A Monte Carlo analysis of Guidewire Safety Comparing a Body and Local coil

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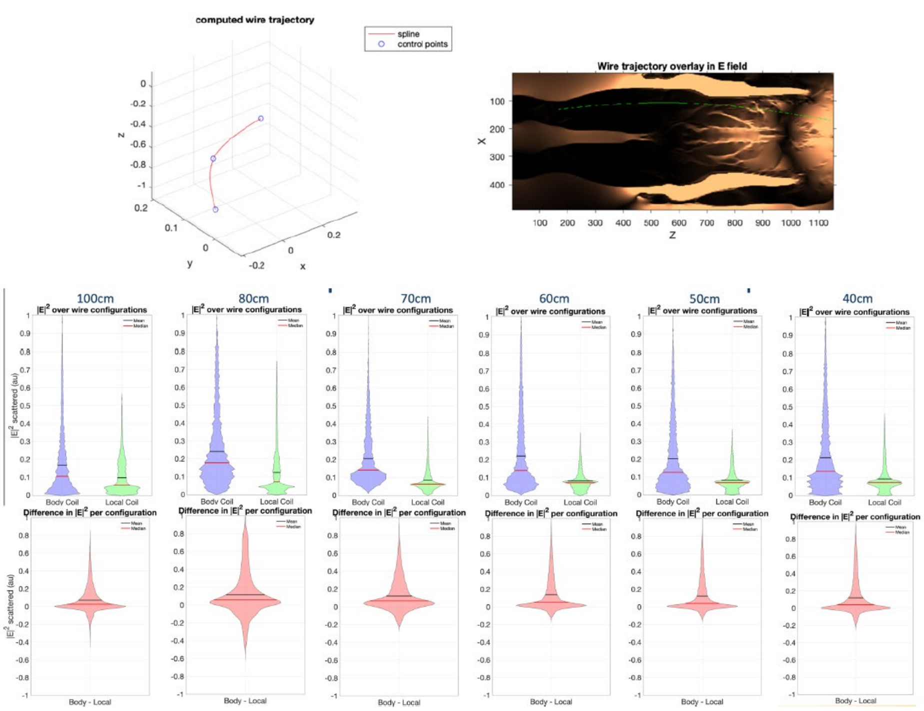
Introduction: In MRI, Interventional devices are unsafe due to heating caused by coupling to the transmit coils of the scanner. A novel solution is to design a transmit coil with a small electric field footprint, in comparison to a body coil which emits a larger electric field. Using simulation, the potential for heating at the device tip was evaluated by comparing a local coil array and a body coil.

Methods: The electric transfer function for a 100cm long wire in a dielectric medium (insertion depths: 100cm, 80cm, 70cm, 60cm, 40cm) was calculated from simulated excitations with a plane wave at the tip. The guidewire was modeled as an insulated 1mm wire with 5mm of the tip exposed by removing the insulation. A full human sized phantom was excited with a local coil array with 8 coil loops, with 4 coils posterior and 4 anterior, and a body coil (bird cage coil) 45cm long with 16 rungs, for comparison. Ten thousand wire trajectories were randomly generated in the phantom. The scattered electric field at the tip was computed by integrating the tangential component of the electric field produced by either coil along each wire trajectory multiplied by the relevant wire electric transfer function.

Results: The body coil to local coil array ratios for the mean electric power at the tip were 1.7, 1.9, 2.4, 2.7, 2.5, and 2.3 for depths 100cm to 40cm, respectively. The 99th percentile electric power at the tip (close to worst case) was 98%, 40%, 115%, 198%, 175%, and 125% greater for the body coil, for depths 100cm to 40cm, respectively.

Conclusion: We have compared a body coil with a local transmit coil and numerically evaluated the heating risks that each can pose on many different guidewire trajectories in a dielectric medium. In most cases the local coil array was the safer coil.



The calculated spline trajectory in MatLab (top left). The overlay of the projection of the tangential component along the guidewire and the incident electric field is shown (top right). The Violin plots of the electric power at the wire tip for each wire trajectory/geometry for the body coil and local coil, respectively (middle row). Violin plots of the difference in electric power between the body coil and local coil (bottom row).