Evaluation of the clinical impact of CEUS in the treatment of abdominal aneurysms

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Endovascular aneurysm repair (EVAR) is an effective alternative treatment to open repair of abdominal aortic aneurysm [1] and the number of EVAR procedures carried out worldwide is continuously growing. Incomplete exclusion of the aneurysm sac from the circulation, defined as endoleak, is the most frequent complication after EVAR occurring in 10 % to 45 % of cases [2], and it can be associated with aneurysm enlargement and possibly rupture [3]. Thus, life-long surveillance of aortic stent grafts to detect endoleaks and other forms of device failure is required in patients who underwent EVAR. Despite its notable advantages, ultrasonography has not yet achieved reference standard status in the EVAR follow-up because of low diagnostic specificity and sensitivity. Recent studies on ultrasound examinations performed without contrast agents reported sensitivity rates ranging from 43 % to 97 %. These wide differences suggest that this method does not guarantee the necessary reliability [4,5]. Therefore, to date computed tomography angiography (CTA) is the preferred imaging modality to follow up patients after EVAR. However, CTA surveillance carries the risks associated with radiation and contrast media exposure. Magnetic resonance angiography (MRA) and contrast-enhanced ultrasonography (CEUS) have been shown in some studies to offer better accuracy than CTA [6, 7–13]. However, there is no consensus with regard to optimal work-up with diagnostic imaging modalities in surveillance after EVAR. In our study published in EJVES [14] we compared color Doppler ultrasonography (CDUS), CEUS, CTA and MRA in order to identify the most effective imaging work-up for the above mentioned patients.

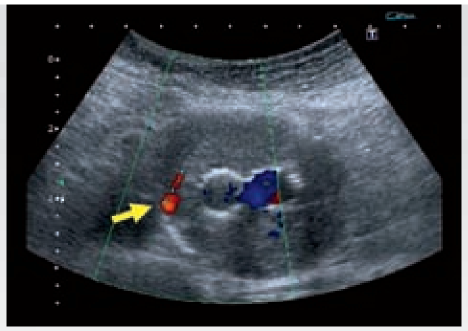

Fig. 1a: Color Doppler US: color flow signal within the aneurysmal sac, on the right side.

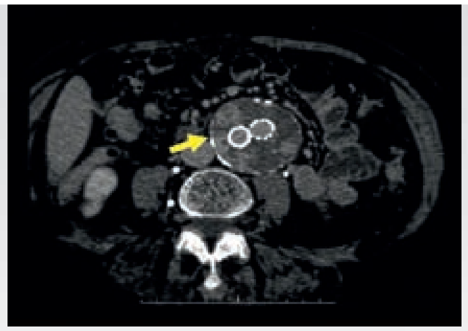

Fig. 1b: MRA with focal contrast-enhancement on the right and posterior site.

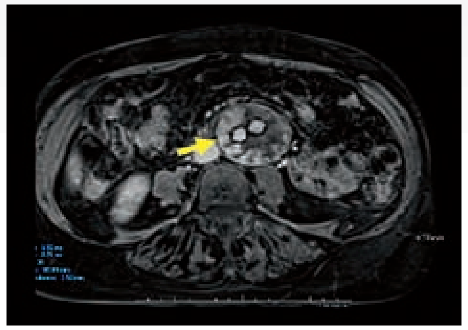

Fig. 1c: CTA with similar findings to MRA.

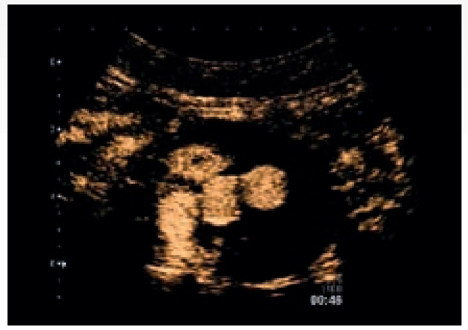

Fig. 1d: CEUS reveals type II endoleak due to lumbar artery revascularization.

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CDUS and CEUS examinations were performed with Aplio XG using a 3–5 MHz probe. The aneurysm sac size was measured in both anterior-posterior and transverse dimensions at its widest points and the mean values of these measurements were used for the purposes of this study. Arterial flow hemodynamics was documented throughout the stent graft with spectral Doppler velocity measurements. Color Doppler was adjusted for optimum sensitivity to slow flows, and the entire stent graft and aneurysm sac were scanned to detect any endoleak that might have been present. Any suspected endoleak was further documented for flow characteristics with spectral Doppler velocities. Subsequently, patients underwent CEUS with a 3-5-MHz probe and with a low mechanical index (varying from 0.06 to 0.10; about 35–45 KPa), with Pulse Subtraction Contrast Harmonic Imaging. These imaging techniques enable selected tuning of the signal from the contrast agent microbubble resonance, notably filtering tissue echoes. A second-generation contrast agent (SonoVue, Bracco, Milan, Italy) was injected intravenously in all cases.

In conclusion, CDUS is inadequate for the surveillance of patients after EVAR. Endoleak detection in patients with MR imaging-compatible stents is relatively more sensitive as shown in previous papers [11,13] and confirmed by the findings of our study. In this study we observed a sensitivity and specificity of MRA in the detection of endoleak of 96 % and 100 %, respectively.

The results of the present prospective study indicate that CEUS is significantly more sensitive and specific than CDUS as far as the identification of leaks ($p<0.001$) is concerned, although not statistically significant more accurate than CTA and equal to MRA. In addition, CEUS allowed better classification of endoleaks in ten, two and one case compared with CDUS, CTA and MRA, respectively. It is noteworthy that in four cases CTA missed endoleaks or endotensions, since the aneurysm sac was increased. In two cases this was probably due to metallic artefacts, in the remaining two cases because the amount of endoleak was too small.

Regarding classification in two cases CTA and MRA had misdiagnosed an endoleak as type III while CEUS clearly showed inflow vessels such as lumbar hypertrophic arteries indicating a type II endoleak. Moreover CEUS, unlike CTA, provides hemodynamic information on blood flow and direction, in addition to the morphological evaluation, and allows real-time comparison of baseline and contrast images on one screen.

In conclusion, CDUS is inadequate for the surveillance of patients after EVAR. The results of the present study and the review of the literature showed that CEUS is an effective tool for surveillance after EVAR because it is fast, cheaper but as accurate as CTA or MRA, it can be repeated frequently even at bedside, also in the immediate postoperative period. The limitations of CEUS are mainly its operator dependency and patients' condition. Based on these findings, we do believe that CEUS is a valuable adjunctive imaging modality to CTA and MRA in detecting endoleaks after EVAR.

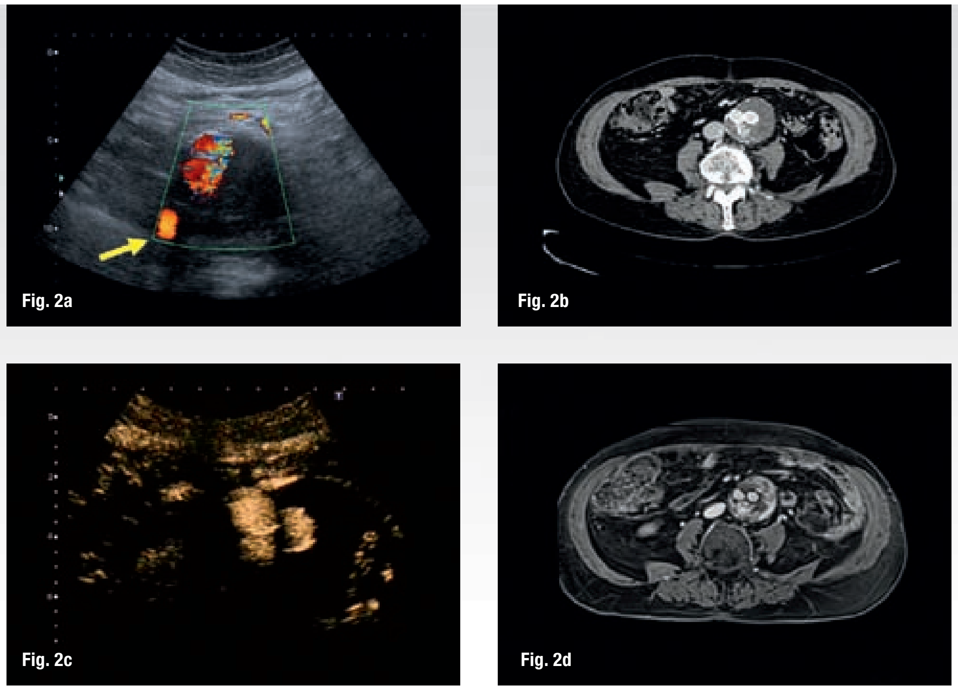

Fig. 2: Color Doppler US (a) shows no flow within the aneurysmal sac; hypertrophic lumbar artery (arrow). Focal contrast-enhancement behind the iliac branches during arterial phase consistent with II-type endoleak was detected at CTA (b), MRA (c) and CEUS (d).

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