Long-T2 Suppressed Ultra Short-TE 3DPR Imaging

P. Gurney[1], P. Larson[1], D. Nishimura[1]
[1]Electrical Engineering, Stanford University, Stanford, CA, United States

Introduction: Imaging of ultra short-T2 species provides novel contrast for such applications as brain and tendon imaging [1,2]. In order to minimize the TE, images from two slice-selective half-pulse RF excitations are added to obtain an 2D image [3]. The half-pulse results in long tails in the slice selection axis which obviate the use of multi-slice scanning for volumetric coverage . Volumetric coverage can be achieved using a hard-pulse RF excitation combined with a 3D imaging sequence, such as 3DPR [4]. This work uses a long-T2/fat suppression pulse [5] to enhance short T2 species, followed by an ultra short TE 3DPR sequence which provides isotropic resolution.

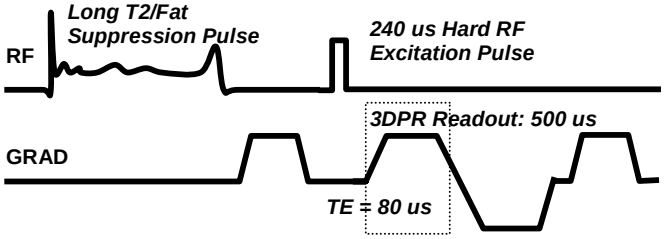

Figure 1: *Pulse sequence used for 3D ultra short T2 imaging*

Methods: In the pulse sequence shown in Figure 1, a 20 ms RF pulse is played out which rotates long T2 species and fat spins into the transverse plane. These spins are then dephased using a crusher pulse. A 240 us 45 degree hard RF pulse excitation is then played out which excites the remaining short T2 species. These spins are imaged using a 3DPR sequence with as short a TE as possible (80 us). Sampling occurs on the ramp of the PR spoke. Using the high-speed gradients of the GE Excite 1.5T scanner (150 mT/m/ms) and high bandwidth acquisition (+/- 250 kHz) allows a 1 mm isotropic resolution to be obtained using a readout length of less than 500 us. Therefore, full 1 mm isotropic resolution will be obtained for spins with T2s on the order of 500 us.

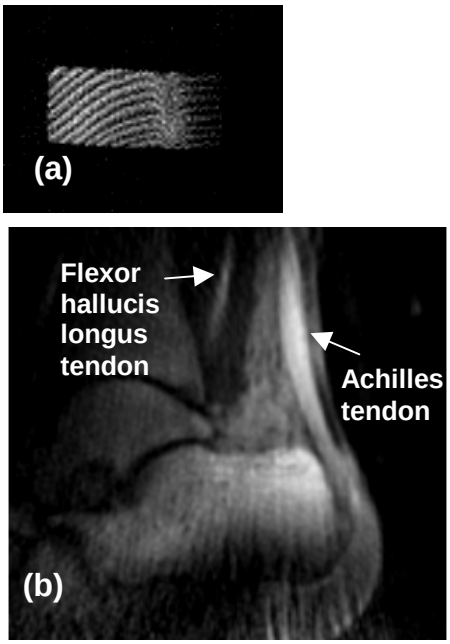

Figure 2: (a) *A block of wood,* (b) *Multi-planar reformat through a 3D ankle dataset.*

Results: This pulse sequence was implemented and used to scan a number of short T2 species. Figure 2(a) shows a scan of a solid block of wood, in which the age lines and a knot are clearly distinguishable. Figure 2(b) shows the Achilles tendon of a volunteer. 8192 3DPR spokes were acquired at a TR of 150 ms (scan time of 20 minutes). A multi-planar reformat through the 3D data set (Figure 2) showed good long-T2 suppression and reasonable fat suppression – the ultra short T2 species appeared to be very bright compared to the surrounding tissue. In order to obtain a reasonable scan time, the 3DPR was undersampled by a factor of about 3 which leads to some streaking artifacts. Due to B0 inhomogeneity in the foot, the fat suppression appears to have been compromised at the top of the calcaneus bone.

Discussion: Using a hard RF pulse and a 3DPR readout eliminates the problems of using slice-selective half-RF pulses for ultra short TE imaging (such as varying slice thickness for ultra short T2 species, and artifacts due to imperfections in the half-RF pulses). Furthermore, using the long T2 suppression pulse results in good contrast and eliminates the need to subtract images acquired with longer TEs. However, the time required for a full 3DPR acquisition is long and can cause motion blurring and patient discomfort. Further 3D short-TE work should examine the use of alternate trajectories, such as Cones or Spiral-PR. While these trajectories will require an increase in readout time to be effective, the reductions in scan time could make it worthwhile.

Conclusion: While resulting in longer scan times, using a long T2/fat suppression pulse combined with a 3DPR readout provides good contrast accentuating ultra short T2 species and is capable of providing volumetric coverage with nominal 1 mm isotropic resolution.

References:

[1] Waldman et al. Neuroradiology (2003) 45; [2] Robson et al. Clinical Rad. (2004) 59; [3] Pauly et al. US Patent 5025216, 1991; [4] Rahmen et al. ISMRM 2004 #2345; [5] Larson et al. ISMRM 2004 #2653