MRI and MRA for Follow-up after Endovascular Abdominal Aortic Aneurysm Repair

L.W. Bartels[1], M.J. van der Laan[2], M. Olree[1], C.J.G. Bakker[1],
J.D. Blankensteijn[2] and W.P.Th.M. Mali[1]

Departments of Radiology[1] and Vascular Surgery[2], University Medical Center Utrecht, Utrecht, The Netherlands

Abstract

In this study we evaluated the potential of MRI and MRA for follow-up after endovascular repair of abdominal aortic aneurysms. T_1 and T_2-weighted imaging allowed the evaluation of thrombus composition and aneurysm volume. Endoleaks on post-contrast T_1 images corresponded well to hyper-intense regions in T_2 images, indicating thrombus material probably fed by blood. Dynamic 3D CE-MRA with SENSE allowed a fast depiction of contrast dynamics in the endograft. High-resolution CE-MRA scans clearly revealed fast arterial endoleaks that could be confirmed on post-contrast T_1 images. MRI seems to be more sensitive to the presence of endoleaks than CTA is.

Introduction

After successful endoluminal repair of an abdominal aortic aneurysm (AAA), in which the aneurysm sac was completely depressurized, aneurysm sac shrinkage will occur. In clinical practice however, a significant number of aneurysms enlarge or do not shrink after endovascular aneurysm repair (EAR) even without apparent endoleak on spiral computed tomographic angiography (CTA) scans. In addition, late stent graft deformation may occur, which can lead to graft thrombosis, endoleak or rupture of the aneurysm.

For all these reasons, endovascular repair of an AAA (EAR), unlike open aneurysm surgery, requires regular postoperative imaging to evaluate the treatment success. At our institution, physical examination and spiral CTA with three-dimensional post-processing that allows aneurysm volume measurements are performed. However, its excellent soft tissue contrast, its inherent three-dimensionality with free scan plane definition and the lack of ionizing radiation and nephrotoxic contrast agent, make magnetic resonance imaging (MRI) an interesting alternative for postoperative imaging. It was already recognized in the literature that the aging and decay processes that take place in the arterial thrombus in excluded AAA's will influence the thrombus relaxivities. This allows a direct evaluation of thrombus organization on MR images. In addition, MR angiography (MRA) techniques making use of gadolinium-based contrast agents allow fast three-dimensional imaging of the abdominal aorta, its branches and the iliac arteries. Recent technological developments in MRI hardware, like the implementation of SENSE techniques [1] and ultrafast gradient systems, have paved the way for fast dynamic scanning, which might be capable of depicting endoleaks.

The aim of the present pilot study is to investigate whether MRI and MRA techniques can provide adequate data for follow-up after EAR and whether these techniques can help us to gain insight in thrombus decay processes.

Materials & Methods

All scans were performed on a Philips Intera 1.5-T scanner (Philips Medical Systems, Best, The Netherlands). For all scans, a quadrature wrap-around synergy body coil was used as a receive coil.

Five patients, all participating in a regular CTA follow-up scheme after EAR, were scanned. Three patients were treated using the Ancure device (Guidant, Menlo Park, CA, USA) and the other two had an Excluder (W.L. Gore, Flagstaff, AZ, USA) implanted. The following scans were acquired (total examination time approximately 25 minutes):

- T_1-weighted spin echo
- T_2-weigthed turbo spin echo
- Dynamic 3D CE-MRA using SENSE (6s per volume)
- High-resolution 3D CE-MRA
- Post-contrast T_1-weighted spin echo (as pre-contrast)

The T_1 and T_2-weighted (turbo) spin echo scans were used to evaluate the thrombus organization inside the aneurysm sac. The dynamic 3D SENSE CE-MRA was performed to evaluate the usability of this fast dynamic imaging technique for detection of endoleaks and the high-resolution 3D CE-MRA scan served to evaluate the graft patency and for the detection of stenoses or pseudostenoses. In total, 40 ml of Gd-DTPA (Magnevist, Schering, Berlin, Germany) was administered intravenously. After the two MRA acquisitions, the T_1-weighted spin echo scan was repeated to visualize the possible depostion of contrast agent because of the existence of endoleaks. The MR images were evaluated by readers blinded to the CTA data.

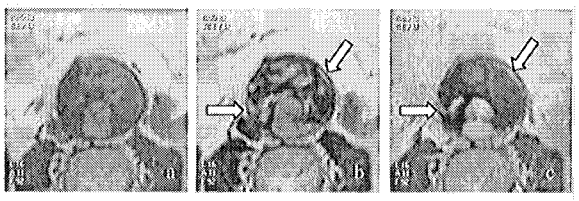

Figure 1: *Transverse anatomical scans through the aneurysm, just below the bifurcation of the prosthesis (Ancure device). a) T_1-weighted SE image, b) T_2-weighted TSE image, c) post-contrast T_1-weighted image. The arrows indicate regions of long T_2 that correspond to locations where contrast agent accumulates (endoleaks).*

Results

In the T_2-weighted anatomical scans considerable differences in signal intensity were seen. High signal areas in these images indicate rather "wet" (long T_2) thrombus material. In all patients who showed an endoleak on the post-contrast T_1-weighted scans, the corresponding regions in the T_2-weighted scans were also bright (see the example in Figure 1). The anatomical transverse scans could well be used to measure the thrombus volume. The 3D CE-MRA scans allowed a clear visualization of the aorta and the graft lumen. The metal artifacts caused by the nitinol Excluder stent-graft were minor and did not complicate the interpretation of the MR angiograms. The Ancure device showed more severe metal artifacts at the distal and proximal attachment systems, which can appear as stenoses on the 3D CE-MRA's. Still, the patency of the graft lumen at locations outside the attachment systems could be well observed. Browsing through the coronal source images allowed the identification and localization of endoleaks as is shown in Figure 2.

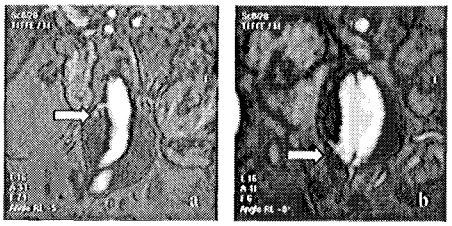

Figure 2: *Coronal slices, taken out of the 3D CE-MRA scans in two patients, showing endoleakage of contrast agent into the aneurysm sac. a) patient treated with Ancure device, b) patient with Excluder.*

In the dynamic 3D CE-MRA acquisitions using SENSE the contrast dynamics of the endoleaks could well be appreciated at a frame rate of 1 3D volume every 5-6 seconds. All endoleaks found on CTA data were also found on the MR data. In two cases, an indistinct contrast blush on CTA that was reported to be "possibly an endoleak" was directly diagnosed as such on the MR scans.

Discussion & Conclusions

The results we obtained in this pilot study for evaluation of the succes of EAR with MRI and MRA are very promising. Especially the ability of MRI to depict endoleaks without ambiguity between contrast agent, calcification and metal artifacts, which is a problem with CTA, is an important advantage of the MR technique. In addition, MRI seems to be more sensitive to the presence of endoleaks than CTA. The artifacts caused by the metallic implants in the MR images were acceptable, although the proximal and distal attachment systems of the Ancure device prohibit the evaluation of the graft lumen at the graft's ends. A larger study aiming at the comparison of MR and CTA for follow-up after EAR is presently initiated at our institution.

[1] Kassner, A. et al., ISMRM 2000, Denver CO, USA, p. 1805.
[2] Wever, J.J. et al., Eur. J. Vasc. Endovascv. Surg., 20, 177,2000.