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Contrast Enhanced Ultrasound can Replace Computed Tomography Angiography for Surveillance After Endovascular Aortic Aneurysm Repair

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WHAT THIS PAPER ADDS

Previous studies have been conducted either as duplex ultrasound (DUS) versus computed tomography angiography (CTA), or contrast enhanced (CEUS) versus CTA for endoleak detection after endovascular aneurysm repair (EVAR). In this study the performance of DUS and CEUS in post-EVAR endoleak detection was evaluated in 278 consecutive patients and the long-term clinical consequences of endoleaks not demonstrated by the two ultrasonic modalities were observed. Compared with endoleaks missed by CEUS, this study showed that endoleaks missed by DUS were more prone to have significant clinical implications. The study shows that future EVAR surveillance protocols can be carried out safely with CEUS, but the role of DUS remains limited to cases with stable residual sacs and freedom from endoleak on prior CEUS or CTA.

Objective/Background: Surveillance after endovascular aortic aneurysm repair (EVAR) is mandatory and computed tomography angiography (CTA) is considered the standard imaging modality, although patients are exposed to ionizing radiation and nephrotoxic contrast medium. The primary aim of this study was to determine the diagnostic efficacy of duplex ultrasound (DUS) and contrast enhanced ultrasound (CEUS) using CTA as the gold standard. The secondary aim was to determine the clinical consequences of endoleaks missed by DUS and CEUS, or CTA.

Methods: All patients with EVAR for an aorto-iliac aneurysm between 1 August 2011 and 31 October 2014 were prospectively and consecutively enrolled. CEUS was added to the existing surveillance protocol, which included DUS, plain abdominal X-ray, and CTA at 3 and 12 months after stent implantation.

Results: In 278 patients, endoleaks were detected in 68, 69, and 46 cases by CTA, CEUS, and DUS, respectively. The sensitivity and specificity of DUS and CEUS were 46% and 93%, and 85% and 95%, respectively. CEUS and CTA were diagnostically equivalent, as opposed to DUS and CTA ($p = .002$). Endoleaks detected by CTA led to re-intervention in 11 (4%) patients. These endoleaks were also detected by CEUS; however, three out of 11 patients were missed by DUS and underwent re-intervention: limb extension, re-cuff, and attempt to coil lumbar leaks. Endoleaks missed by CEUS or CTA were type II endoleaks without sac expansion.

Conclusion: In surveillance programs after EVAR a diagnostic CEUS examination may replace CTA.

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INTRODUCTION

Lifelong surveillance after endovascular aneurysm repair (EVAR) is necessary to detect endoleak and prevent rupture.[1] Thus far, computed tomography angiography (CTA) has been the preferred imaging modality for EVAR surveillance; however, it has significant drawbacks: risk of contrast induced nephropathy, stochastic risk of radiation induced cancer, and cost.[2–4] Conversely, duplex ultrasound (DUS) is harmless but criticized for inferior endoleak detection compared with CTA.[5] Ultrasound contrast agents increase the signal to noise ratio and thus the ability to discriminate persistent blood flow in the residual sac and thereby the conclusiveness of the ultrasound examination. The ability of contrast enhanced ultrasound (CEUS) to detect endoleak and direct re-intervention has been confirmed in a number of studies.[6–8] However, studies comparing DUS with CEUS in detecting endoleaks are sparse.[9] Moreover, the long-term clinical consequences of

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endoleaks missed by DUS or CEUS have not been addressed previously. The aims of this study were to compare the ability of DUS and CEUS to detect endoleaks using CTA as the gold standard, and to observe the course and consequence of undetected endoleaks in the clinical setting.

MATERIALS AND METHODS

Study design and patients

In a cross sectional and single center design, the ability to detect endoleaks with DUS and CEUS was compared using CTA as the gold standard. In order to determine the clinical implications of endoleaks missed by DUS, CEUS, and CTA, data from clinical follow up were prospectively recorded, and retrospectively analyzed in patients in whom an endoleak was seen with one imaging modality but not mutually confirmed by the other.

The post-EVAR surveillance program comprised plain abdominal X-ray, DUS, and CTA 3 and 12 months after EVAR. Standard surveillance thereafter did not include CTA and patients were therefore not recruited at time points beyond 12 months after EVAR (Fig. 1).[1] CTA showing a type I or type II endoleak with sac expansion $>$ 5 mm indicated re-intervention was required.

Between 1 August 2011 and 30 October 2014, CEUS was added to the standard post-EVAR surveillance at 3 or 12 months after stent implantation. The comparisons of DUS versus CTA and CEUS versus CTA were only performed once, at the patient's first visit. All patients were prospectively and consecutively recruited, and patients with endoleaks missed by one or two modalities were followed from recruitment until 30 October 2015, and their data were analyzed retrospectively (Fig. 1).

Patients who underwent EVAR for abdominal aortic aneurysm, or aorto-iliac or iliac aneurysms were eligible. Patients were excluded if they died between EVAR and the control visit, underwent post-EVAR surveillance at another institution, had impaired renal function and were unfit for CTA, were unwilling to give written informed consent, or were seen with complete residual sac resolution on DUS (Fig. 1).

CTA and ultrasound investigations were considered concurrent if they were done within 7 days. Commercially available EVAR devices (Zenith Flex®; Cook Medical, Bloomington, IN, USA) were inserted in all cases. The study was approved by the local ethics committee of Copenhagen (H-2-2011-016).

DUS

One investigator (K.K.B.) with 1 year's experience in vascular DUS, blinded to the results of CTA, performed all the DUS and CEUS investigations using a diagnostic ultrasound system

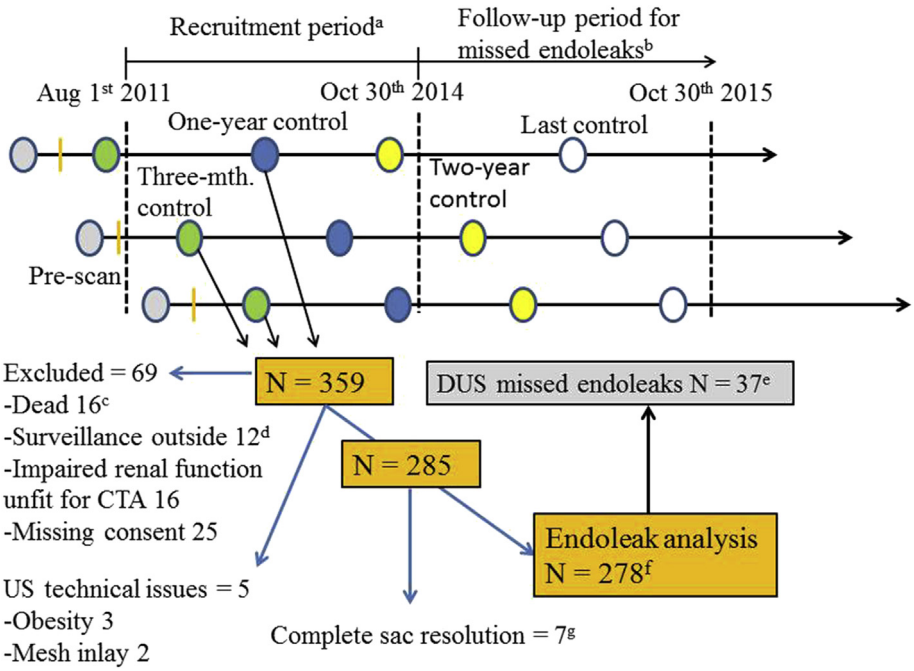

Figure 1. Study design and flow chart of patient selection. Gray circles: pre-operative scan. Green circles: 3 month standard surveillance (computed tomographic angiography [CTA], duplex ultrasound [DUS], X-ray, and contrast enhanced ultrasound [CEUS]). Blue circles: 1 year standard surveillance (CTA, DUS, X-ray, and CEUS). Yellow circles: standard surveillance beyond 1 year (follow up without CTA unless type II endoleak was seen at 1 year follow up with stable sac size). White circles: data from the last follow up visit were recorded for patients in whom CTA, CEUS, and DUS results at recruitment were in disagreement with regard to diagnosis of endoleak. *Note*. [a] Only the patient's first visit within the recruitment period was used for the comparative analysis in Table 3. [b] Follow up was specifically dedicated to patients with missed endoleaks on DUS that were confirmed on CTA, and the follow up period was extended to 1 year. [c] Died between endovascular aneurysm repair (EVAR) and scheduled date of control. [d] Patients were followed at another institution. [e] Patients with false negative DUS endoleak diagnosis at their first visit were followed for clinical consequences. [f] Of 278 patients, 215 (77%) patients were enrolled at the 3 month visit, and 63 (23%) patients at their 12 month visit as the latter group had their 3 month visit before study start. [g] Withdrawn owing to complete residual sac resolution on DUS.

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