

The relationship between T1rho measurements in the meniscus and cartilage in healthy subjects and patients with osteoarthritis

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INTRODUCTION

Meniscal damage has been shown to play a central role in the development and progression of osteoarthritis (OA). However, few studies have investigated the interrelationship between cartilage and meniscus using quantitative magnetic resonance imaging (MRI) measurements. The purpose of this study was to investigate the relationship between cartilage and meniscus and to determine which cartilage and meniscal compartments have the strongest interrelationship in OA knees using 3T MR T1rho relaxation quantification.

METHODS

MRI was performed on 64 subjects using a 3-T GE MR scanner and 8 channel phased-array knee coil. The mean age of the subjects was 52 (± 12.6), mean BMI of 26.0 (± 5.37) and 57% of the subjects were female. The clinical assessment of the meniscus was performed by 2 experienced radiologists using a sagittal fat-saturated FSE T2-weighted clinical imaging sequence (matrix 512x256, FOV=16cm, slice thickness=2mm) and graded using the semi-quantitative Whole-organ magnetic resonance imaging scoring (WORMS) while the morphological cartilage assessment was done using a fat-saturated 3D SPGR sequence (matrix 512x512, FOV=16cm, slice thickness=1mm). Cartilage T1rho maps were generated using a 3D T1rho mapping technique based on SPGR sequences previously developed in our lab (matrix 256x128, slice thickness=4 mm, time of spin lock (TSL)=0/10/40/80 ms, spin lock frequency =500 Hz). The 5 cartilage compartments [lateral femoral condyle (LFC), medial femoral condyle (MFC), medial tibia (MT), lateral tibia (LT), and patella (P)] were segmented semi-automatically in the 3D SPGR sequence using MATLAB based software developed in-house. The 4 meniscal compartments [anterior horn lateral meniscus (AHLAT), anterior horn medial meniscus (AHMED), posterior horn lateral meniscus (PHLAT), and posterior horn medial meniscus (PHMED)] were segmented using the third echo of the T1rho map (Fig. 1). The 3D SPGR images were rigidly registered to the T1rho maps using VTK CISG Registration Toolkit. T1rho values from each defined compartment of cartilage and meniscus were calculated. Spearman rank correlations were used to investigate the correlation between the cartilage T1rho and the meniscus T1rho for each region.

RESULTS

MRI revealed that 48% of the patients had a meniscal tear in one or more compartments. The incidence of a meniscal tear was higher in the posterior compartment (42% in the PHMED, 15% in the PHLAT) than the anterior compartment (14% in the AHLAT, 6% in the AHMED). Subjects with a tear in the medial posterior horn had a significantly higher T1rho in the MT, PHMED, and PHLAT compared to subjects without a tear in the medial posterior horn (Fig. 2). Despite the higher incidence of a meniscal tear in the medial posterior horn, moderate but significant correlations were primarily found between the cartilage and meniscus T1rho in the lateral meniscal compartments. The rho values reported for AHLAT versus LFC, MFC, and LT were 0.319, 0.441, and 0.297 respectively with corresponding p values of 0.018, 0.0007, and 0.028 respectively. The rho values for the PHLAT versus LFC, MFC, and LT were 0.280, 0.260, and 0.370 respectively with corresponding p values of 0.036, 0.048, and 0.005 respectively. The only medial meniscal compartment that had a significant correlation with the cartilage T1rho was the AHMED which correlated significantly with the MT cartilage T1rho ($\rho=0.307$, $p=0.019$).

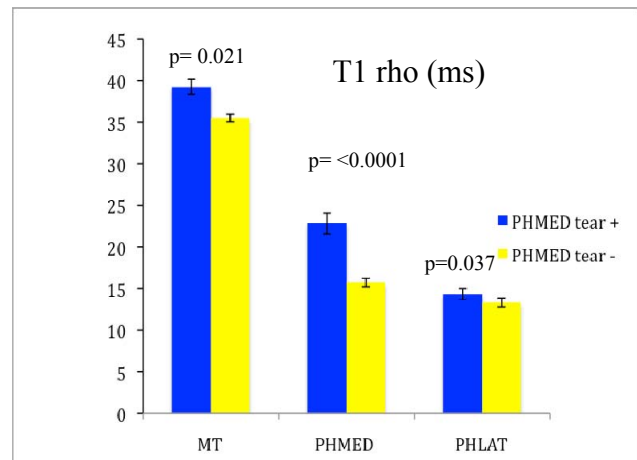
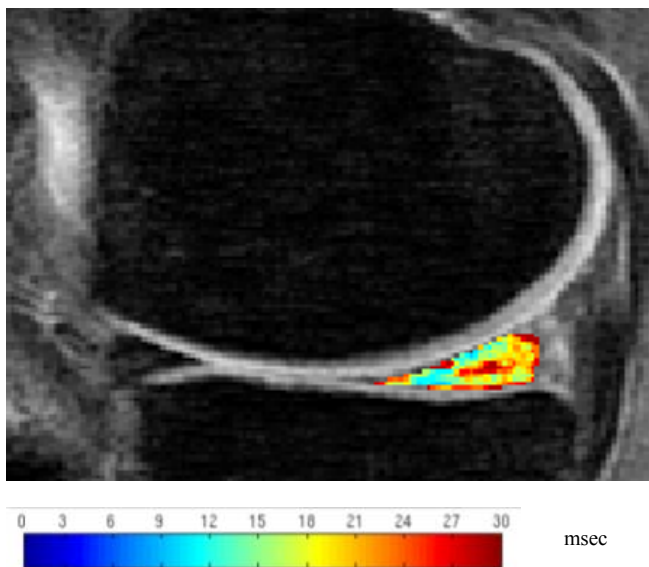


Figure 2. T1rho measurements in subjects with (+) or without (-) the presence of a posterior horn medial meniscus tear (PHMED).

Figure 1. T1rho map showing the segmented posterior horn of the medial meniscus in a subject with a meniscal tear (meniscal WORMS score=2). The color bar indicates the gradation of T1rho values in the posterior horn of the medial meniscus.

DISCUSSION

While meniscal tears may play a central role in the progression of osteoarthritis, the interrelationship between the cartilage and meniscus may be more complex. The presence of a meniscal tear in one region may not necessarily only correlate with changes in the articular cartilage in the adjacent region. Rather, a meniscal tear can lead to global degenerative cartilage changes. We will follow up these patients to investigate the progression of cartilage degeneration and their relationship with meniscal damages.

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