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POSTER PRESENTATION

Stiffness-matched segmented metallic guidewire for interventional cardiovascular MRI

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Background

Conductive guidewires and intravascular catheters are at risk of RF-induced heating under MRI [1]. Heating is found predominantly at the tip of conductive wires [2], and is modulated by wire diameter, length and insulation thickness [3]. Non-conductive materials, such as polymer, impart unsatisfactory mechanical properties on guidewires in terms of flexibility, stiffness, and torquability, for navigating tortuous cardiovascular structures and for safely delivering catheter devices.

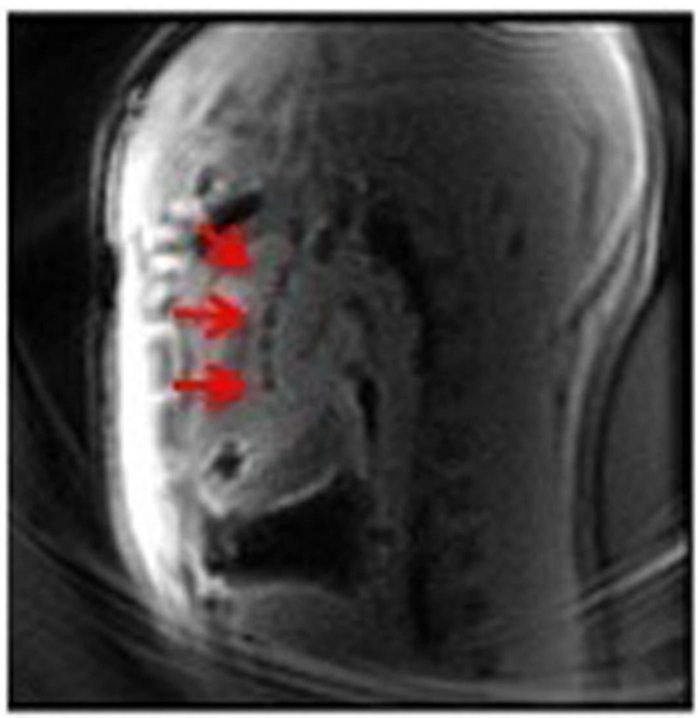

Figure 1 In vivo left heart catheterization in swine using MRI safe guidewire design. Iron-oxide markers on device tip shown with red arrows. TE/TR=1.9/4.2 ms, slice thickness=6mm, matrix=192x192, flip angle=15.

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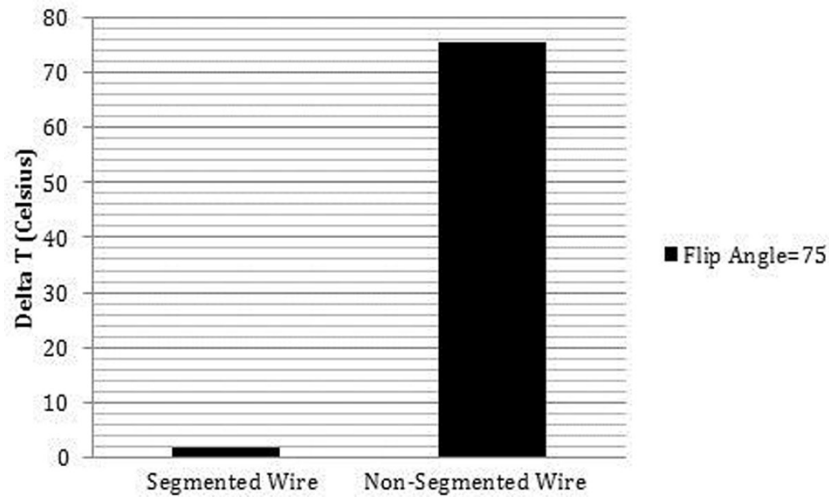

Figure 2 Deviation from baseline temperature readings acquired over 30 seconds prior to scanning during *in-vitro* heating experiments.

We developed a novel MRI guidewire design that avoids RF heating yet preserves the mechanical features of conventional X-ray guidewires. Short non-resonant segments of nitinol are connected using stiffness-matched insulated notched couplers, preventing standing wave formation yet appearing mechanically indistinguishable from nitinol guidewires.

Methods

The core of a passive 120cm guidewire was constructed from nitinol rod segments shorter than a quarter-wavelength in vivo at 1.5T (10cm). The segments were joined by electrically insulated nitinol tubes. A surrounding outer braided polymer enhanced torque response, insulation and safety. The distal tip was insulated using non-braided polymer and low durometer thermoplastic polymer for flexibility and trackability. Iron-oxide markers created MRI susceptibility artifacts for enhanced visualization *in vivo* in a swine (Fig 1).

RF heating was measured in an ASTM F2182 gel phantom. Tip and shaft temperature was measured using a fiber optic probe (*OpSense*) at 1.5T (*Aera*, Siemens) [4]. Heating was measured at high flip angle (75°) bSSFP (TR/TE, 2.88/1.44 ms; thickness, 6 mm; FOV, 350×350 mm; matrix, 192×144) and compared to a custom non-segmented nitinol core wire with identical jacketing serving as a control.

Results

The segmented MRI guidewire exhibited a maximum temperature increase of 1.6°C at the tip, compared with 74°C for the non-segmented comparator, during a 60s scan at a flip angle of 75° (Fig 2). Systematic temperature measurements along the shaft detected negligible heating, confirming successful electrical insulation by the inter-segment connectors. Trackability in a tortuous vascular phantom resembled commercial comparators (*Glidewire*, Terumo).

Conclusions

We demonstrate a simple and intrinsically safe new design for passive metallic MRI guidewires. The guidewire exhibits negligible heating at high flip angles in conformance with ISO standards (<2°C) [5], yet mechanically resembles a high-performance conventional metallic guidewire. This may represent a significant advance once applied in clinical MRI catheterization.

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