation contrast agent with continuous low-mechanical index (range, 0.01-0.04) real-time tissue harmonic imaging. The unenhanced US and CEUS studies were interpreted separately by two independent experienced readers to detect the presence of endoleaks by viewing recorded videotapes according to a five-point confidence scale. The standard of reference was represented by the consensus reading of CTA performed by two experienced radiologists not involved in the image analysis. Qualitative analysis as well as sensitivity, specificity, negative predictive value, and diagnostic accuracy in detecting endoleaks of each reading session were compared. **RESULTS:** CEUS imaging significantly improved the diagnostic performance of unenhanced US studies in the detection of endoleaks in terms of sensitivity (97.5% vs 62.5%), negative predictive value (97.3% vs 65.1%), accuracy (89.3% vs 63.1%), and specificity (81.8% vs 63.6%). The optimal dose of contrast agent to detect and characterize endoleaks was 2.4 mL. No adverse events were recorded during the study. **CONCLUSIONS:** The results showed CEUS imaging is a fast, noninvasive, reliable, and valid alternative to multislice CTA for endoleak detection in endovascular aortic stent graft patients, and is superior to unenhanced US imaging. Contrast-enhanced ultrasound imaging should be performed using a recommended contrast medium dose of 2.4 mL.

26. Atherosclerosis. 2009 Feb;202(2):505-12. Epub 2008 Jun 3.

Simplified contrast ultrasound accurately reveals muscle perfusion deficits and reflects collateralization in PAD.

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BACKGROUND: Simplified contrast-enhanced ultrasound (CEUS) can be used to evaluate muscle perfusion in peripheral arterial disease (PAD). Here, we report its diagnostic accuracy for detecting symptomatic PAD. Additionally, we hypothesize that the extent of collateral formation is reflected by CEUS. **METHODS:** Ultrasound contrast agent was injected into an antecubital vein of 58 control subjects and 52 symptomatic PAD patients and its appearance in the calf muscle was evaluated. Interreader variability was tested using 118 raw data films. Arterial collateralization of PAD patients was assessed by angiographic imaging. **RESULTS:** PAD patients showed a significantly longer median time to peak intensity (TTP, 36.9s) than control subjects (19.4s, $p < 0.001$) with longer TTPs in advanced PAD stages. The area under the receiver operating characteristic curve was 0.942 and the mean TTP difference between two blinded readers was 0.28s. A TTP cut off at 30.5s was associated with 91% positive predictive value. PAD patients with good collateralization showed a significantly shorter TTP (34.1s) than patients with poor collateralization (44.0 s, $p = 0.008$) but not a higher ankle-brachial index (ABI). **CONCLUSIONS:** CEUS accurately displays perfusion deficits of the calf muscle in symptomatic PAD patients. The degree of arterial collateralization is reflected by CEUS and not by ABI.

27. Cerebrovasc Dis. 2009;27 Suppl 2:25-39. Epub 2009 Apr 16.

Ultrasound contrast agents in ischemic stroke.

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The general indication for the use of ultrasound contrast agents in neurosonologic applications is an insufficient signal-to-noise ratio when investigating the cerebral macro- and microcirculation. Clinical problems that are often encountered in native sonography are 'no flow, slow flow and low flow' phenomena. In these cases, ultrasound contrast agents are used to differentiate between vessel occlusion and insufficient insonation conditions, as well as for the detection of very slow blood flow velocities and low flow volumes. Echo-contrast agents significantly increase the success rate of transcranial color duplex examinations of patients with acute cerebrovascular disease. Ultrasound contrast imaging also allows assessment of the cerebral microcirculation. There are a number of techniques available for performing perfusion studies. These generally utilize high mechanical index imaging, since until recently lower acoustic outputs were unable to detect microbubbles in the brain. New-generation microbubbles in combination with very sensitive contrast-specific ultrasound techniques now enable real-time visualization of stroke. Moreover, destruction sequences with assessment of microbubble replenishment using real-time,

low mechanical index imaging are now available. This article reviews of state-of-the-art contrast-specific imaging techniques for ultrasound evaluation of acute stroke patients.

28. Cerebrovasc Dis. 2009;27 Suppl 1:9-18. Epub 2009 Apr 3.

Update on ultrasound techniques for the diagnosis of cerebral ischemia.

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Ultrasound (US) techniques increase the ability of neurologists specializing in stroke to rapidly evaluate stroke patients, determine likely mechanisms of brain ischemia, determine arterial patency, quantify stenosis severity, and determine the most appropriate clinical management. Furthermore, the development of new US techniques based on the detection of US contrast agents may permit the evaluation of cerebral microcirculation and the identification of regions of angiogenesis, inflammation and thrombus during brain ischemia.

29. Clin Hemorheol Microcirc. 2009;43(1):129-39.

Contrast-enhanced ultrasound versus conventional ultrasound and MS-CT in the diagnosis of abdominal aortic dissection.

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PURPOSE: To evaluate the diagnostic results of different ultrasound techniques: B-scan, color-coded Doppler sonography (CCDS) and contrast-enhanced ultrasound in the diagnosis of abdominal aortic dissection in comparison to multislice computed tomography (MS-CT). **MATERIALS AND METHODS:** Between March 2006 and December 2008, 35 patients (28 males, 7 females) with a mean age of 58 years (range 37-87 years) with abdominal aortic dissection and 15 patients (11 males, 4 females) with a mean age of 53 years (range 42-78 years) without abdominal aortic dissection as a control group were examined with B-scan, CCDS and contrast-enhanced ultrasound (CEUS) after injection of 1.0-1.2 cc of SonoVue (Bracco, Italy). The examinations were performed using a Sequoia 512 (Siemens/Acuson, Mountain View) system with CPS software. Standardized MS-CTA using a 16 or 64 row scanner (Somatom Sensation 16 or 64, Siemens Medical Systems, Forchheim, Germany) served

as the reference standard. **RESULTS:** The sensitivity of B-scan and CCDS for detecting abdominal aortic dissections were both 23/35 (68%); for contrast-enhanced ultrasound it was 34/35 (97%). Dissection membrane, differentiation of true and false lumen and flow direction within the true and false lumen were better detected by CEUS than by CCDS. The lack of angle dependence of the US probe and lack of flow and pulsations artifacts in CEUS made the examination procedure easier. All findings were confirmed by MS-CT. **CONCLUSION:** With contrast-enhanced ultrasound, diagnostic accuracy sensitivity and specificity for the diagnosis of abdominal aortic dissections is improved as compared to B-scan and CCDS. Dissection membrane and flow within the true and false lumen are clearly differentiated by CEUS. Thus CEUS is a promising alternative for patients whose condition does not allow an examination by CTA.

PMID: 19713607 [PubMed - indexed for MEDLINE]

30. Clin Hemorheol Microcirc. 2009;43(1):119-28.

Contrast harmonic imaging ultrasound and perfusion imaging for surveillance after endovascular abdominal aneurysm repair regarding detection and characterization of suspected endoleaks.

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OBJECTIVE: Is Contrast Harmonic Imaging (CHI) comparable to computed tomography angiography (CTA) scan in detecting and characterizing suspected endoleaks after endovascular abdominal aneurysm repair in a non-selected group including reintervention procedure and branched endografts in daily practice?

MATERIAL/METHODS: In a prospective study computed tomography angiography (CTA) and contrast-enhanced ultrasound (CEUS) were performed in 30 consecutive patients (26 males, 4 females, mean age: 72 years, range: 38-87) with suspected endoleaks in follow-up (mean 13 months, range: 1-95) after endovascular abdominal aneurysm repair or procedure in dissection or penetrated ulcer of the aorta (25 infrarenal, 5 suprarenal stent grafts, mean aortic diameter 56 mm, range: 27-98). CTA was supposed to be gold standard for determining the presence of endoleaks (multislice CT, collimation 16 x 0.75 mm, 100 ml of iodized contrast agent bolus). Ultrasonography used a multi-frequency probe (1-4 MHz) with the modalities of colour coded Doppler sonography (CCDS), power Doppler (PD) combined with contrast enhancement and the technique of contrast harmonic imaging (CHI) and low mechanical index (MI < 0.2). 2.4 ml of SonoVue (Bracco, Altana Pharma GmbH, Italy) were administered to each patient intravenously as a bolus injection. **RESULTS:** Out of 30 patients, 21 endoleaks were identified in CTA (6 type I or III, 15 type II), 22 in CHI. Thus, sensitivity for CHI was therefore 99%, its specificity 85% (Spearman correlation

coefficient (CC) 0.92). In follow-up the localizations of endoleak type I or III exclusively detected by CHI were confirmed as true positive by angiography. Due to its dynamic characteristic CHI seemed to be more helpful in characterization of endoleaks than CTA. In case of a rupture after reintervention a type III endoleak leads to prompt intervention before receiving the result of the CT scan. Altogether, CHI failed to identify 1 combined type I and II endoleak (sensitivity 0.99). Both, CCDS and PD were positive only in 6/30 patients (CC 0.33 and 0.39). Interestingly the application of contrast agent doubles the detection rate of endoleaks (12/30) in CCDS and PD (CC 0.39). **CONCLUSION:** Contrast harmonic imaging (CHI) compared to computed tomography angiography (CTA) accurately depicts endoleaks after endovascular abdominal aneurysm repair and stent-graft procedure in dissected and ulcerated aorta. It seems to be superior in characterization of the type of endoleaks and can be established in order to reduce iodized contrast agent and radiation exposure in follow-up. In contrast to CTA scan CHI can be offered to patients with chronic renal insufficiency and allows a dynamic examination and a perfusion analysis.

31. Clin Hemorheol Microcirc. 2009;41(3):151-68.

Imaging of endoleaks after endovascular aneurysm repair (EVAR) with contrast-enhanced ultrasound (CEUS). A pictorial comparison with CTA.

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Endoleaks following endovascular aneurysm repair (EVAR) are common and present a diagnostic challenge in the follow-up after EVAR. Contrast-enhanced ultrasound (CEUS) with low mechanical index (low MI) is a promising new method for the diagnosis and follow-up of endoleaks. CEUS with SonoVue allows a more rapid and noninvasive diagnosis, especially in critical patients owing to its bedside availability. This review describes the etiology, classification and importance of different types of endoleaks and compares CEUS findings with computed tomography angiography (CTA), allowing the reader to appreciate the usefulness of CEUS in this clinical situation.

32. J Radiol. 2009 Jan;90(1 Pt 2):141-7.

[Follow up of endovascular abdominal aortic aneurysm repair with contrast ultrasound].

[Article in French]

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Endovascular aortic aneurysm repair (EVAR) is a widely accepted treatment for anatomically fitted abdominal aortic aneurysms. The increasing use of this procedure has prompted the need for close surveillance and reliable post-operative imaging. The current tool for assessing EVAR technical success is to perform computed tomography angiography (CTA) in order to exclude endoleaks and to confirm the exclusion of the aneurysm sac. Contrast enhanced ultrasound with low mechanical index is a promising method for follow-up of patients after EVAR. It seems to allow better identification and characterization of endoleaks than unenhanced ultrasound and even than CTA for very low flow endoleaks.

33. J Radiol. 2009 Jan;90(1 Pt 2):123-38; quiz 139-40.

[Guidelines for contrast enhanced ultrasound (CEUS)--update 2008].

[Article in French]

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These new recommendations are following the text published in 2004 by the group of experts of the EFSUMB that was augmented to reevaluate the indications of ultrasound contrast agents. Initially limited to focal liver lesions, new recommendations include the study of renal and pancreatic diseases, as well as vesico-ureteric reflux, blunt abdominal trauma and trans-cranial Doppler. Contrast-enhanced ultrasound improves the diagnosis of renal pseudo-tumors but does not allow characterization of solid focal masses. Its major contribution includes characterization of complex cystic masses, diagnosis of peripheral vascular disorders such as infarction and cortical necrosis, and radiofrequency ablation follow-up. It is also useful for the study of pancreatic masses visible at ultrasound in order to improve lesion visualization and characterization (adenocarcinoma and neuro-endocrine tumors), as well as for vascular staging.

34. Nucl Med Rev Cent East Eur. 2009;12(2):95-8.

Contrast-enhanced ultrasonography versus computed tomographic angiography in the monitoring of patients after endovascular repair of abdominal aortic aneurysm -- preliminary experience.

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BACKGROUND: Computed tomographic angiography (CTA) is routinely used in the monitoring of patients after endovascular repair of abdominal aortic aneurysm. The aim of the study was to determine if contrast-enhanced ultrasonography (CEUS) provides equivalent results to CTA in detection of endo-leaks in patients after abdominal aortic stentgraft placement. **MATERIAL AND METHODS:** In a group of 7 patients (6 men and 1 woman; aged 71+/-7 years) after repair procedure, 16 CTA and 16 CEUS follow-up examinations were performed. Second-generation contrast agent (Sonovue) and low-mechanical index technique were used for ultrasonography imaging. **RESULTS:** Computed tomographic angiography showed seven cases of type I, five cases of type II, and no endo-leaks in four examinations. In 15 out of 16 studies, the results of CEUS were consistent with the results of CTA. In one discrepant study, type II endo-leak was detected with CEUS while CTA was negative. **CONCLUSIONS:** Contrast-enhanced ultrasonography and CTA examinations in patients after endovascular repair of abdominal aortic aneurysm provide comparable results. CEUS may be considered an alternative technique to CTA.

35. Interact Cardiovasc Thorac Surg. 2008 Oct;7(5):781-4. Epub 2008 Jul 2.

Translumbar treatment of type II endoleaks after endovascular repair of abdominal aortic aneurysm.

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The modality of treatment and the appropriate time point to treat type II endoleaks after endovascular repair of abdominal aortic aneurysms (EVAR) remain controversial issues. The purpose of the present study was to assess the efficacy of translumbar embolization of type II endoleaks after endovascular repair of aortic aneurysm repair. Eighty-four consecutive patients after EVAR were analyzed for the onset of type II endoleaks. Of these, five patients had experienced translumbar embolization after ineffective intraarterial approach to exclude the endoleak. A combination of several liquid embolic agents was used as sealant. Post-procedural contrast-enhanced ultrasound (CEUS) was used to document the outcome of the embolization. Translumbar embolization was successful in four patients. Complete sealing of the nidus was seen on CEUS 24 h after the procedure. In one patient with a duplication of the inferior vena cava, the procedure was aborted because an additional type Ib endoleak was found. The procedure was well tolerated by all patients. The translumbar approach to treat growing aneurysm sacs in patients with persistent type II endoleaks is safe and well tolerated. The immediate post-interventional outcome as documented on CEUS is promising. Long-term follow-ups are yet to be performed.

36. Ultrasound Q. 2008 Sep;24(3):167-71.

Comparison of duplex and nonduplex transcranial Doppler ultrasonography.

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Transcranial Doppler ultrasonography is essential in the management of children with sickle cell anemia and is a valuable adjunct to the evaluation of a variety of intracranial pathologies in children and adults, including vasoconstriction caused by subarachnoid hemorrhage, demonstration of major intracranial vessel stenoses or occlusion, determination of brain death, demonstration of the nidus of arteriovascular malformations, and assessment of cerebral hemodynamics after trauma, stroke, or migraine. There are 2 types of transcranial Doppler equipment currently available: nonduplex (nonimaging) and duplex (imaging). The purpose of this review is to compare and contrast the clinically relevant differences between these 2 types of equipment.

37. J Thromb Thrombolysis. 2008 Apr;25(2):219-23. Epub 2007 May 20.

Microbubble potentiated transcranial duplex ultrasound enhances IV thrombolysis in acute stroke.

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BACKGROUND: We studied whether 2 MHz transcranial color-coded duplex ultrasound (TCCD), combined with a second generation ECA, accelerate IV rtPA-thrombolysis in the acute phase of MCA stroke more than TCCD monitoring alone. **METHODS:** Non-randomized acute MCA stroke patients undergoing IV rtPA-thrombolysis and 2 MHz-TCCD monitoring over 60 min, with (N = 11) or without (N = 15) additional continuous ECA (5 ml, SonoVue perfusion, were compared. Recanalization of the MCA was measured pre- and post-thrombolysis with the thrombolysis in brain ischemia (TIBI) grading system, clinical outcome was assessed at admission and 24 h after treatment using the NIH stroke scale (NIHSS). **RESULTS:** Patients who received ECA improved their NIHSS significantly more than those who were only TCCD monitored (Mann-Whitney U = 48.0; P = 0.050), and their flow signal improved more (Mann-Whitney U = 40.0; P < 0.03). **CONCLUSIONS:** The results of this pilot study show that in IV-thrombolysis the use of ECA in addition to TCCD monitoring lead to a greater immediate clinical improvement and to a better flow signal.

38. Clin Hemorheol Microcirc. 2008;40(4):267-79.

Imaging of aortic lesions with color coded duplex sonography and contrast-enhanced ultrasound versus multislice computed tomography (MS-CT) angiography.

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PURPOSE: The purpose of this study was to compare color coded duplex sonography (CCDS), contrast-enhanced ultrasound (CEUS) and multislice computed tomography (MS-CT) angiography in pathological aortic lesions. MATERIAL AND METHODS: 36 patients with a mean age of 71 years (range 51-87 yrs) with known or suspected treated and untreated aortic lesions detected by CTA were included in this prospective study. Standardized MS-CTA using a 16 or 64 row scanner (Somatom Sensation 16 or 64, Siemens Medical Systems, Forchheim, Germany) served as reference standard. The patients were examined with CCDS and CEUS (Logiq 9, General Electrics, Milwaukee, WI) using the low MI technique with intravenous injection of 1.6-2.4 ml SonoVue (Bracco, Italy). Contrast enhanced ultrasound was performed in the arterial, venous and late venous phase. RESULTS: In all patients CEUS resulted in a relevant diagnosis of an aortic pathology. In total, two covered ruptures, nine aortic dissections and five aortic aneurysms were detected. In the routine follow-up of 20 patients following endovascular repair (EVAR) of abdominal aortic aneurysm (AAA), one type 3 and three type 2 endoleaks after γ -stent graft were detected. For presurgical planning, in addition to the perfused true and false lumen after dissection the perfusion of the renal arteries was examined. CONCLUSION: CEUS with SonoVue allows the evaluation of aortic lesions. It is an additional examination to CTA. It may allow a more rapid and noninvasive diagnosis, especially in critical patients from intensive care units because of its bedside availability. As the examination is dynamic, additional information about blood flow in the true and false lumen and about renal perfusion after dissections can be evaluated. Especially in patients with contraindications to CT contrast agents (e.g. due to renal failure or severe allergy), CEUS provides a good alternative to MS-CT.

39. Clin Hemorheol Microcirc. 2008;39(1-4):147-54.

Contrast-enhanced ultrasound versus CT and operative findings in evaluation of renal vein aneurysm with AV fistula.

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We report the case of a 61-year-old patient admitted to our hospital owing to recent nonspecific abdominal pain. Five years earlier he had been treated with a graft owing to thoracic and abdominal aortic aneurysm with dissection. He now showed a left renal vein aneurysm with a diameter of 11x7.5 cm. This case demonstrates that contrast enhanced ultrasound (CEUS), employed in addition to computed tomography angiography, offers a promising new option for diagnosis and preoperative treatment planning in patients with abdominal vascular diseases. The results were compared with operative findings.

40. Clin Hemorheol Microcirc. 2008;39(1-4):121-32.

Color duplex ultrasound and contrast-enhanced ultrasound in comparison to MS-CT in the detection of endoleak following endovascular aneurysm repair.

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The purpose of this study was to compare Color Duplex Ultrasound (CDU), Contrast-Enhanced Ultrasound (CEUS) and Multislice Computed Tomography (MS-CT) angiography in the routine follow up of patients following Endovascular Repair (EVAR) of Abdominal Aortic Aneurysm (AAA). 43 consecutive patients with AAA underwent endovascular aneurysm repair and were imaged with CDU, CEUS and MS-CT angiography at regular intervals after the procedure. Each imaging modality was evaluated for the detection of endoleaks. The presence of endoleaks was analyzed and the conspicuity of findings was assessed. CTA was used as gold standard in determining the presence of endoleaks. CDU was true positive for endoleaks in 5/43 patients (11.6%) and false positive for endoleaks in 2/43 patients (4.6%). The sensitivity of CDU was therefore 33.3% and its specificity 92.8%; the positive and negative predictive values were 0.71 and 0.72, respectively. CEUS was true positive for the detection of endoleaks in 15/43 patients (34.9%) and false positive in 2/43 patients (4.6%). The sensitivity of CEUS was therefore 100% and its specificity 93%; the positive and negative predictive values were 0.88 and 1. In the follow up the two false positive endoleaks in CEUS were confirmed as true positive endoleaks by CEUS and MS-CT. In our small patient group, contrast-enhanced ultrasound seemed to be more accurately in demonstrating endoleaks after EVAR than MS-CT angiography and may be considered as a primary surveillance modality whereas duplex ultrasound scanning alone is not as sensitive as CEUS and MS-CT angiography in detection of endoleaks. Especially in patients with contraindications for CT contrast agents (e.g. due to renal failure or severe allergy) CEUS provides a good alternative to MS-CT.

41. Eur Neurol. 2008;59 Suppl 1:2-8. Epub 2008 Mar 26.

Clinical utility of contrast-enhanced ultrasound in neurosonology.

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Extracranial and transcranial colour-coded duplex sonography (TCCD) are used routinely in clinical practice to assess physiologic and pathologic arterial blood flow to the brain. Such investigations are straightforward, safe, and cost effective, and can be repeated frequently for patient follow-up. In addition, the portability of extracranial colour-coded duplex sonography and TCCD provides the option of bedside investigations, particularly useful for evaluation of the critically ill patient. However, duplex ultrasound can be hampered by insufficient acoustic penetration, an unfavourable insonation angle, or by conditions of low or no flow. Echocontrast agents capable of surviving pulmonary and capillary transit have been developed, and such agents increase the Doppler signal and, therefore, the success rate of neurosonographic investigations. Approximately 20% of TCCD studies involve poor insonation conditions and, therefore, the use of echocontrast agents is of particular interest for this application. Levovist and SonoVue are the two agents currently approved for use in neurosonography. Such agents have a relatively long-lasting effect (up to 7 min), and can be administered as a single injection or, alternatively, a fractionated injection protocol can be used, depending on the quality of the window.

42. J Neuroimaging. 1997 Apr;7 Suppl 1:S15-21.

Clinical experience with echo-enhanced transcranial Doppler and duplex imaging.

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Transcranial Doppler (TCD) and transcranial color-coded duplex sonography (TCCD) are ultrasound neuroimaging modalities that can provide useful diagnostic information on the intracranial vasculature with a high degree of safety. However, the skull can serve as an effective bone barrier, reducing reflected ultrasound signal by up to 100% in some patients and thereby challenging both technical quality and clinical interpretation of TCD and TCCD. Levovist is an IV ultrasound echo-enhancement agent that withstands passage through the heart and lung, increasing signal throughout the entire vascular pool. As part of European phase II and III clinical trials, this agent has been studied for utility of enhancement for TCD and TCCD studies in patients with signs and symptoms of cerebrovascular disease. All patients had either highly insufficient or nonexistent native signal on baseline transcranial ultrasound studies

before administration of Levovist. The agent was administered at concentrations of 200, 300, or 400 mg/ml, and studies were repeated. In all studies, 300 to 400 mg/ml was sufficient for enhancement, although in several phase II studies 300 mg/ml Levovist was the preferred dosage in terms of superior imaging with a low level of side effects. In a phase III study, Levovist improved diagnostic utility of TCD and TCCD without compromising safety. Reviews of clinical phase II and III studies show that echo enhancement with Levovist facilitates routine clinical investigation of intracranial vascular anatomy in patients with signs and symptoms of intracranial vascular disease. In patients with no native signal, Levovist-enhanced imaging permits visualization of small peripheral vessels, venous circulation, tissue characteristics, and perfusion data, with no significant loss of safety.