Self-Expandable Intra-Vascular MR Imaging and MR Tracking Catheters

E. J. Schmidt[1], V. K. Reddy[2], M. Hayase[3], I. Basu Ray[4], C. L. Dumoulin[4]

[1]GE Applied Science Laboratory, Boston, MA, United States, [2]Cardiology, Massachusetts General Hospital, Bsoton, MA, United States, [3]Cardiology, Massachusetts General Hospital, Boston, MA, [4]Cardiology, Massachusetts General Hospital, Boston, MA, United States

ABSTRACT

MR-guided interventional procedures in moving anatomy demand rapid high-resolution imaging, which is, in some cases, difficult to provide with surface coils. A family of expandable array coils (Large ,Medium and Small) mounted on catheters for vascular deployment, whose intended use is in the Left Atrium, Left Ventricle , Pulmonary Veins and Aorta, is presented. The coils provide 4, 9 and 16 times (Large, Medium, Small, respectively) the **S**ignal-to-**N**oise -**R**atio (SNR) of the GE 4-channel cardiac array over small **F**ields **O**f **V**iew (FOV) (6x6, 2x2, 1x1cm , respectively), assuming a 12cm distance between the surface and the imaged-region. Self-expansion provides larger coil SNR and reduced motion-sensitivity. MR-tracking coils are included for navigation and residual motion correction.

INTRODUCTION

MRI-guided cardiovascular interventions require imaging of anatomy and physiology at time-scales on order of a breath-hold. Limited imaging FOVs are required and high spatial resolution is desired. Other demands include catheter-based vascular introduction (typically <3.3mm OD), and minimal blood-flow occlusion. A family of invasive MRI-imaging and tracking catheters which satisfy such requirements was designed and tested in a variety of applications.

MATERIALS AND METHODS

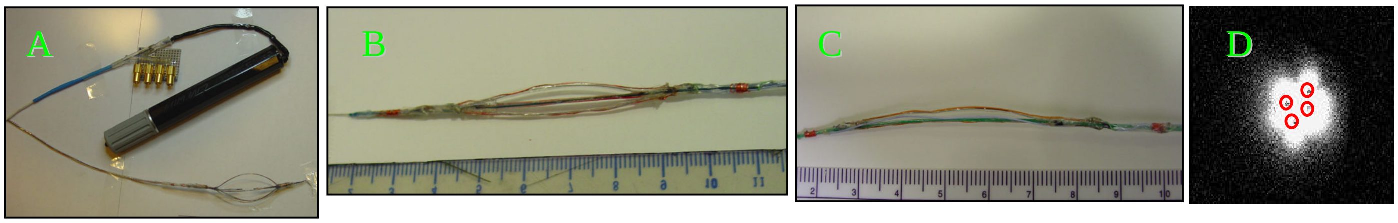

Figure 1 – Self-expanding MR-imaging catheters: (**A**) Large expandable catheter. The self-expanding imaging array-coil is composed of a 4-bar expandable Nitinol frame with externally mounted copper conductors, providing 2 RF quadrature loops. Dimension of the expanded elliptical coil is 2.5x6.0 cm. MR-tracking micro-coils are located on the shaft for positional localization and for motion correction. **(B)** Medium expandable catheter (distal end only). Single RF channel. Both catheter sides expand to 1x6 cm. **(C)** Small expandable catheter **(**distal end only). Single-RF-channel. One-side expands to 0.8x4.0 cm**. (D)** Radial lobe pattern of an expanded Large expandable array. Red overlays show actual wire elements. The Nytenol-copper wire distance is optimized to increase the RF field about the coil, at the expense of the field within the coil.

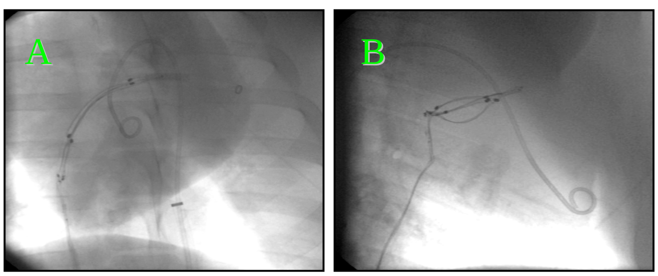

Figure 2 X-ray fluoroscopy of the large expandable catheter after transseptal deployment into a swine left atrium. **(A)** Insertion of the folded expandable coil within a 3.3mm diameter sheath **(B)** After retracting the sheath, the coil expands to full size within the left atrium. The open coil geometry prevents thrombosis following deployment.

RESULTS AND DISCUSSION

Figure 3 Swine single-breath-hold black-blood FSE images taken with self-expandable catheters**. (A)** Large expandable coil, in array along with a 4-channel-cardiac–array. LV Chronic infarct, TE 105msec, 16x16cm FOV, 5mm slice width. **(B)** Medium expandable coil. Right Inferior Pulmonary Vein wall, TE 105msec, 18x18cm FOV, 3mm slice width **(C)** Small expandable coil imaging the aortic wall**,** TE 85msec, 9x9cm FOV, 3mm slice width**.**

CONCLUSIONS

The feasibility of use of multiple-size self-expandable imaging catheters for high-resolution vessel-wall imaging is demonstrated.