

Ultrashort TE Imaging of the Short T2 Components in White Matter Using Half Pulse Excitation and Spiral Sampling

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INTRODUCTION

In the human body there exists a group of tissues which have such short T2 relaxation times that they normally produce no detectable signal when imaged with clinical MR pulse sequences (1, 2). It is necessary to switch rapidly from transmit to receive mode and use pulse sequences designed to detect and spatially encode rapidly decaying signals before they have disappeared. Recently pulse sequence with ultrashort TE (UTE, TE=8 μ sec) has been implemented by use of half radio-frequency excitations with radial projection reconstruction (3). Our initial tests show that short T2 components in white matter can be detected with good contrast using an inversion pulse and later echo subtraction to suppress long T2 signals. However, long scan time, low SNR and streak artifact limit its application. Spiral trajectories allow higher duty cycle and higher SNR efficiency than radial trajectories. We report the use of a UTE sequence employing spiral trajectories to improve SNR, reduce streak artifact and scan time.

MATERIALS AND METHODS

In the spiral UTE sequence (Figure 1), half-pulse excitation was followed by a spiral readout trajectory, which was generated numerically using a 4th order Runge-Kutta method (4). A complete slice profile was generated by collecting data with the slice selection gradient in one direction and adding this to data collected with the slice selection gradient reversed. Volunteer studies were carried out on a 1.5 T Signa TwinSpeed scanner (GE Healthcare Technologies, Milwaukee, WI) using a head coil. A long slice selective adiabatic fast passage (Silver-Hoult) inversion pulse was played to invert the long T2 magnetization. Image acquisition began following a time delay (TI) necessary for the magnetization of inverted long T2 components to reach the null point for white matter. For multislice imaging, the inversion pulses were sequentially applied to all slices. Comparisons were made between radial UTE and spiral UTE, with the following imaging parameters: FOV = 26 cm, TR/TE = 1.5s/8 μ s, TI = 380 ms, flip angle = 80°, BW = 31.25 kHz, readout = 192/256, projection = 191/153, slices = 12, slice thickness = 5 mm, 100% slice gap, scan time = 9.5 min / 7.5 min, and the same pixel size of 1.35×1.35 mm².

RESULTS AND DISCUSSION

Figure 2 shows the short T2 components in white matter using radial UTE and spiral UTE, respectively. For each slice, two images with echo times of 8 μ sec and 5 msec were acquired and subtracted to selectively depict the short T2 components. Spiral UTE provided significantly higher SNR and less streak artifact in a shorter scan time than radial UTE. Figure 3 shows multislice images of the short T2 components in white matter with excellent contrast. The sampling points were 256 for spiral UTE and 98 for radial UTE, which accounts for the SNR improvement and artifact

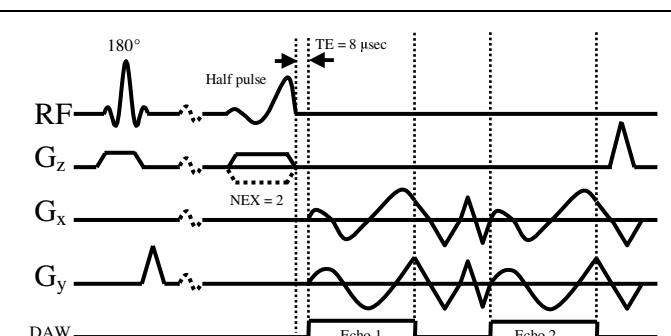


Fig 1. Pulse sequence for 2D ultrashort TE (UTE) imaging using half pulse excitation and spiral sampling. Long T2 signals are suppressed with a slice selective inversion pulse and dual-echo subtraction. Hysteresis gradient was played between the two echoes to reduce eddy current effect.

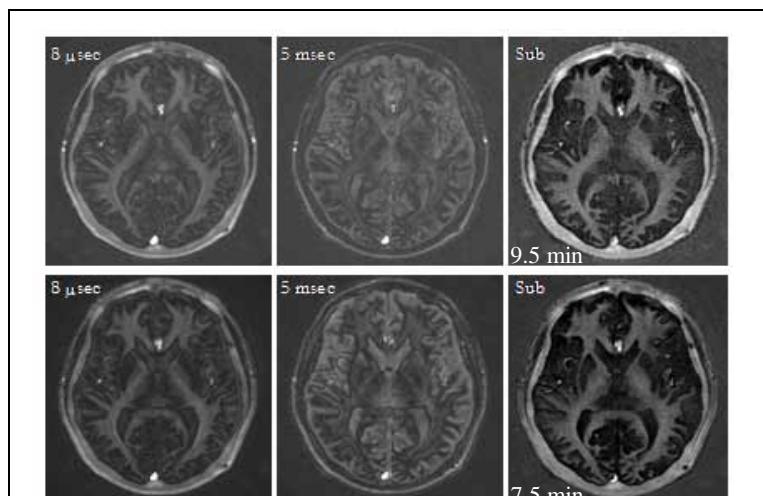


Fig 2. Ultrashort T2 brain imaging using radial UTE (upper row) and spiral UTE (lower row). Two images were acquired at echo times of 8us and 5 ms, and were subject to subtraction to depict the short T2 components in white matter. Spiral UTE sequence provides higher SNR and less streak artifact in a shorter scan time.

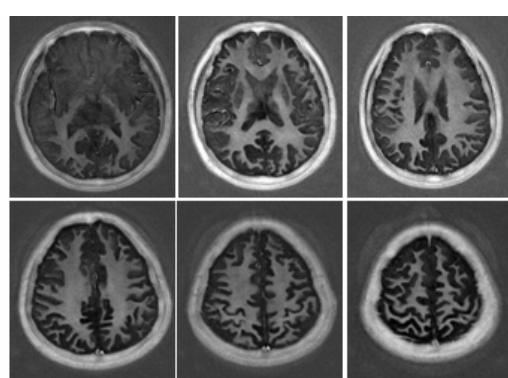


Fig3. Multislice spiral UTE imaging of the short T2 components in white matter.

reduction for spiral UTE. Little T2* blurring was observed in the spiral UTE images. Longer spiral readouts may provide higher SNR, but more T2* blurring.

CONCLUSIONS

The short T2 components in white matter can be imaged using UTE sequences. Spiral UTE provides higher performance than radial UTE in terms of SNR improvement and streak artifact reduction, and has considerable potential for clinical imaging of short T2 tissues.

REFERENCES

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