

Quantitative Assessment of Cartilage Using CubeQuant

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Introduction: Osteoarthritis (OA) is a chronic degenerative disease of the entire joint, involving the articular cartilage. Measurements of T1rho and T2 relaxation times, which are sensitive to changes of matrix composition in cartilage, have the potential to detect early onset of OA (1). A new method, called CubeQuant, based on the 3D fast spin echo approach Cube™(GE Healthcare, Waukesha, WI) has been recently reported as a highly SNR efficient approach for 3D T1rho or T2 mapping (2). In this work, we assess CubeQuant for 3D T1rho and T2 quantification of cartilage in patients. We also performed comparison of CubeQuant with a standard 3D T1rho/T2 mapping approach, magnetization-prepared angle-modulated partitioned-k-space SPGR snapshots (MAPSS) (3) on phantoms.

Theory and Methods: 9 patients (6M, 6F, ages 27-48) with knee pain were imaged on a Discovery MR750 3T scanner (GE Healthcare, Waukesha, WI) using a transmit-receive 8-channel knee coil (Invivo Inc., Gainesville, FL). For *in vivo* scans, informed consent was obtained. The imaging parameters include: 15x15cm FOV, 3mm thickness with total 44 slices, 320x256 matrix, 1 NEX, ± 62.5 kHz BW, 2X ARC (GE Healthcare) along both phase encoding and slice selective direction, 4 acquisitions with TSL = 1, 10, 30, 60ms for T1rho quantification, and 4 acquisitions with effective TE = 6.5 13.4, 27, 40.7ms for T2 quantification. The total scan time was 5:24 for either T1rho or T2 quantification of full knee. A phantom with 6 tubes with different T2 relaxation times was imaged with slightly reduced matrix with both MAPSS and CubeQuant using the same system and T2 mapping parameters. In patients, the femoral cartilage was segmented into 5 regions (anterior superficial, anterior deep, central, and posterior superficial, posterior deep) by a single observer and T1rho and T2 relaxation times were measured.

Results and Discussion: Figure 1 shows good agreement between T2 relaxation time measurements with MAPSS and CubeQuant in the phantom. Figures 2 shows the comparison of T1rho and T2 relaxation times measured in five regions in our patients using CubeQuant. The measured T1rho value is significantly higher than T2 in all regions (p-value < 0.001). Correlations were seen between T1rho and T2 measurements in most regions of the cartilage (Figure 3). Figure 4 shows elevated T1rho and T2 relaxation times measured using CubeQuant in a patient with cartilage damage.

Conclusion: CubeQuant is a highly SNR efficient method for 3D T1rho and T2 quantification (2). Our assessment in patients shows this technique is promising for 3D quantitative T1rho and T2 imaging of cartilage. Using a biochemical imaging method based on 3D FSE has the potential to provide traditional anatomic information, such as cartilage damage and meniscal tears, in addition to important biochemical data.

References: 1. Regatte et al, JMRI 2006, p547 2. Chen et al, ISMRM 2011, p231 3. Li et al, MRM 2008 p298

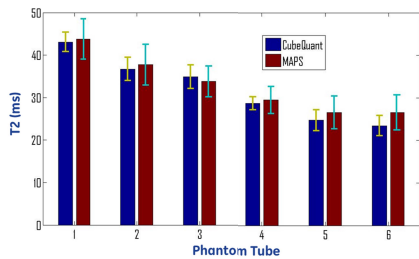


Fig 1. Comparison of MAPSS and CubeQuant for T2 quantification of phantoms. No significant differences in T2 measurements between the two methods was seen.

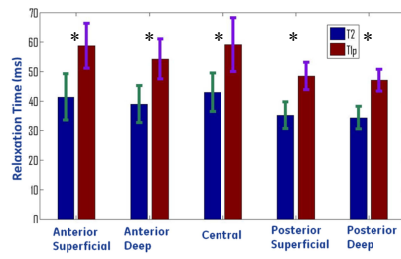


Fig 2. Comparison of T1rho and T2 from CubeQuant scanning of 9 patients. Significant increases in T1rho relaxation times were seen in all regions (asterisks).

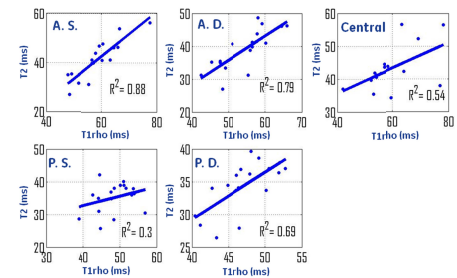


Fig 3. Scatterplot of T1rho and T2 from CubeQuant in 9 patients at different locations on cartilage (AS = anterior superficial, AD= anterior deep, PS = posterior superficial, PD = posterior deep).

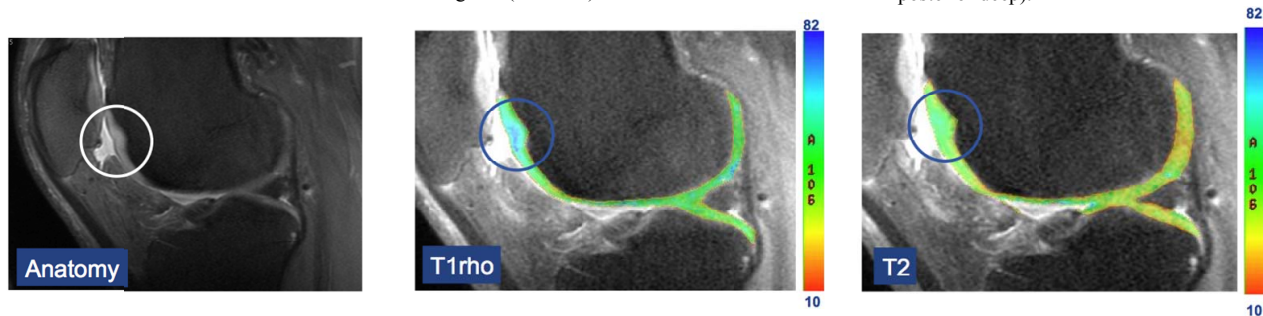


Fig 4. Images from a patient with cartilage damage in the femoral trochlea. The anatomic image shows increased signal, whereas the T1rho and T2 maps show elevated values in the cartilage in this region, likely correlated with glycosaminoglycan depletion and collagen matrix damage.