Zero Echo Time (ZTE) Imaging of Human Brain Tumor at 7T

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Target Audience: Physicists, radiologists, system designers

Purpose: Zero echo time (ZTE) imaging using 3D RUFIS[1] optimized for 7T has been shown to deliver robust controllable contrast throughout the brain in volunteers and multiple sclerosis patients, with sensitivity to short T2 components, such as skull and meninges (as well as foam padding and RF coil components). The technique allows acquisition of high spatial resolution images in a practical scan time, with a substantial reduction in acoustic noise compared to conventional sequences. We extend this approach to brain tumor patients to demonstrate the robustness of the performance around the surgical cavity.

Methods: All studies were performed on a 7T human research system (General Electric MR950, Waukesha WI) using a 32 channel brain coil (Nova Medical, Wilmington MA). Informed consent was obtained from all subjects under a protocol approved by the Committee on Human Research. IR prepared ZTE images were acquired on a 192x192x192 matrix with a 212 mm isotropic field of view, resulting in 1.1 mm voxels. A nominal flip angle of 4 degrees was used with an HS2 adiabatic inversion pulse applied 650 ms before each segment of 384 spokes, broken into three groups of 128 spokes each with a separate fat suppression pulse. After each segment, a 1 second delay was inserted to allow partial magnetization recovery. For each receiver element, the data is interpolated to a Cartesian grid using a Kaiser-Bessel kernel, and then interpolated across the center of k-space. The effective echo time was 48 microseconds as determined from the central k-space interpolation parameters. The resulting images were then combined by root sum of squares, Additionally, a density weighted image set with 2.2 mm isotropic resolution was acquired with a 2 degree nominal flip angle and 32 spokes per segment, each preceded by a fat suppression pulse. Conventional IR-prepared gradient echo images were also acquired for comparison.

Results:

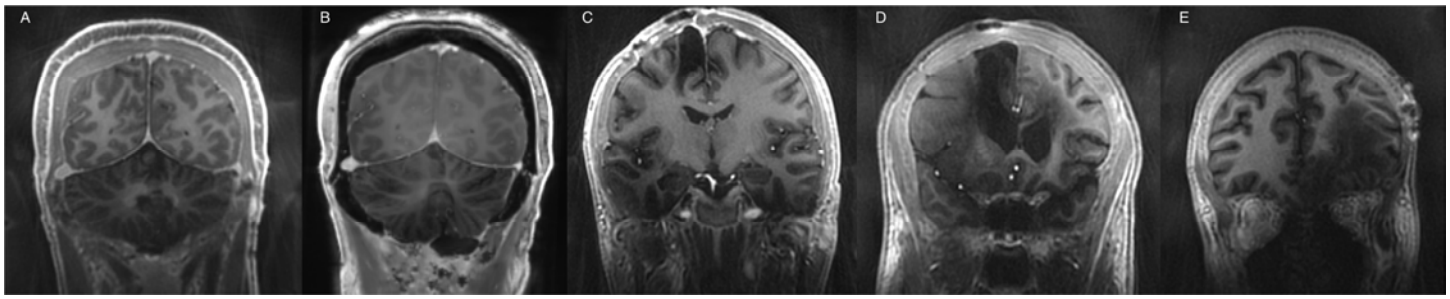

Figure A shows a ZTE image (acquired axially and reformatted coronally) depicting the greater contrast uniformity from ZTE at 7T. Figure B shows the same section from a conventional IR prepared 3D fast gradient echo (acquired sagitally and reformatted coronally) from the same session. Neither image has been intensity corrected. Figures C, D, and E show representative slices through three subjects examined with this protocol showing the depiction of the skull around the surgical cavity in 2 of the cases, as well as the anatomical detail.

Discussion and Conclusion: The ZTE sequence delivered consistently robust contrast in the peritumor region as well as the rest of the brain. Susceptibility artifacts around the surgical cavity were acceptable, showing a spatial ring pattern characteristic of the radial acquisition trajectory. The 5:23 scan time was easily integrated into the research protocol.

References: 1. Madio D & Lowe I *Ultra-fast Imaging Using Low Flip Angles and FIDs* **Magnetic Resonance in Medicine** 34 (4) pp 525-9. 1995.