

A Longitudinal Study of T2 Changes in Articular Cartilage of the Osteoarthritic Knee

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Introduction: Osteoarthritis (OA) is a skeletal disease characterized by cartilage degradation. Previous studies of articular cartilage in the knee with OA have shown increased T2 values compared to normal cartilage [1]. Studies evaluating cartilage properties by T2 measured on clinical MR scanners have been performed [2], in addition to examination of degradation on ex vivo cartilage T2 [3]. To the authors' knowledge, investigations into the T2 relaxation changes during progression of knee OA over time have not been reported previously. The purpose of this study was to observe changes in T2 measurements of knee cartilage in patients with OA between two scans separated by between 400 and 1050 days.

Methods: Twelve patients (mean age 59 years, range 43-76 years, 4 females) were evaluated radiographically and scored by the Kellgren-Lawrence (KL) method for assessing osteoarthritic changes of the knee. Four patients had a KL score of "1", one had a "2", six were "3", and one was "4". All patients had two scans with a mean time between the baseline and follow-up scan of 680 days (range 400 – 1050 days). Imaging was performed on a SIGNA 1.5 T echo-speed system (GE Medical Systems) with a dual phased array coil (USA Instruments, Cleveland, OH). A 2D dual echo SE sequence was used ($TE_1/TE_2 = 10/45$ ms, TR = 1500 ms, .468 x .468 x 4 mm³ voxel size) to generate a T2 map using an in-house IDL routine (Research Systems, Boulder, CO). SPGR images with fat suppression by the spectral inversion at lipids (SPECIAL) technique (TI = 8 ms, TE = 3.3 ms, TR = 30 ms, flip angle 40°, .234 x .234 x 2 mm³ voxel size) were acquired along with the T2 maps. The cartilage from the SPGR image was segmented by manually placing control points for Bezier spline curves to enclose the region of interest [4]. The segmentation was applied to the T2 map after 2D downsampling and taking the union of adjacent slices to adjust for the differing voxel sizes between the scans. The cartilage compartments were determined based on anatomical landmarks, and classified into four compartments: medial and lateral tibia and femur. For qualitative comparison, three normal volunteers (mean age 44 years, range 28-70 years) were scanned and similarly analyzed. The mean value across patients of the mean T2 for each cartilage compartment was determined at baseline and follow-up. The paired Student's t-test was used to compare the values between the baseline and follow-up exams for each compartment.

Results and Discussion: The mean T2 was found to increase significantly ($p < 0.05$) between the baseline and follow-up exams for all cartilage compartments except the lateral tibia (Figure 1). The results emphasize the increased incidence and progression of OA in the medial compartments of the knee. For qualitative comparison, in all cases the patients had a higher mean T2 value compared to normal volunteers except for the baseline scan of the medial tibia. Assessment and quantification of OA disease factors over time could prove clinically valuable. Our results are consistent with the hypothesis of more mobile water, and hence higher T2, in the cartilage matrix with OA degradation over time.

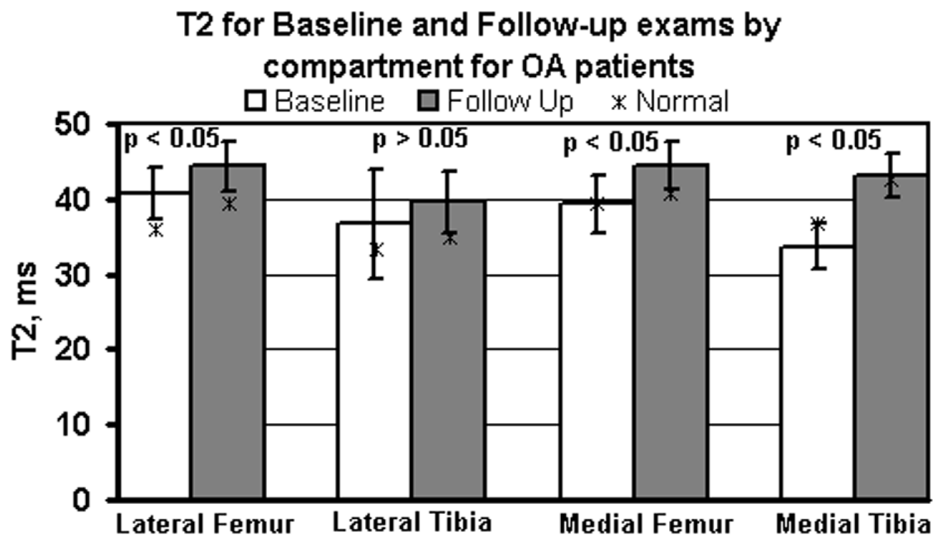


Figure 1. Comparison of mean T2 values across 12 patients in the knee cartilage compartments at baseline and follow-up. The T2 was observed to significantly ($p < 0.05$) increase over time for all compartments except the lateral tibia. Mean T2 values for three normal volunteers are shown for qualitative comparison, and are lower in all cases except the baseline scan of the medial tibial compartment.

References:

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Acknowledgements: This work is supported by NIH grant R01 AR46905.