MRI Compatibility of Endovascular Stentgrafts for Abdominal Aortic Aneurysm Repair

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Background

Recently, several studies have shown that Magnetic Resonance Imaging (MRI) and Magnetic Resonance Angiography (MRA) techniques are more sensitive for endoleak after Endovascular Aneurysm Repair (EVAR) than standard CTA surveillance (1-3). For adequate evaluation of treatment success after endovascular aneurysm repair, several specific items should be monitored: the effectiveness of exclusion of the aneurysm sac, graft patency, graft migration and graft integrity. MRI and MRA techniques are potentially well suited for the evaluation of aneurysm sac exclusion and graft patency. However, a possible disadvantage of MR techniques is that the endografts have to be MR compatible. The problem is the presence of metallic components in the endografts may pose a problem as these may produce susceptibility and RF artifacts that may considerably degrade image quality. The purpose of this study was to investigate the MR compatibility of commercially available endografts. The issues were addressed: compatibility, safety and susceptibility and RF artifacts (4).

Materials & Methods

In vitro experiments: The grafts were mounted in a plastic container in which they were hanging freely in water doped with Gd-DTPA, mimicking the relaxation properties of contrast enhanced blood. The phantom was placed inside a birdcage head receiver coil. Scans were made on a clinical 1.5-T MR scanner (Gyroscan NT, Philips Medical Systems, Best, The Netherlands).

Data acquisition: Out of our clinical EVAR MR-follow-up protocol two scans were selected that give a good representation of the impact of possible image artifacts on a clinical evaluation of a post-operative patient: 3D T_1-weighted spoiled gradient echo scan and a transverse T_1-weighted spin echo scan. The scans of each endograft were evaluated for artifacts influencing the endograft surroundings and artifacts influencing the appreciation of the endograft lumen. The assessment of RF caging was done in the T_1-weighted spin echo scan and was expressed as a percentage of signal loss with respect to the undisturbed signal in water-Gd-DTPA solution outside the endograft. Of each endograft Minimum Intensity Projections (mIP) were made in order to have a good overview of all artifacts.

Force and Torque: An estimate of the risk of migration of the endograft due to an attractive magnetic force or magnetic torque was obtained by moving the stent, lying on a smooth surface, inside the bore of the scanner, where the field strength is at its maximum, and near the entrance of the bore, where the largest spatial gradients are located.

Results

Appreciation of the endograft lumen: The Lifepath device and the Zenith device showed significant artifacts that seriously affect the depiction of the lumen. In the Ancure graft, depiction of the lumen was compromised at the attachment sites. The four other devices did not produce disturbing susceptibility artifacts. Slices of the T_1-weighted spin echo scan through the body of the endograft demonstrated the differences in RF shielding or "caging" between the different endografts. In table 1 the imaging results are summarized.

Appreciation of the tissue surrounding the endograft: Artifacts from nitinol supported endografts did not compromise the depiction of the tissue directly surrounding the endograft. Elgiloy and stainless steel resulted in large artifacts, severely affecting the diagnostic value. Figure 1 shows the imaging results of the mIP's derived from the three-dimensional T_1-weighted spoiled gradient echo scan.

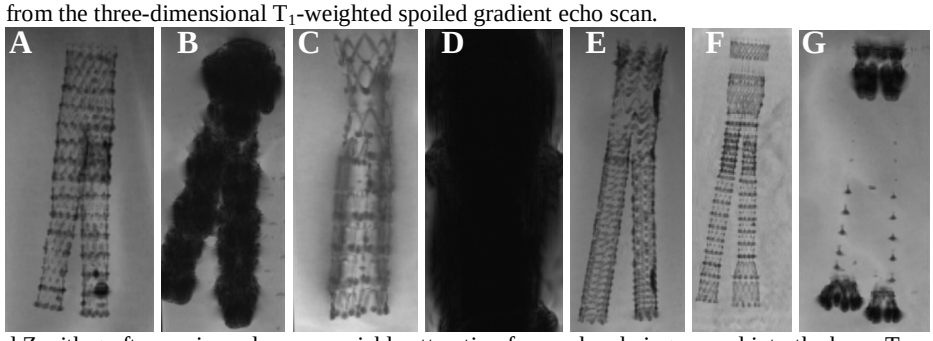

Figure1
mIP of the seven endografts from our MRA derived scan. A.AneurX B.Lifepath C.Talent D.Zenith E. Excluder F.Quantum LP G.Ancure

Force and Torque: The stainless steel Zenith graft experienced an appreciable attraction force when being moved into the bore. Torque was felt when moving it near the entrance of the bore of the scanner. In the Lifepath (Elgiloy) a very mild attraction and torque were felt. In none of the other endografts attraction or torque were noted.

Table 1

Percentage signal attenuation of the graft interior caused by each of the endografts. N/A: due to severe artifacts, signal attenuations could not be quantified.

	Lumen	*Attachment*
AneuRx	37%	24%
Lifepath	N/A	N/A
Talent	4%	1%
Excluder	8%	15%
Zenith	N/A	N/A
Quantum LP	73%	66%
Ancure	3%	13%

Discussion & Conclusion

In conclusion, our findings show that for most endografts MRI and MRA based follow-up is an option. When considering the diagnostic interpretation of the imaging results, artifacts caused by the metallic stents should be kept in mind as these artifacts can mimic stenosis or occlusion of the endograft. For the Ancure graft, MR based follow-up is not impossible, but the attachment site does pose problems. An MR based follow-up of the Lifepath and the Zenith will be useless as the images will have no diagnostic value. These grafts are better assessed by CTA.

References

1) Cejna M et al. Eur Radiol 2002; 12(10):2443-2450.
2) Haulon S et al. Eur J Vasc Endovasc Surg 2001; 22(1):62-69.
3) Haulon S et al. Ann Vasc Surg 2001; 15(2):148-154.
4) Bartels LW et al. J Vasc Interv Radiol 2001; 12(3):365-371.