AbstractID: 3827 Title: Factors Affecting Remote Control Endovascular Catheter Steering for iMRI

Purpose: Current applied to a wire solenoid wound at the tip of an endovascular catheter can be used to remotely steer a catheter in interventional MRI. In this study, we attempted to 1) optimize catheter visualization by comparing "real-time" pulse sequences, 2) derive and verify an equation that characterizes the relationship between the number of solenoid turns, applied current, catheter stiffness, and resulting catheter tip deflections.

Method and Materials: Solenoids of 50, 100, 150 turns were wound on separate 1.8 F (using 44 AWG magnet wire) and 5F catheters (using 37 AWG magnet wire). Varying currents were applied using a DC power supply in the MRI control room. Images were obtained with 1.5 T scanner with the distal catheter suspended at 90 degrees to the main magnetic field in a water bath on the scanner bed, using ssFSE, spiral SPGR, FSPGR, FIESTA, and GRE-EPI pulse sequences. Deflection angles were measured on acquired sagittal images using eFilm.

Results: ssFSE and FIESTA images had the highest SNR and the lowest sensitivity to local field inhomogeneity artifact. The deflection angleθ was predicted by the equation, $\theta = [nIAB/k]\sin(\gamma-\theta)$, where n is solenoidal turns, I is current, A is area, B is the scanner magnetic field, k is related to the catheter elastic modulus, and γ is the initial angle between the catheter and B ($R^2 = 0.9671$-0.9875). For a 1.8 F catheter and 60 mA applied, deflection was 31.5, 36, and 45.5 degrees from baseline for 50, 100, and 150 turns, respectively. Less flexible catheters required currents over 800 mA to cause deflection.over 20 degrees.

Conclusion: SsFSE and FIESTA real-time pulse sequences are optimal for visualization of catheter tip deflection. The number of solenoidal turns, applied current, and catheter stiffness are important considerations for remote steering of endovascular catheters in iMRI.