

Relationship of Joint Space Width and Cartilage T₂ Values in Subjects with Osteoarthritis

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INTRODUCTION

The MRI image analysis technique of T₂ mapping has been developed to investigate osteoarthritis (OA) in diarthrodial joints [1]. T₂ values of cartilage are related to the local collagen fiber orientation and water content of the tissue [2,3]. A previous study correlated T₂ values and OA using radiographic grading [4]. Relating cartilage T₂ values to alternative methods of assessing diarthrodial joint OA would be beneficial for determining the clinical implications of the T₂ mapping technique.

Standard in-vivo assessment of OA is routinely performed by examination of the joint space width (JSW). JSW is known to change during the progression of OA [5]. The relationship between JSW and the corresponding T₂ value of cartilage within the joint is unknown. The purpose of this study was to assess the relationship between patellar cartilage T₂ values and JSW measurements to determine if the correlation is dependent upon stage of OA.

METHODS

Subjects: Following IRB approval with informed consent, 113 consecutive subjects (56 ± 11 y.o., 29M, 84 F) were enrolled in the study.

Data Acquisition: Standing lateral radiographs centered on the patella were obtained for each knee. Following the radiological exam, MR images of each subject's patellae were obtained. For T₂ calculations, a series of axial T₂-weighted fast spin-echo (FSE) images were acquired across 10 slices locations spanning the length of the patella. Eight echo images were acquired at each slice location: TR = 1000ms, TE = 8-76ms, slice thickness = 2mm, slice spacing = 4mm, FOV = 12cm x 12cm, in-plane resolution = 0.49mm x 0.49mm. Immediately following, an oblique sagittal spiral fast SPGR sequence was used to acquire images for joint space width calculations: slice thickness = 3mm, slice spacing = 1mm, FOV = 15x15 cm, in-plane resolution: 0.29mm x 0.29 mm, flip angle: 90 degrees. The knee was in approximately 20° flexion for both imaging sequences.

Data Analysis: Radiographs were graded for patello-femoral (PF) OA based on the Kellgren and Lawrence (KL) scale from 0 (no OA) to 4 (end-stage OA). This scale assigns a level of OA based on the evaluation of joint space width and the presence and size of osteophytes. Custom written software was used to analyze the MR images. For T₂ calculations, patellar cartilage was manually segmented on each image. T₂ values of patellar cartilage were calculated on a pixel-by-pixel basis by fitting the echo time (TE) data and the corresponding signal intensity (SI) to a mono-exponential equation: $SI(TE) = S_0 \exp(-TE/T_2)$. Data from the first echo image was discarded in calculating T₂ values to increase T₂ accuracy [6]. Pixels with T₂ values greater than 200 ms were considered outliers and were excluded from statistical analysis [4]. An average T₂ value generated from all analyzed pixels of each patella was used for statistical analysis. Measurement of JSW was made using a semi-automated program which assigned each pixel a value based on the ratio of local signal intensity differences to maximal signal intensity differences in the image [7]. The program then performs a line search on the processed image to determine the edges of the joint space, from which the minimum JSW is calculated. Regression analysis and calculation of the Pearson correlation coefficient (r) was performed between average T₂ values and minimum JSW measurements. Regression and correlation analysis was also performed for JSW within each stage of KL OA. Statistical significance was set at p<0.05.

RESULTS

No correlation was found between T₂ values and JSW for all combined stages of OA (r=0.0644, p=0.34, Figure 1). In addition, weak correlations and insignificant regressions of T₂ values with JSW were found for all stages of OA (Table 1). Regression and correlation analysis for KL OA Stage 4 was not performed due to limited sample size (n=3).

DISCUSSION

This study evaluated the relationship between T₂ values of patellar cartilage and measurements of patello-femoral JSW measurements. No relationship was found between these two variables for combined and individual stages of PF OA. This finding is primarily due to two factors. First, changes of T₂ values likely occur during the onset of OA, while changes of JSW occur at a later time point. The time difference between changes of T₂ values and changes of JSW would result in weak correlation between the two variables. Second, this study evaluated the minimum JSW of the PF joint with an average patellar cartilage T₂ value. While we often found focal increases of T₂ values on individual image slices, statistical analysis using an average T₂ value of the patella diminished the effect of focal increases of T₂ values on the total patellar T₂ value. A regional specific analysis of T₂ values with JSW may result in significant findings. Our results indicate that measurement of patello-femoral minimum JSW may not be used as a surrogate for average patellar cartilage T₂ values. Further work is needed to investigate the relationship of patellar cartilage T₂ values to standard clinical assessment of PF OA.

REFERENCES

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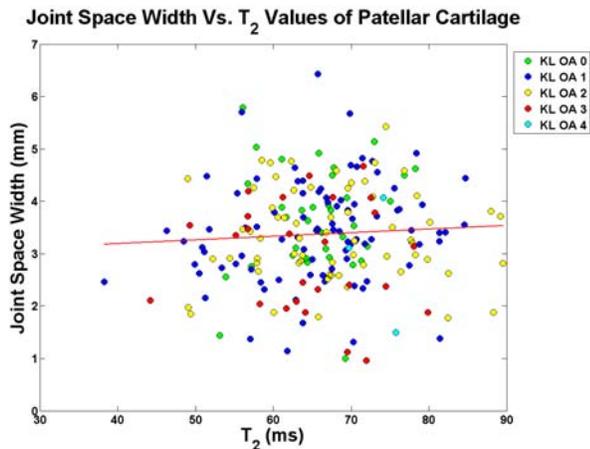


Figure 1. Scatter plot of T₂ values of patellar cartilage by OA stage verses joint space width measurements of the patello-femoral joint.

Regression and Correlation Analysis of Patello-Femoral Joint Space Width and Patellar Cartilage T ₂ Values			
Kellgren-Lawrence OA Stage Grouping	n	Correlation Coefficient (r)	Regression p-value
All	220	0.0644	0.34
0	39	0.1197	0.47
1	88	0.1677	0.12
2	64	-0.0179	0.89
3	26	-0.1088	0.60