Novel Magnetization-prepared Multi-slice Multi-shot EPI Pulse Sequence for T1rho Quantitation

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Introduction In recent years, quantitative T1ρ pulse sequence development has focused on novel 3D acquisition schemes, supporting the coverage of fairly large anatomical regions of interest (i.e. full knee coverage) [1-3]. However, there are still numerous clinical scenarios where rapid or higher res evaluation of a focal region-of-interest is desired. Examples of such scenarios include the monitoring of a focal cartilage repair, hippocampal imaging for Alzheimer's disease, and the assessment of disc degeneration. In such cases, a multi-slice 2D acquisition method may be more appropriate and time-efficient than a 3D approach. Unfortunately, current multi-slice 2D T1ρ techniques [4, 5] have shortcomings that impede their clinical adoption. Ref 4 obtains T1ρ-weighted images that are contaminated by T2ρ effects. By assuming a global T2ρ value for all cartilage, Ref 4 attempts to retrospectively correct for these effects. Ref 5, on the other hand, successfully acquires images that exhibit "pure" T1ρ decay. However, to achieve a clinically acceptable scan time, this approach uses multi-shot spiral readouts for image acquisition. Slice prescriptions for this sequence are, therefore, largely limited to oblique axial planes; because of aliasing the sequence is often unable to acquire images in the sagittal or coronal orientations. To overcome the shortcomings of these existing techniques, a novel magnetization-prepared multi-shot EPI pulse sequence is proposed. This novel sequence can acquire images in any arbitrary plane and does not require retrospective correction for contrast contaminants.

Methods Pulse Sequence: Unlike the EPI method proposed by Borthakur [6], this novel acquisition plays out a *single* T1ρ Prep RF pulse cluster, 90°_x-SL_y-(-)90°_x, prior to the rapid acquisition of *all* prescribed slices (1 shot per slice). As with Ref 5, this new pulse sequence uses RF chopping to maintain – during the subsequent 2D multi-slice acquisition – the contrast imparted by a non-selective magnetization preparation module, which would otherwise be corrupted by T1 recovery [7]. T1ρ-weighted images were acquired by varying the duration of the spin lock pulse (TSL) during T1ρ preparation. Experiments: After obtaining informed consent, the knees, spines and brains of healthy volunteers were scanned on a 3.0T GE Signa HDx system (GE Healthcare, Waukesha, WI). An 8-ch T/R knee coil (Invivo) was used for imaging the knee. Spine images were acquired with an 8-ch CTL coil. A Quad T/R coil was used for head imaging. Spine T1ρ images were acquired with a spin lock frequency of 300 Hz. 500 Hz spin lock frequency was used for the imaging of all other anatomical sites.

Results The figures below show example *in vivo* T1ρ-weighted images (a-d) and their corresponding T1ρ maps (e). T1ρ values of the tissues imaged were will within the range of previously published values. Cartilage: 35-55 ms. Muscle: 28-32 ms. Intervetebral discs: 75-110 ms. White matter: 65-75 ms. Grey matter: 85-110 ms.

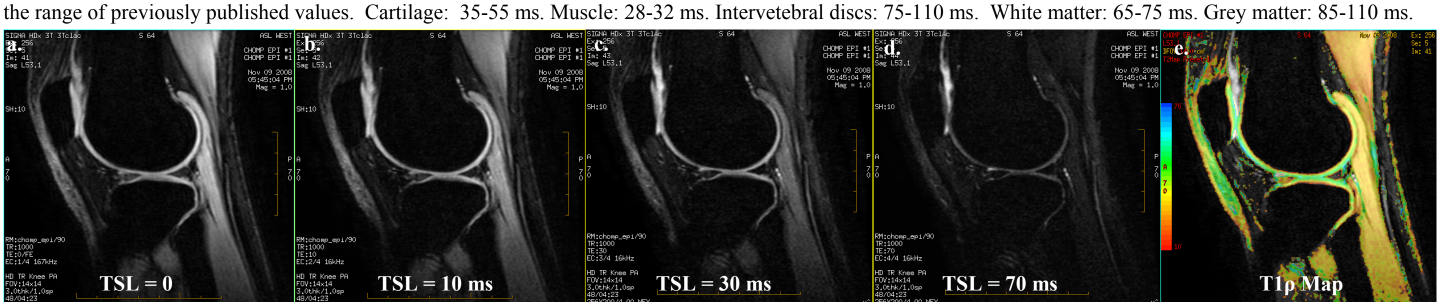

Fig 1. FOV: 14 cm; matrix: 256 x 200; slice thickness: 3 mm; 15 slices acquired; 10 shots; NSA: 4; ramp sampled, partial-ky, ASSET (R=2); scan time: 4 min 30 sec

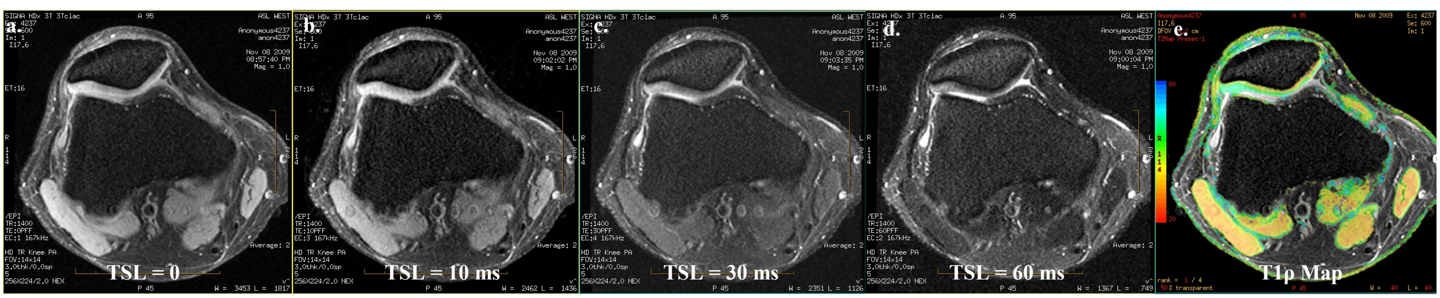

Fig 2. FOV: 14 cm; matrix: 256 x 224; slice thickness: 3 mm; 10 slices acquired; 16 shots; NSA: 2; ramp sampled, partial-ky; scan time: 3 min 30 sec

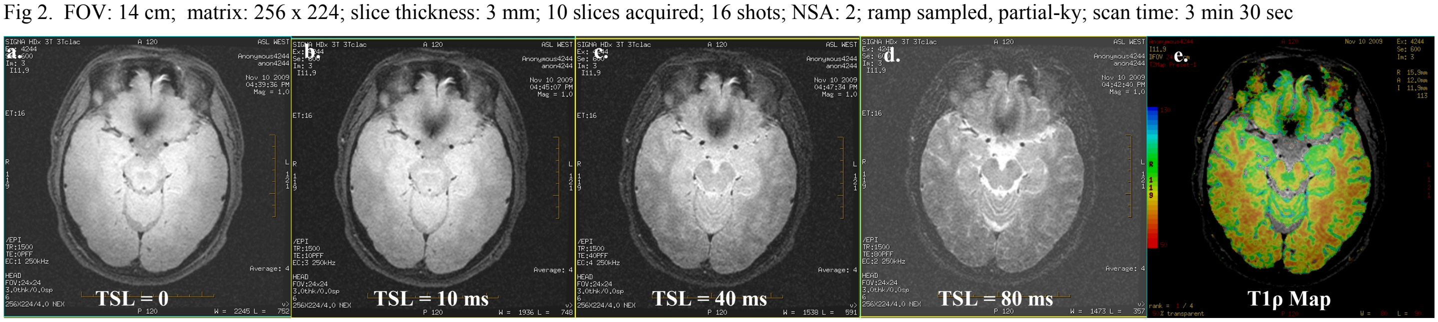

Fig 3. FOV: 24 cm; matrix: 256 x 224; slice thickness: 3 mm; 6 slices acquired; 16 shots; NSA: 4; ramp sampled, partial-ky; scan time: 7 min 45 sec

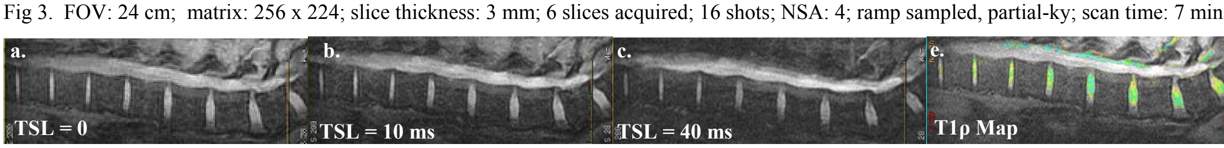

Fig 4. FOV: 26 cm; matrix: 256 x 224; slice thickness: 3 mm; 6 slices acquired; 16 shots; NSA: 4; ramp sampled, partial-ky; scan time: 10 min

References [1] Borthakur. JMRI, 2003 [2] Li.. MRM, 2008 [3] Witschey. JMRI, 2008 [4] Wheaton. MRM, 2004 [5] Li.. MRM, 2005 [6] Borthakur. JMRI 2006 [7] Wright. ISMRM, 1996