

Artifact-Free MR-Compatible Coronary Stent: In-Vitro and First Human MR Imaging Experience With an Absorbable Mg-Alloy Stent

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Synopsis:

Bare metal coronary artery stents are associated with artifacts hampering non-invasive follow-up studies by CT and MRI. Recently, a novel Mg-alloy absorbable metal stent (AMS) has been developed and implanted in patients in a clinical study. MR compatibility and MR imaging features of this stent were examined in-vitro and after implantation into human coronaries. No metal artefacts were seen in the in-vitro experiment and in MR coronary angiography making the depiction of vessel lumen possible. The investigated novel stent may allow for non-invasive MRI-based follow-up after coronary stenting.

Introduction:

Bare metal stents used in interventional cardiology are associated with artifacts hampering non-invasive follow-up studies by CT¹ and MRI². Stent prototypes in experimental settings have shown to allow artifact-free MRI³. Recently, a novel absorbable metal stent (AMS) has been developed and for the first time implanted into human coronary arteries. Due to its composition of a magnesium-based alloy, the stent is not radio-opaque and can, therefore, not be visualized by x-ray or CT. The MRI features of this AMS are still unknown. Artifact-free imaging would allow for non-invasive follow-up of coronary stents as an attractive alternative to coronary cath angiography. Purpose of the present study was to evaluate the MR compatibility of the AMS in-vitro and after implantation in human coronary arteries.

Methods:

In an in-vitro study, expanded as well as unexpanded AMS (Biotronik, Berlin, Germany) were examined in a water bath phantom using a 1.5 Tesla MR-scanner (Sonata, Siemens, Erlangen, Germany) with different sequences. A comparison with standard bare metal stents in terms of visibility and artifacts was performed by visual analysis. As part of the first-in-man trial, 5 patients (age: 39-72 yrs, 3 male / 2 female) underwent AMS implantation. MR coronary angiography (MRCA) was performed the day before and 3 to 4 days after implantation using two different sequences: a) a segmented steady-state free precession sequence without contrast material (SSFP, TrueFISP) and b) contrast-enhanced MRCA with a segmented inversion-recovery 3D gradient-echo sequence (FLASH). Both sequences were applied during breath-hold with a navigator-based slice follow option. Images were compared in terms of visibility of the stented coronary artery lumen and artifacts.

Results:

In the in-vitro study, the stents could be visualized by MRI. The magnesium-alloy stent did not produce recognizable susceptibility artifacts allowing for unhampered detailed evaluation of the stent lumen in the water bath. Conversely, the bare metal stents showed the typical material-dependent susceptibility artifacts rendering evaluation of the stent lumen impossible. In the patients, all coronary arteries could be delineated before AMS implantation with both described techniques. After AMS implantation the corresponding parts of the stented coronary arteries (2x RCA, 1x LAD, 2x LCX) could also be visualized by MRCA. The artifact-free visualization allowed for evaluation of the stented lumen without image quality loss.

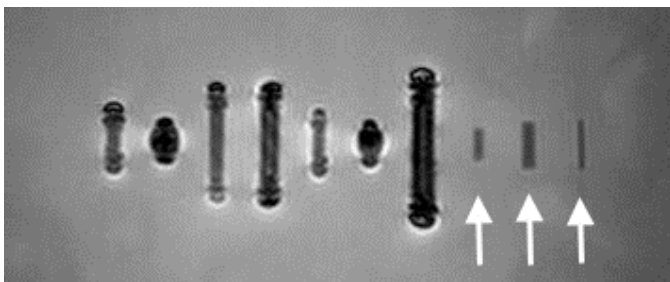


Figure 1: MRI of stents in water bath. Different expanded bare metal stents (no. 1 to 7 from left) show remarkable metal artifacts. Arrows show 3 absorbable Mg-alloy stents (AMS, 3.0/10 mm and 3.5/15 mm expanded, right one not expanded) without any metal artefacts.

Discussion:

MR imaging of a novel absorbable magnesium-alloy stent was performed demonstrating artifact-free visualization of the stent in-vitro and after implantation in coronary arteries. MRCA yielded diagnostic images of the stented artery lumen without quality loss. This may provide the basis for non-invasive follow-up studies of coronary stent patency.

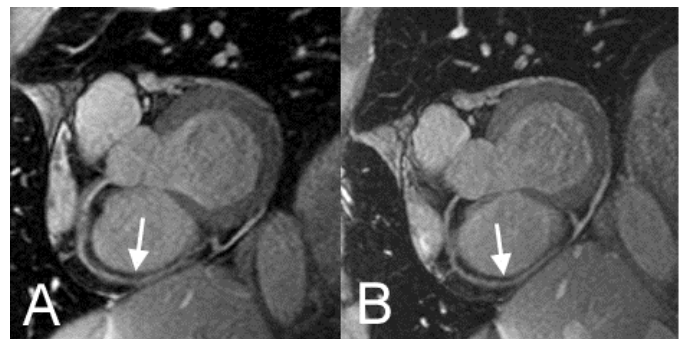


Figure 2: Patient with intermediate stenosis (arrows) of segment 2 of the right coronary artery. Thin MIP of a 3D-SSFP MR coronary angiography before (A) and three days after (B) implantation of the absorbable metal stent (AMS). No stent artifacts are visible, the vessel lumen is clearly depicted after stenting and shows no residual stenosis.

References:

1. Schuijff JD et al. *Am J Cardiol* 2004; 94:427-430.
2. Holton A et al. *J Cardiovasc Magn Reson* 2002; 4:423-430.
3. Buecker A et al. *Invest Radiol* 2004; 39:250-253.