Cartilage T2 of the patella and focal knee abnormalities at 3T in relation to physical activity in non symptomatic subjects from the incidence cohort of the Osteoarthritis Initiative

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Purpose:

The aim of this study was to study cartilage T2 relaxation time measurements, morphological cartilage and meniscus abnormalities in 3.0 Tesla MR studies obtained in 100 asymptomatic subjects aged 45-55 years from the Osteoarthritis Initiative (OAI) incidence cohort. The association of MR measurements to physical activity levels of the subjects assessed with the PASE (Physical Activity Scale for the Elderly) scale was determined. Our hypothesis was that physically active individuals will show higher T2 values of the patella and a significantly higher number and larger size of cartilage abnormalities than sedentary subjects.

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 5000 participants in the OAI Study. We analyzed 100 individuals from the Incidence Cohort 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 either high or low activity levels, as determined with the Physical Activity Scale for the Elderly (PASE). A cohort of 50 women and 50 men was examined, divided in 2 subgroups each: 25 patients with high activity level (strenuous sports) and 25 patients with low activity level based on the PASE score (PASE scale: 0-400, average: 160). Bilateral radiographs and 3T MRI (Siemens Trio) of the knees and clinical data were obtained in every subject. The knee MRI acquisition consisted of a cor intermediate-weighted (IW) 2D turbo spin-echo (TSE), 3D dual-echo in steady state (DESS) with selective water excitation (WE), sag 2D IW TSE with fat suppression (FS) and sag 2D multi-echo (ME) spin-echo (SE) sequences[1]. Radiographs and 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 and meniscus were analyzed using the WORMS-Score[2,3] and the RECHT-Score[4,5]. Cartilage and meniscal abnormality was counted using a threshold of 1 and above. Segmentation of the patella cartilage was performed to generate T2 maps from the sagittal 3.0 T MR images of the knee. Statistical significance between the groups and of correlations between the measurements and scores were determined using Student t-Test, Wilcoxon Test, one-way analysis of variance (ANOVA) and Spearman correlation coefficients test.

Results:

Meniscal lesions were found in 46/100 resp. 46% (m=50%, f=42%) of the asymptomatic subjects, in 79/100 resp. 79 % (m=74%, f=84%) of these subjects cartilage lesions were detected; 39% of the cartilage lesions were located at the patella (m=32%, f=46). When separating subjects according to their activity levels, in a low (PASE: 0-159) and a high PASE scale group (160-400), a higher incidence of abnormalities was found in the high PASE scale group. Patella cartilage lesions were found in 50% (versus 35.9% in sedentary subjects) of the subjects with high PASE scale and meniscus abnormalities in 60% (versus 32%). Differences between the groups were significant (p<0.05). The T2 values of the patella cartilage were also significantly increased in the high PASE scale group (mean 44.7 ± 3.0 vs. 49.7 ± 4.0, p ≤ 0.0001). There was a significant correlation of T2 patellar cartilage values with PASE scale values (0.55 p ≤ 0.0001), with WORMS (0.43 p ≤ 0.0001) and RECHT (0.43 p ≤ 0.0001) scores of the patella cartilage as well as the WORMS (0.47 p ≤ 0.0001) and RECHT (0.48 p ≤ 0.0001) score of all cartilage knee compartments. Subjects with meniscus abnormalities had significantly higher T2 values of the patella cartilage (mean 46.1 ± 3.71 vs. 48.7 ± 4.58, p ≤ 0.0021).
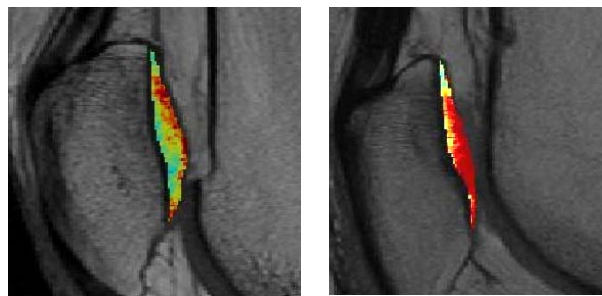

Fig. 1: Color-coded T2 maps overlaid on first-echo time images. Left: low T2 values in a sedentary patient. Right: high T2 values in an active patient of the same age.
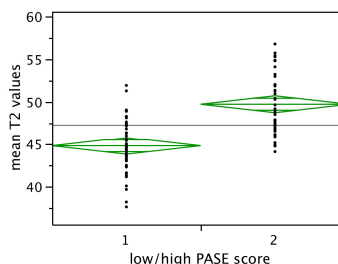

Fig. 2 : Significant difference in T2 values of the patella cartilage for subjects with low/high PASE scale (p<0.05).

Discussion and Conclusion:

Middle-aged non-symptomatic individuals in our cohort had a very high prevalence of cartilage (79%) and meniscus (46%) knee lesions. A highly significant correlation between patella cartilage T2 values and the severity of cartilage and meniscus lesions based on the WORMS and RECHT-scores was also found. Physically active individuals showed significantly more cartilage and meniscus abnormalities compared with more sedentary subjects. Stahl et al. obtained similar results in a smaller cohort[6]. In contrast to their results we also found a high correlation between the physical activity level and T2 values. These data indicate that T2 relaxation time measurements at the patella may be a marker for internal joint derangement in terms of cartilage and meniscal lesions and that patients with higher activity levels and high T2 values may be at greater risk for cartilage and meniscal abnormalities and thus higher risk for developing OA.

References:

1. Peterfy CG, Schneider E, Nevitt M. The osteoarthritis initiative: report on the design rationale for the magnetic resonance imaging protocol for the knee. Osteoarthritis Cartilage 2008;.
2. Peterfy CG, Gold G, Eckstein F, Cicuttini F, Dardzinski B, Stevens R. MRI protocols for whole-organ assessment of the knee in osteoarthritis. Osteoarthritis Cartilage 2006;14 Suppl A:A95111.
3. Stahl R, Luke A, Ma CB, Krug R, Steinbach L, Majumdar S, Link TM. Prevalence of pathologic findings in asymptomatic knees of marathon runners before and after a competition in comparison with physically active subjects-a 3.0 T magnetic resonance imaging study. Skeletal Radiol 2008;37(7):627-638.
4. Recht MP, Piraino DW, Paletta GA, Schils JP, Belhobek GH. Accuracy of fat-suppressed three-dimensional spoiled gradient-echo FLASH MR imaging in the detection of patellofemoral articular cartilage abnormalities. Radiology 1996;198(1):209-212.
5. Link TM, Steinbach LS, Ghosh S, Ries M, Lu Y, Lane N, Majumdar S. Osteoarthritis: MR imaging findings in different stages of disease and correlation with clinical findings. Radiology 2003;226(2):373-381.
6. Stahl R, Luke A, Li X, Carballido-Gamio J, Ma CB, Majumdar S, Link TM. T1rho, T(2) and focal knee cartilage abnormalities in physically active and sedentary healthy subjects versus early OA patients-a 3.0-Tesla MRI study. Eur Radiol 2008.