

High spatial resolution multispectral quantitative MRI of the human knee: mixed-TSE pulse sequence

A. Murakami¹, J. Tkacz¹, and H. Jara¹

¹Radiology, Boston University Medical Center, Boston, MA, United States

Purpose: To develop a very high spatial resolution mixed-TSE pulse sequence for clinical quantitative MRI of the human knee that provides full anatomic coverage, negligible flow artifacts, and clinically acceptable scan time. Also to assess the image quality of the following the mixed-TSE-derived self-coregistered Q-MRI maps: PD, T1, T2, correlation time diffusion coefficient (D), and T1/T2 ratio.

Methods: The high resolution mixed turbo spin echo (mixed-TSE) pulse sequence was adapted from a previously described brain sequence (Ref. 1) and was tested with a 1.5 T clinical scanner (Philips Medical Systems, Cleveland Ohio) using the standard quadrature knee coil. Protocol was set up in the sagittal plane with cranial-caudal phase encoding direction in order to minimize artifacts from flowing blood in the popliteal artery. Key imaging parameters: 272 x 198 acquisition matrix, 40 slices, 0.35 x 0.35 x 2.5 mm³ reconstructed voxel size, 600/3,545 ms inversion times, 5.6/96ms echo times, 22 ETL, 7,058ms repetition time, 2 NEX, 3.6 W/kg whole body SAR and 8:30min scan time.

The directly acquired images (see Fig. 1) were processed with model conforming Q-MRI algorithms (Ref. 1) programmed in Mathcad 2000i (Mathsoft, Cambridge MA) to generate self-coregistered maps of PD, T1, T2, correlation time diffusion coefficient (Ref. 2), and the longitudinal to transverse relaxation time ratio T1/T2.

Results: Representative self-coregistered Q-MRI maps are shown in Fig. 2. Similar high map quality was observed for all 40 slices, with only minor residual ghosting stemming from the popliteal artery in a few central slices. Cartilaginous surfaces were best delineated in the T1/T2 map because cartilage has large T1/T2 ratio and is adjacent to low T1/T2 tissues (fatty bone marrow and synovial fluid). Region of interest Q-MRI measurements of several tissues are in good agreement with accepted values.

Conclusion: Very high spatial resolution quantitative MR imaging with full knee coverage can be achieved with the mixed-TSE pulse sequence with a scan time of 8:30min. Described technique has the potential of replacing standard MRI protocols via Synthetic MRI (Ref. 3) a process by which images of arbitrary contrast weightings can be generated by post processing Q-MRI maps with a mathematical model of the MRI scanner.

References

1. Suzuki S, Sakai O, Jara H. **Combined volumetric T1, T2, and secular-T2 quantitative MRI of the brain: age-related global changes (preliminary results).** Magnetic Resonance Imaging 2006; 24(7):877-887.
2. Jara H. **High spatial resolution diffusion-MRI of the human brain with the mixed-TSE pulse sequence: a non-Pulsed Field Gradient technique.** RSNA 2005, Chicago, IL.
3. Jara, H: **Synthetic Images for a Magnetic Resonance Imaging Scanner Using Linear Combination of Source Images to Generate Contrast and Spatial Navigation.** United States Patent: US 7,002,345 (02/21/2006).

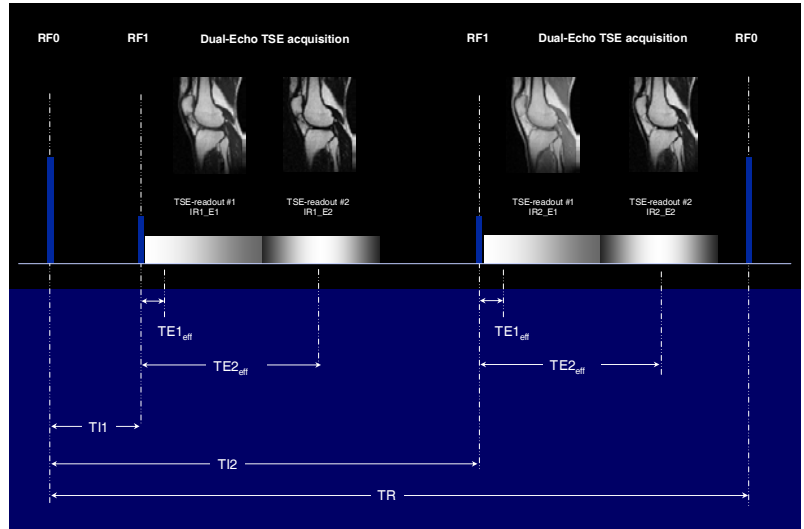


Fig 1: Mixed-TSE pulse sequence diagram showing the four directly acquired images from which all Q-MRI maps are derived.

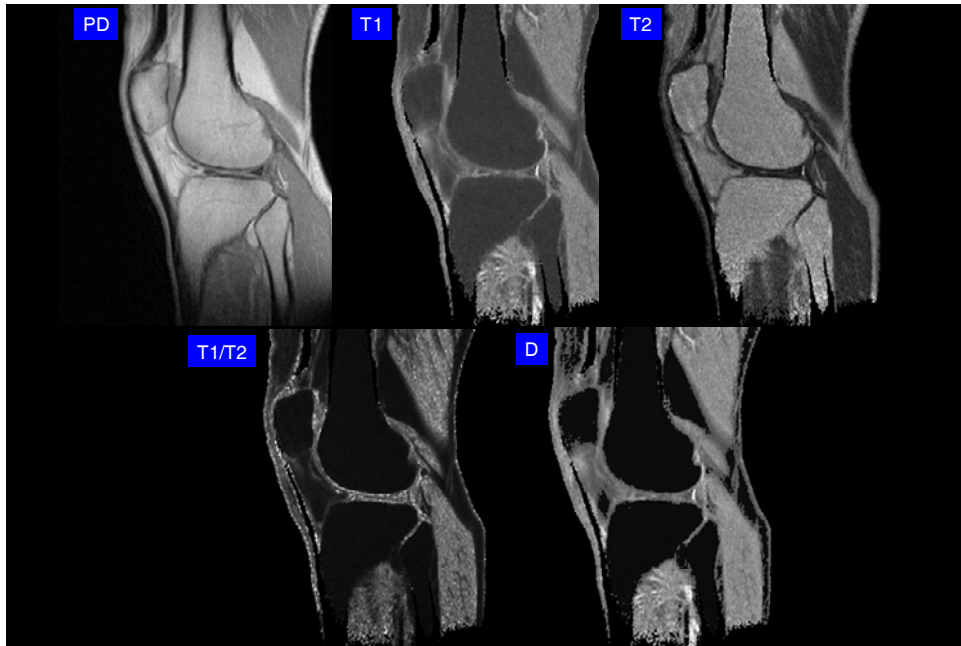


Fig 2: Representative Q-MRI maps generated from mixed-TSE directly acquired images. From left to right, (top row): PD, T1, and T2 and (bottom row) T1/T2 and correlation time diffusion coefficient.