

Changes of Knee Cartilage T2 in Relation to Physical Activity: 24-Months Follow-up Analysis of 182 Non Symptomatic Individuals from the Osteoarthritis Initiative

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Purpose:

The aim of this study was to analyze morphological cartilage abnormalities at baseline and cartilage T2 relaxation time measurements at baseline and after 24 months, at 3.0 Tesla in 182 asymptomatic subjects aged 45-55 years from the Osteoarthritis Initiative (OAI). The association of these MR measurements with physical activity levels of the subjects assessed with the PASE (Physical Activity Scale for the Elderly) scale were studied. Our hypothesis was that asymptomatic subjects from the Osteoarthritis Initiative (OAI) with pre-existing knee abnormalities or high activity levels at baseline demonstrate accelerated T2 changes after 24 months compared to individuals with lower PASE and less severe morphological abnormalities.

Material and Methods:

The Osteoarthritis Initiative (OAI) is a multi-center, longitudinal, prospective observational study of knee osteoarthritis (OA). The overall aim of the OAI is to develop a public domain research resource to facilitate the scientific evaluation of biomarkers for osteoarthritis as potential surrogate endpoints for disease onset and progression. The subjects included in this analysis were a subset of the 4796 participants in the OAI Study. We analyzed 182 individuals of the OAI without pain, based on a low Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC score = 0), who did not have symptomatic osteoarthritis yet had risk factors for OA. Subjects were middle-aged (age range: 45–55 years) and had normal BMI (19–27). In addition subjects had different activity levels, as determined with the Physical Activity Scale for the Elderly (PASE). Based on their physical activity level (PASE from 27 to 378) subjects were divided into three groups with the same PASE range of 117 and were defined as low activity group with PASE values of 27-144, as medium activity group with PASE values of 145-261 and as a high activity group subjects with PASE values of 262-378. 3T MRI (Siemens Trio) of the right knee was obtained in every subject at baseline and after 24 months. The knee MRI acquisition consisted of a coronal intermediate-weighted (IW) 2D fast spin-echo (FSE), sagittal 3D dual-echo in steady state (DESS) with selective water excitation (WE), sagittal 2D IW FSE with fat suppression (FS) and sagittal 2D multi-echo (ME) spin-echo (SE) sequences¹. MR images were evaluated by two musculoskeletal radiologists separately, if scores were not identical by both observers consensus readings were performed. Pathology of cartilage surfaces were analyzed using the WOMBS-Score^{2,3}. Cartilage abnormality was counted using a threshold of 1 and above. Segmentation of tibia, femur, trochlea and patella cartilage was performed to generate T2 maps from the sagittal 3.0 T MR images of the knee at baseline and after 24 months. Statistical significance was determined using a multi-regression model to correct the data for the impact of age, gender and BMI and risk factors of OA (knee injury or surgery in history, family history of knee replacement and Heberden's nodes at the hands).

Results:

Cartilage T2 values increased significantly over time (44.52±2.31 ms vs. 45.88±2.46 ms: p<0.0001). Subjects with cartilage abnormalities had higher T2 values at baseline (p=0.035) and at 24 months (p=0.006). Patient with higher PASE scales showed higher T2 values at baseline (p=0.01) and follow up (p=0.0002) and a higher increase in T2 values over time compared to more sedentary subjects (p=0.03). These changes were found in the femoropatellar (p=0.048) and the medial femorotibial joint (p=0.037), but not in the lateral femorotibial joint (p=0.574).

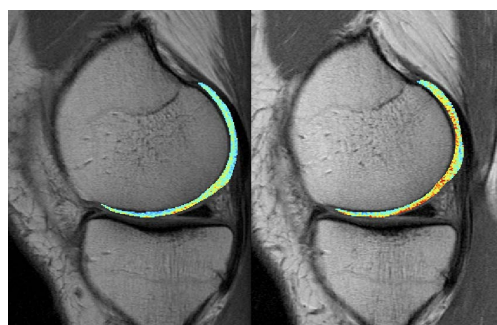


Fig. 1: Color-coded T2 maps. Figure (A) shows an MR image of the MFC at baseline and Figure (B) the same region in the same subject after 24 months with increasing T2 values.

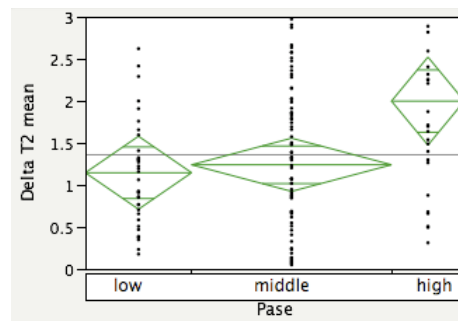


Fig. 2 : Significantly higher increase of T2 over time (Delta T2) in subjects with higher physical activity (p<0.05).

Discussion and Conclusion:

Cartilage T2 relaxation time measurement is a relatively new quantitative MR parameter to assess the water content and collagen quality in subjects with evolving cartilage degeneration. It has been used with good results in differentiating normal subjects and those without early OA^{4,5}. Significant differences in subjects with and without OA indicate that both T2 and morphometric parameters may be useful in quantifying early OA related changes, like collagen matrix changes and hydration of the cartilage. While a previous study⁵ with 12-months follow-up, did not show significant alterations of the T2, we were able to show changes of the integrity of the collagenous structures, which may be due to the length of the observation interval and technical factors (different T2 mapping sequence). Interestingly pre-existing focal cartilage lesions and higher physical activity levels induced accelerated cartilage matrix changes in the weight-bearing joint compartments as assessed with T2 relaxation times. These results suggest for the first time that T2 mapping may be a useful quantitative parameters to assess longitudinal changes in early OA.

References:

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