lower deep UTE-enhanced T2* values (p=0.05) than those retaining OCT form birefringence. For superficial T2, SA without OCT form birefringence had 25% higher values than those with birefringence (p=0.047). No difference was found between the superficial T2* values of cores with and without OCT form birefringence. However a significant decrease in superficial T2* relaxation time was noted between SA with OCT grades B and C (p=0.014). No difference was found between type-II collagen content and OCT grade or quantitative MRI values.

Conclusions: This multimodal study shows correlations between OCT grade, MRI T2, MRI UTE-enhanced T2* and PLM. OCT and PLM signs of matrix degeneration increased with increasing T2 and with decreasing T2*. Although no correlation was found between any of the imaging modalities and type-II collagen content, the correlations with PLM suggest that these emerging imaging technologies are more sensitive to changes in collagen structure than collagen content. As changes to collagen and matrix structure can occur prior to breakdown of the articular surface, these results demonstrate the potential of OCT, T2 and UTE-enhanced T2* to detect cartilage injury and degeneration in clinically normal appearing cartilage. Techniques for clinical detection of cartilage damage prior to gross tissue failure could lead to identification of new treatment windows for chondroprotective and chondrorestorative therapies that can delay or prevent the onset of osteoarthritis.

029

TEMPORAL STRUCTURAL CHANGES IN HIP OA DETECTED BY SHAPE AND APPEARANCE MODELLING OF DXA IMAGES: A ONE-YEAR PROSPECTIVE LONGITUDINAL STUDY

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Purpose: Quantitative assessment of osteoarthritis (OA) progression is difficult over short time periods, although this is a critical step in assessing the effect of potential OA disease modifying agents. We have previously shown that Active Shape modelling (ASM) of the hip joint using plain radiographs can identify subjects with early OA and fast progressors. Although Dual Energy X-ray Absorptiometry (DXA) images have lower resolution than radiographs, they are acquired using a lower radiation dose and have the added advantage of providing reliable information on bone mineral density. Active Appearance Modelling (AAM) is an extension of ASM to include the variation of image intensity within a defined shape and describe both in terms of linearly independent variables (modes of variation). In this study, we explored the ability of ASM and AAM of hip DXA images to detect temporal changes over a 6 month period in OA patients.

Methods: 62 participants were identified and recruited using the local Radiology Information System based on pelvic radiographs taken in the previous 12 months. They were stratified into 3 groups based on Kellgren-Lawrence grading (KLG) of the most affected hip: 20 mild (KLG 1), 20 moderate (KLG 2), and 22 severe (KLG 3 or 4). DXA images were acquired at baseline, 6 months and 12 months (GE Lunar iDXA). An 85-point model of the hip, developed using the AAM toolkit (Manchester University, Manchester, UK), was applied to the DXA images. Shape or Appearance Modes of interest were identified as those whose mean score significantly and monotonically increased (or decreased) in parallel with KLG, as assessed by one-way ANOVA. Significant changes over time in these modes and baseline radiographic KLG were tested using repeated measures ANOVA. KLG was used as a between subject factor in the 54 participants, with hip DXA images available from all three visits.

Results: Shape Mode 4 significantly increased with increasing KLG ($P<0.001$) and captured osteophytes, joint space narrowing (JSN) and widening of the femoral head and neck. Repeated measures ANOVA revealed significant changes over time ($P<0.001$), with no interaction with KLG ($P = 0.45$) (Figure 1). Analysis showed significant differences between baseline KLG 0 vs 4 and KLG 1 vs 4. Similarly, the mean score of Appearance Mode 4 significantly increased with increasing KLG ($P<0.00001$), where higher scores were visually associated with sclerosis, JSN, widening of the femoral neck and reduced curvature of the superior femoral neck. Repeated measures ANOVA revealed significant changes over time ($P=0.001$), with no interaction effect ($P = 0.61$). Analysis showed significant differences within baseline KLG ($P<0.05$). No significant parallel changes in KLG scores were observed over the same period of time.

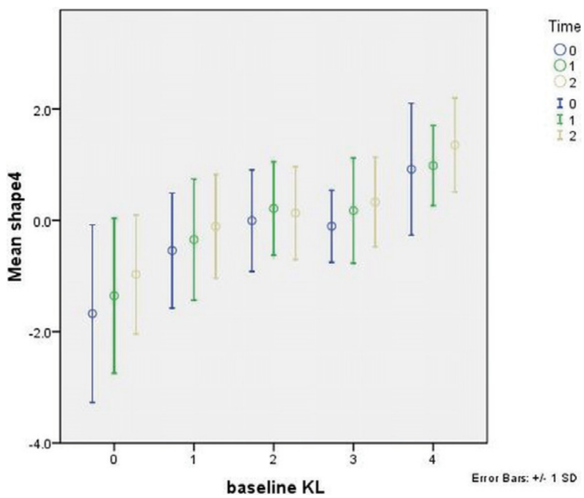

Figure 1

Conclusions: These results demonstrate the ability of IDXA ASM and AAM of the hip to visualize and quantify anatomical features indicative of OA progression and detect significant changes over a 6 month period in the absence of changes in KLG. Shape and Appearance modelling hold promise as reliable biomarkers in the early diagnosis of hip OA, monitoring its short-term progression and possibly assessing response to disease modifying drugs.

030

RADIAL MRI AND 3D dGEMRIC IN DEVELOPMENTAL DYSPLASIA OF THE HIP AND IN FEMOROACETABULAR IMPINGEMENT

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Purpose: Aberrant hip anatomy as found in developmental dysplasia of the hip (DDH) or femoroacetabular impingement (FAI) can lead to premature osteoarthritis (OA). Magnetic Resonance Imaging (MRI) has become the method of choice for hip assessment due to its ability to directly visualize cartilage and soft tissue. Delayed Gadolinium Enhanced MRI of Cartilage (dGEMRIC) allows quantitative assessment of cartilage glycosaminoglycan (GAG) content. A novel three dimensional gradient echo (3D GRE) sequence allows the radial reconstruction of T1 maps.

The aim of this preliminary study was to evaluate cases with either DDH or FAI with contrast enhanced morphologic MRI and 3D dGEMRIC to gain preliminary data on the patterns of damage and GAG loss.

Methods: 25 cases of symptomatic DDH or FAI each were included (diagnosed on plain radiographs, Toennis grade 0-2). The mean age was 29±11.4 years, joint space width (JSW) was 4.1±0.84 mm and WOMAC Index for pain was 6.8±4.7.

MR images were obtained at 1.5T with a dedicated coil and the use of contrast agent (Magnevist, Schering, 0.2mM/kg body weight). A 3D isotropic True-FISP Gradient Echo sequence was used for morphologic imaging (resolution 0.6 mm^3, 160×160 mm FOV, TR 12.57 ms, TE 5.48 ms, flip angle FA 30 deg.). T1 assessment was carried out with a 3D GRE dual FA sequence (TR 15.00 ms, TE 3.27 ms, FA 4.1/23.5 deg., FOV 160mm, resolution 0.8 mm^3). Radial reconstruction aligned to the femoral neck included seven slices (3mm slice thickness, anterior - posterior, intervals of 30 deg.) to evaluate labrum (form, lesions, cyst), cartilage signal intensity and alterations of the bone (cyst, ossification). Categorical lesion parameters throughout all slices were summed up to obtain a numeric MR Score ranging between 0 (no alterations) and 154 (maximum damage). T1 region of interest (ROI) analysis were performed for each radial slice. It was not possible to separate femoral and acetabular cartilages.

Results: Age, WOMAC and Toennis grade were comparable in DDH and FAI, as was the MR Score (DDH: 40.1±14.0, FAI: 35.6±10.5).

In the respective subcategories we observed however differences. Alteration of labrum shape, the occurrence of paralabral cysts, acetabular rim ossifications and acetabular cysts were more commonly seen in DDH. In contrast, os acetabuli was more likely to occur in FAI (Mann Whitney U Tests, $P<0.05$).

Quantitative T1 assessment demonstrated a significant difference in global T1 between DDH and FAI (508±100 ms vs 558±69 ms, P=0.45). Radial ROI evaluation showed different T1 profiles (Figure 1: 1 = anterior, 2 = anterior-superior, 3 = superior-anterior, 4 = superior, 5 = superior-posterior, 6 = posterior-superior, 7 = posterior). In DDH we found a marked increase in the weight bearing profiles (superior, superior-posterior) despite an overall T1 decrease compared to FAI. In contrast, the FAI line profile indicated a more homogenous distribution.

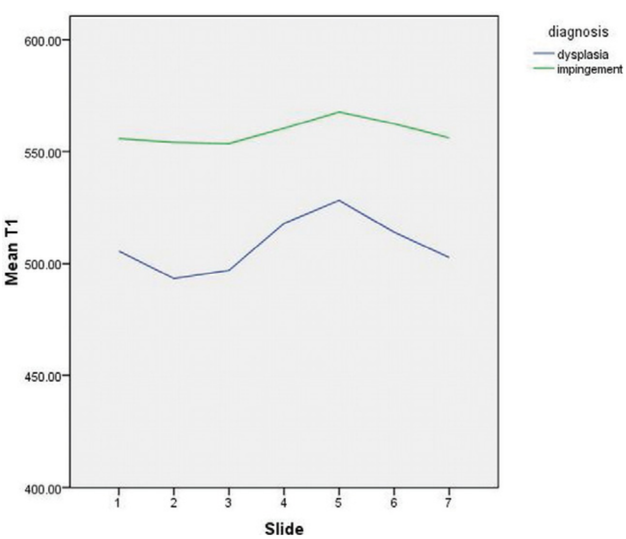

Figure 1

Conclusions: Both DDH and FAI may result in premature OA, however the underlying patho-mechanisms are different. The patterns of damage in DDH and FAI differ in morphologic MRI. Paralabral cysts and change in labral shape were more frequent in DDH whereas os acetabuli was more common in FAI. Radial dGEMRIC evaluation demonstrates a different distribution of glycosaminoglycan in acetabular and femoral cartilage. The respective biomechanical properties associated with DDH and FAI apparently lead to different patterns of damage in MRI. Knowledge of these MRI patterns might improve the planning of surgical intervention, especially in complicated cases.

031

RELATIONSHIP BETWEEN MENISCUS VOLUME AND CARTILAGE MORPHOLOGY IN MR IMAGES OF OSTEOARTHRITIS PATIENTS

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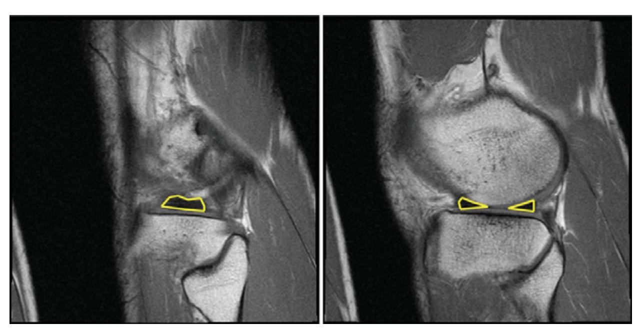
Purpose: To determine associations between meniscus volume and knee cartilage morphological measurements in subjects with osteoarthritis (OA).

Methods: All data was obtained from the Osteoarthritis Initiative's (OAI) public use dataset (www.oai.ucsf.edu). A sample of progression subjects produced by the OAI was used for the study (Subgroup B, release 0.B.2). Out of the 160 subjects in the sample, two had no discernable meniscus and were excluded, leaving 158 subjects in the analysis. The current study focused on the right knee, as this was the only knee for which cartilage measures were available from the OAI. The lateral meniscus was manually delineated by trained readers on sagittal T2-weighted MR scans for each subject (Fig. 1). Volume measures of the anterior horn (AH), posterior horn (PH), and total meniscus were calculated using Matlab (Mathworks, Natick, MA). Cartilage morphological measurements and related bone measurements were obtained from the quantitative studies of Eckstein (kMRI_QCart_Eckstein00, release 0.1). Repeated variable measurements in the Eckstein dataset were removed, leaving only a single measurement per variable. Linear regression models were used to analyze relationships between the quadriceps CSA measures and the cartilage measures, with adjustments made for sex, age group (age less than 62, or age greater than or equal to 62), and obesity (BMI less than 30: non-obese, BMI greater than or equal to 30: obese). Since 92 cartilage measures were evaluated, statistical significance was assessed at a Bonferroni-correct alpha of 0.0005. All statistical analyses were performed using JMP 8.0 (SAS Institute, Cary, NC).



Results: The total volume of the meniscus has the largest number of significant associations with the cartilage measures (Table 1). All but one association between meniscus volume and cartilage measures are related to the tibia. While the majority of the lateral meniscus relationships are to the cartilage in the lateral compartment, there are a few relationships to medial compartment cartilage. The volume of the posterior horn is the only volume related to the percent of subchondral bone denuded of cartilage.

Conclusions: The results suggest that there may be an important association between the lateral meniscus and the tibia cartilage. It is interesting to note that there was no statistically significant association found between the meniscus and femur cartilage. This result implies that the tibia cartilage and lateral meniscus may