High-Resolution Real-Time and Color-Flow MRI of Nitinol Stents

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Abstract
Stents are commonly used to treat coronary and vascular disease, but they typically impair MR imaging. Nitinol stents, in contrast, have reduced artifacts and may allow real-time MRI evaluation of stent delivery and patency, even in coronary-size stents. Seven rabbits had 3 and 4 mm stents placed in the aorta. Nitinol stent patency was seen in vivo with both high-resolution real-time and color-flow MRI sequences in all cases. Real-time MRI, combined with favorable stent materials, may improve MR-guided stent placement and patency evaluation.

Background
Stenting has become the dominant interventional procedure for treating coronary and vascular stenoses. However, traditional stainless-steel stents cause significant artifacts on MRA, limiting the utility of MRI-guided interventions and noninvasive follow-up of stent patency by MRI. Nitinol stents, in contrast, have reduced artifacts and may allow real-time MRI evaluation of stent patency, even in coronary-size stents. The objective of this study was to evaluate high-resolution real-time and color-flow MRI sequences for imaging nitinol stents in vivo.

Methods
A 1.5 T GE MR system with high-performance gradients (40 mT/m, 150 mT/m/ms) and an interactive real-time workstation was used, with an extremity coil for signal reception. Three imaging sequences were used: 1) a high-resolution real-time interleaved spiral sequence (Fig 1), 2) a velocity-encoded real-time color-flow sequence (Fig 1), and 3) a non-real-time multi-slice spiral angiography sequence (16 cm FOV, 0.4 x 0.4 mm). The real-time sequences use a sliding window reconstruction and were displayed at 14 fps. To improve visualization within the stent, the flip angle was increased from 30 to 90 degrees.

Results
The high-resolution real-time sequence successfully imaged inside the nitinol (but not the stainless steel) stents on both long-axis and short-axis views (Fig 2, top). Stent patency was further visualized and confirmed with the non-real-time angio sequence (Fig 2, bottom). Color flow within the nitinol stents could also be visualized in all cases (figure not included due to black-and-white-only abstract format). No restenosis was detected at the initial 1 month follow up, with imaging out to 6 months planned.

Discussion
Imaging within stents by MRI is an important issue both for performing MR-guided vascular interventions and for allowing noninvasive follow-up of stent patency. We have successfully imaged within coronary-size nitinol stents using a real-time interactive MRI system, which is also capable of color flow evaluation. Combining favorable stent materials with a real-time imaging environment may enhance MR-guided stent placement and patency evaluation.

References

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