MR Evaluation In Vivo of Nine Different Abdominal Aortic Stent Grafts: Assessment of Imaging Characteristics

A. Gossmann[1], M. Gawenda[2], K. Krueger[1], M. Zaehringer[1], J. Brunkwall[2], K. Lackner[1]

[1]Department of Radiology, University of Cologne, Cologne, NRW, Germany, [2]Division of Vascular Surgery, University of Cologne, Cologne, NRW, Germany

INTRODUCTION Percutaneous stent-grafting is increasingly employed as a less invasive alternative to surgery for the treatment of abdominal aortic aneurysms (AAAs). It requires long-term follow up since endovascular repair has a unique array of procedure-related complications, such as stent migration, kinking, and leakage in the aneurysm sac. Computed tomography angiography (CTA) is the most commonly used method for follow-up of patients treated with endoluminal stent grafts. However, CTA exposes the patients to ionizing radiation and potentially nephrotoxic iodine-based contrast media. Magnetic resonance (MR) imaging can be used as an alternative imaging modality. It provides excellent soft-tissue contrast, lack of ionizing radiation and the advantage of gadolinium-based contrast media, which are significantly less nephrotoxic and less allergic than iodinated contrast media. Magnetic resonance angiography (MRA) has already been proven to be safe for the examination of non-ferromagnetic stents and stent grafts, with regard to stent deflection and heating. Moreover, previous studies have already shown the efficiency of MRA in the detection of endoleaks. However, for many of the existing stent grafts the degree and expression of metal artifacts of the stent grafts remains unclear. Thus, the aim of our study was to evaluate *in vivo* image artifacts in nine different stent grafts in patients with endovascular treatment of AAA.

MATERIALS AND METHODS From January 2002 to January 2003 nine patients (all men; mean age 63.6 years; age range, 52–75 years) who had been treated with nine different bifurcated stent grafts (Table 1) for an AAA underwent MR imaging three to four months following placement of the stent graft. MR imaging was performed on a whole body MR imaging system operating at 1.5 Tesla (ACS-NT, Philips Medical Systems, Eindhoven, The Netherlands). The imaging protocol of the whole abdomen and the stent grafts, respectively, was started with axial multislice T_2-weighted turbo-spin-echo images obtained with the following parameter settings: TE 2000 ms, TR 90 ms, three signals acquired, matrix 178 × 256, 20 turbo-factors, slice thickness 8 mm with a gap of 0.8 mm, 75% rectangular field of view 350 × 260-mm, acquisition time 2 minutes 55 seconds. Subsequently, axial multislice T_1-weighted spin-echo images (TE 500 ms, TR 10 ms, two signals acquired, matrix 178 × 256, 5 turbo-factors, slice thickness 8 mm with a gap of 0.8 mm, 75% rectangular field of view 350 × 260-mm, acquisition time 3 minutes 44 seconds) were acquired. For MRA, a coronal contrast-enhanced (0.05 mmol Gd-BOPTA per kg bodyweight, MultiHance™, Bracco-Byk Gulden, Konstanz, Germany), three-dimensional gradient-recalled-echo technique (TE 6.6 ms, TR 1.6 ms, 25° flip angle, 1 NSA, matrix 180 × 512, 75% rectangular field of view 350 × 260 mm, acquisition time 17 seconds per volume of 35 slices) was used to acquire 35 3-mm-thick image sections that were reconstructed with a zero-fill algorithm to produce 70 1.5-mm-thick sections. The imaging delay time was determined by performing a dynamic gradient-recalled-echo sequence. Sixteen rotated maximum intensity projections (MIP) at 22.5° intervals were rendered. Following the MRA sequences, T1-w post contrast sequences with and without fat suppression were acquired with the identical imaging parameters as described above. Four independent readers (three radiologists, one vascular surgeon) evaluated the MR images of the nine different stent graft prostheses; each investigator was blinded for the analyses of the others. The sizes and pattern of the stent-related artifacts were measured, and a total of 28 clinically relevant parameters were investigated. To quantify the extent of the artifacts, and their effect of the critical examination, a score of 0 to 4 (0, not assessable; 1, poor; 2, moderate; 3, good; 4, excellent) was assigned to a pattern of distinct criteria.

Table 1. Investigated stent grafts.

Devices	Manufacturer	Material
Anaconda™	Vascutec/Terumo	Nitinol
AneuRx™	Medtronic AVE	Nitinol
Endofit™	Endomed Inc	Nitinol
Excluder™	WL Gore & Associates	Nitinol
LifePath™	Edwards Lifesciences	Elgiloy
PowerLink™	Endologix	Stainless steel alloy
Talent™	Medtronic AVE	Nitinol
Vanguard™	BostonScientific Cooperation	Nitinol
Zenith™	William Cook	Stainless steel

RESULTS Only three of the nine examined stent graft prostheses were scored ≥3 points for the overall diagnostic confidence (AneuRx™, 3; Excluder™, 4; Vanguard™, 3). In these three systems, only minor artifacts occurred and the aortic lumen was clearly visible (Example given in Figure 1a). Two devices (Endofit™, Zenith™) were found to be completely incompatible with MR angiography (0 scoring points for diagnostic confidence). In four devices (Anaconda™, PowerLink™, LifePath™, Talent™) the diagnostic confidence was limited due to severe artifacts (scoring points between 1 and 3 for diagnostic confidence) (Example given in Figure 1b).

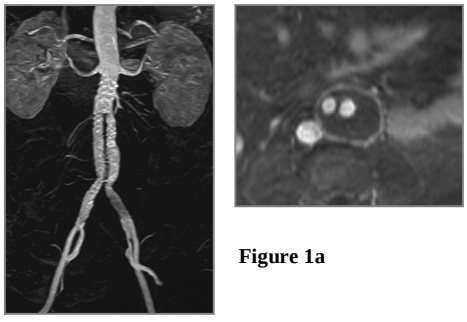

Figure 1a

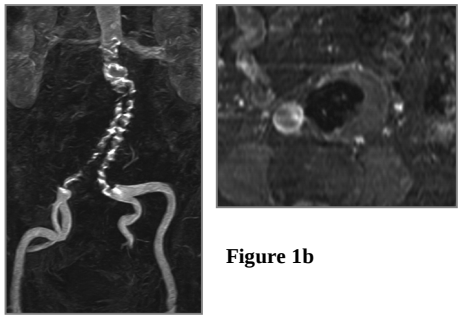

Figure 1b

Conclusion Stainless steel containing devices are not suitable for follow up examinations of endoluminally treated AAA at MR angiography. Nitinol and elgiloy based devices are better suited for MR angiography, however, of the seven examined stent graft protheses, only three devices were found to provide a good diagnostic confidence.