

Does prestructural, asymptomatic cartilage degeneration occur in early FAI? A T1rho study.

Gerd Melkus¹, Kawan S Rakhra¹, Arturo Cardenas-Blanco², Andrew Speirs³, Ian Cameron¹, Mark E Schweitzer⁴, and Paul E Beaulé⁵

¹Department of Medical Imaging, The Ottawa Hospital, Ottawa, Ontario, Canada, ²German Center for Neurodegenerative Diseases, Magdeburg, Germany,

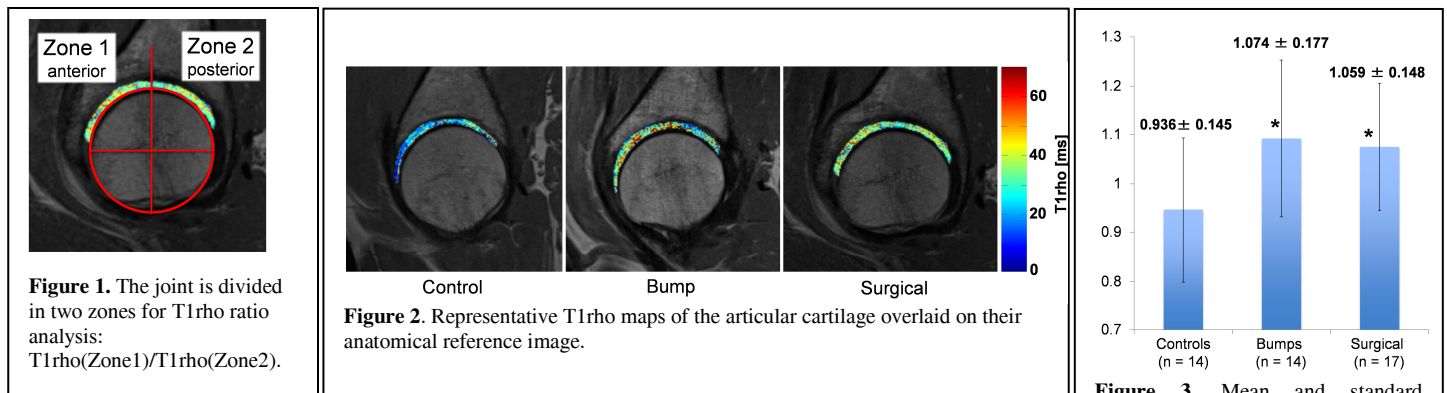
³Department of Mechanical and Aerospace Engineering, Carleton University, Ottawa, Ontario, Canada, ⁴Department of Radiology, Stony Brook University,

Brookhaven, New York, United States, ⁵Division of Orthopedic Surgery, The Ottawa Hospital, Ottawa, Ontario, Canada

PURPOSE: Osteoarthritis (OA) of the hip is a debilitating and painful condition affecting a significant proportion of the population. In the last decade, a growing body of literature suggests that up to 80% of adult idiopathic hip OA cases are caused by femoroacetabular impingement (FAI)^{1,2}. Development of an effective screening program for FAI could identify patients early and allow for intervention before structural changes occur. It has been shown that quantitative MRI imaging using T1rho relaxation time mapping techniques has the potential to detect early biochemical cartilage degeneration in OA³. In this study we investigated if articular hip cartilage T1rho parameters (ratios) differ between asymptomatic subjects with cam deformities (Bumps), healthy volunteers (Controls) and symptomatic cam-type FAI patients, imaged before their surgery (Surgery).

METHODS: MR imaging was performed at 1.5 T (Siemens Healthcare, Erlangen, Germany) and included 45 subjects from the three different groups: 14 Controls (mean age = 34 years; age range 24-48 years), 14 Bumps (asymptomatic subjects with cam deformity defined as alpha angle greater than 55 degrees; mean age = 34 years; age range 28-45 years) and 17 Surgery (clinical diagnosis of cam-FAI requiring surgery; mean age = 40 years; age range 23-51 years). The study was approved by the institutional research ethics board, with informed consent obtained. T1rho images of the hip were acquired using a spin-lock preparation module combined with a standard TSE acquisition scheme (FOV = 180 x 180 mm², number of slices = 22, slice thickness = 3 mm, matrix = 384 x 384, in-plane resolution = 0.47 x 0.47 mm², TR/TE = 274/13 ms, averages = 1). Five different spin-lock times (TSL) of 12/18/25/35/45 ms and a spin-lock field of B₁ = 400 Hz were used. The total scan time for T1rho imaging was 21 minutes. A proton density TSE weighted sequence (TR/TE = 3090/24 ms, averages = 2) was used for anatomical reference of the hip joint which matched plane, FOV, slice thickness and matrix to the T1rho scan. T1rho maps were calculated offline by fitting the images pixel wise to a mono-exponential function: $S = S_0 \cdot \exp(-t/T1rho)$. The center of the femoral head was found semi automatically and the joint was divided into two regions (Zone 1 (anterior) and Zone 2 (posterior)) (see Figure 1) and individual T1rho ratios (T1rho(Zone1)/T1rho(Zone2)) were calculated for each slice. The femoral head and acetabular roof cartilage were analyzed as a single bilayer. The region of interest included the three most lateral slices, reflecting the periphery of the weight bearing region of the joint, and the T1rho ratios were averaged for each subject. The mean and the standard deviation of the T1rho ratios for each of the three groups were also calculated. The mean T1rho ratios were compared using a two-tailed t-test.

RESULTS: Figure 2 shows representative T1rho maps from subjects of the three groups investigated. The color-coded cartilage T1rho maps are overlaid on the anatomical reference images. The mean and the standard deviation of T1rho ratios (T1rho(Zone1)/T1rho(Zone2), three most lateral slices) of the three subjects groups are plotted in Figure 3. Statistically significant different T1rho ratios were found between the Control and the Bump group ($p = 0.033$), the Control and the Surgical group ($p = 0.027$), but not between the Bump and the Surgical group ($p = 0.803$).



DISCUSSION: The primary aim of this study was to investigate if subjects with asymptomatic cam deformities demonstrate PG loss in the anterior-lateral cartilage of the hip joint using T1rho MRI. For comparables we choose a group of healthy volunteers with morphologically normal hip joints and a patient group with symptomatic cam-type FAI, with substantial PG loss expected in the latter. By analysing the T1rho ratio of the anterior zone over the posterior zone, each individual hip acted as an internal control and would eliminate confounding variations due variations into age and sex⁴. The analysis of the asymptomatic cam deformity (Bump) group showed that the superolateral periphery of the weight-bearing region of the hip joint, where earliest chondral changes of FAI are known to begin, demonstrated a significant increased T1rho ratio compared to the Control group suggesting that PG depletion had already commenced despite the lack of symptoms. Furthermore, the degree of PG loss from cartilage in the anterior region of the joint was similar between asymptomatic cam subjects and surgical cam-FAI patients.

CONCLUSION: Quantitative T1rho imaging and T1rho ratio analysis has the potential to detected cartilage PG loss in patients with symptomatic cam-type FAI as well as in subjects with asymptomatic cam deformities.

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