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Magnetic Resonance Imaging with a Weak Albumin Binding Contrast Agent can Reveal Additional Endoleaks in Patients with an Enlarging Aneurysm after EVAR

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WHAT THIS PAPER ADDS

In patients with enlarging aneurysms of unknown origin after endovascular aneurysm repair, magnetic resonance imaging (MRI) with a weak albumin binding contrast agent has additional diagnostic value for both the detection and determination of the origin of the endoleak. Therefore, MRI should be considered in patients with aneurysm growth of unknown origin in cases where computed tomography angiography imaging does not reveal a clear cause.

Objectives/Background: To examine the additional diagnostic value of magnetic resonance imaging (MRI) after administration of a weak albumin binding contrast agent in post-endovascular aneurysm repair (EVAR) patients with aneurysm growth with no or uncertain endoleak after computed tomography angiography (CTA).

Methods: This was a prospective diagnostic cross sectional study carried out between April 2011 and August 2013. MRI was performed in all patients with aneurysm growth $\geq$ 5 mm after EVAR implantation and no or uncertain endoleak on CTA, or the inability, on CTA, to identify the source of a visible endoleak. All MRI scans were performed on a 1.5 T clinical MRI scanner after administration of a weak albumin binding contrast agent. The presence of endoleaks was assessed by visually comparing pre- and post-contrast T1-weighted images with fat suppression. Post-contrast images were acquired 5 and 15 minutes after contrast administration.

Results: Twenty-nine patients (26 men; 90%) with a median age of 74 years (interquartile range [IQR] 67–76) were included. The median interval between EVAR and MRI was 39 months (IQR 20–50). The median increase in maximum aneurysm diameter during total follow up after EVAR was 11 mm (IQR 6–17). At CTA, 16 patients (55%) had no detectable endoleak, five patients (17%) had suspected but uncertain endoleak, and eight patients had a definite endoleak (28%). On the post-contrast MRI images, endoleak was observed in 24 patients (83%). In all patients with uncertain endoleak on CTA, endoleak was detected with MRI. For type II endoleaks, feeding vessels were detected in 22/23 patients (96%) and these were all, except one, lumbar arteries.

Conclusion: In patients with enlarging aneurysms of unknown origin after EVAR, MRI with a weak albumin binding contrast agent has additional value for both the detection and determination of the origin of the endoleak.

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INTRODUCTION

Endovascular aneurysm repair (EVAR) is a suitable alternative for conventional open abdominal aortic aneurysm (AAA) repair. However, a common complication after EVAR is the occurrence of endoleak. Although the incidence of different types of endoleaks reported in the literature varies, and depends on patient selection and on the type of stent graft used, it is assumed type I endoleaks occur in 0–10% of patients and the incidence of type II endoleaks ranges from 10% to 25%.[1] Type III and type IV endoleaks are less common with the use of newer generation stent grafts.[1]

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Besides these four endoleak types, some authors consider endotension as the fifth type of endoleak. Endotension is defined as continued growth of the aneurysm sac after EVAR treatment without endoleak detected on computed tomography angiography (CTA).[2] Recent results from a study investigating a multicenter patient population showed that the 5 year post EVAR rate of AAA sac enlargement in a certain cohort of patients was 41%.[3] Aneurysm sac enlargement after EVAR may result in rupture with severe associated comorbidity and mortality.

Optimal non-invasive imaging is therefore crucial to detect the exact cause of aneurysm sac enlargement. CTA is the preferred imaging modality for the detection of endoleaks after EVAR but may miss endoleaks. The detection of these occult endoleaks is crucial in patients with aneurysm growth because in these patients an intervention may be considered according to guidelines.[4,5] This finding has sparked the search for alternative methods to detect endoleaks after EVAR implantation. One such method, contrast enhanced magnetic resonance imaging (CE-MRI), holds promise for this purpose, as has been shown in a recent meta-analysis, which found that CE-MRI is more sensitive than CTA for the detection of endoleaks, especially for slow flow/type II endoleaks.[6] This is important because type II endoleaks are not always harmless as they may result in adverse outcome after EVAR including rupture.[7,8]

Besides standard gadolinium contrast agents, albumin binding contrast agents can be used for MRI examinations aimed at the detection of endoleaks. The expected advantages of albumin binding contrast agents compared with standard gadolinium chelates are prolonged intravascular presence of the contrast agent resulting in a prolonged T1 relaxation rate.[9–11] In Europe, the European Medicines Agency withdrew the license to market the strong albumin binding contrast agent gadofosveset trisodium (Ablavar; Lantheus Medical Imaging, Billerica, MA, USA) in late 2011, and this agent is no longer available for clinical use.[12] Therefore, the aim of this study was to investigate if a weak albumin binding contrast agent could identify additional endoleaks in the study population. The purpose of this study was to examine the additional value of MRI with a weak albumin binding contrast agent for the detection of endoleaks in post EVAR patients with aneurysm growth.

MATERIALS AND METHODS

Patient selection

Patients were eligible for inclusion if they fulfilled the following criteria: (1) aneurysm growth $\geq$ 5 mm after EVAR of an infrarenal aneurysm; (2) treated with a MR compatible endograft (Table 1); and (3) no or uncertain endoleak on CTA, or the inability to identify the source of a visible endoleak on CTA. Patients between April 2011 and August 2013 were included, regardless of the date of the initial EVAR. Patients were excluded if they had MRI specific contraindications (i.e., claustrophobia or incompatible implants) or contraindications for the administration of gadolinium (renal impairment, defined as glomerular filtration rate $\leq$ 30 mL/minute). The study protocol was reviewed by the local institutional review board. The ethics committee waived the need for informed consent, as CE-MRI for endoleak detection is standard clinical practice in the authors' institution in cases where patients fulfilled one of the criteria listed above.

Table 1. Magnetic resonance imaging (MRI) compatibility (modified from van der Laan et al.)[27]

MRI compatible grafts (nitinol/platinum/gold)	MRI incompatible grafts (stainless steel/elgiloy)
Aneurx (nitinol/platinum)	Zenith (stainless steel/gold)
Talent (nitinol)	Lifepath (elgiloy)
Excluder (nitinol/gold)	Ancure (elgiloy/platinum)
Endurant (nitinol)	
Quantum LP (nitinol/tantalum	
Anaconda (nitinol)	

CTA

During routine CTA follow up after EVAR, arterial and delayed phase CTA were performed on a 256 slice CT scanner (Philips Medical Systems, Best, The Netherlands) with a standardized acquisition protocol (Supplementary Material Appendix S1).

MRI

All MRI scans were performed on a 1.5 T clinical scanner (Ingenia, software release 4.2; Philips Healthcare) after administration of a weak albumin binding contrast agent. A single dose of 0.1 mmoL/kg gadobenate dimeglumine (Multihance; Bracco, Milan, Italy) was administrated at a rate of 1.0 mL/second followed by a 30 mL saline flush at a rate of 1.0 mL/second. A 28 element phased array radiofrequency body coil was used for signal reception. A regional saturation slab was located on the anterior abdominal wall to prevent breathing artefacts. Precontrast T1 weighted fat saturated and post-contrast T1 weighted fat saturated images were acquired 5 and 15 minutes after contrast administration with the following acquisition parameters: TR/TE/α 5.4 ms/2.6 ms/10°; slice thickness 2 mm; field of view 385 $\times$ 300 mm^2; acquisition matrix 1.5 $\times$ 1.5 $\times$ 1.5 mm; acquisition time 21 seconds.

Image analysis

The presence of endoleaks was assessed by comparing pre- and post-contrast T1 weighted fat saturated images. Both the early (after 5 minutes) and late (after 15 minutes) post-contrast T1 weighted fat saturated images were used during the assessment. The presence of endoleak was defined as a high intensity signal inside the aneurysm sac on post-contrast images not present on pre-contrast images.[10] The identification of post-contrast high signal intensity dorsally (lumbar type II endoleak) and ventrally (inferior mesenteric artery [IMA] type II endoleak) in direct connection with the aneurysm sac indicates the presence of a type II endoleak. Furthermore, the presence of prominent lumbar arteries