Table 1. Muscle Strength Characteristics (mean ± SD)

<table>
<thead>
<tr>
<th></th>
<th>Operated leg</th>
<th>Non-operated leg</th>
<th>Controls (mean both legs)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentric peak torque (Nm)</td>
<td>2.67±0.55</td>
<td>2.74±0.47</td>
<td>2.54±0.39</td>
<td>0.26</td>
</tr>
<tr>
<td>Eccentric peak torque (Nm)</td>
<td>3.38±0.78</td>
<td>3.49±0.79</td>
<td>3.26±0.51</td>
<td>0.44</td>
</tr>
</tbody>
</table>

Correlations: Non-significant correlations (r = -0.03 to 0.23) were observed between concentric and eccentric muscle strength and the KOOS subscales Sport/Rec and Pain.

Conclusions: No differences were found in concentric and eccentric muscle strength between the operated and non-operated leg in patients. Furthermore, no differences in strength parameters were observed between patients compared to controls at 2 years post surgery. Self-reported outcomes were however significantly worse in patients. These results indicate that maximal concentric and eccentric muscle strength is not related to pain and function in meniscectomized patients.

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KNEE STRENGTH PREDICTS LOSS OF FUNCTION AND DECLINE IN PHYSICAL ACTIVITY IN PARTICIPANTS WITH OSTEOARTHRITIS: A 2-YR FOLLOW-UP OF THE OAI STUDY

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Purpose: To evaluate changes in strength, performance and overall physical activity over a 24-month period in participants at risk (incidence), or with knee osteoarthritis (KOA).

Methods: Data were extracted from the OAI cohort at baseline and 24-month visits (N=4607). Radiographic KOA (Kellgren-Lawrence) grade and frequency of knee symptoms were used to establish progression and incidence subcohorts during enrollment. The association of knee strength with performance and physical activity of both knees was examined longitudinally. Knee flexor and extensor strength were assessed by isometric testing and performance association of knee strength with performance and physical activity (p=0.001), increasing T2 value (p=0.007), and decreasing UTE-enhanced T2* value (p=0.009, Fig. 1). Deep T2 values increased with increasing OCT grade (p=0.01) while deep UTE-enhanced T2* relaxation time decreased with increasing OCT grade (p=0.02). SA without OCT birefringence showed 50% higher deep T2 values (p=0.012) and 37%

028

OPTICAL COHERENCE TOMOGRAPHY (OCT) AND QUANTITATIVE MRI SHOW EARLY SUBSURFACE MATRIX DEGENERATION IN HUMAN ARTICULAR CARTILAGE

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Purpose: Osteoarthritis is a leading cause of disability. Current clinical imaging modalities do not reliably detect cartilage injury and degeneration prior to breakdown of the articular surface. Optical Coherence Tomography (OCT) and quantitative MRI are emerging technologies with potential to detect early cartilage changes. OCT is a novel nondestructive imaging technology that show changes to cartilage birefringence related to potentially reversible early cartilage degeneration (Chu et al, J Biomed Optics, 2007). The quantitative MRI techniques, T2 and ultra-short echo time (UTE) enhanced T2* may be sensitive to changes in cartilage collagen structure and tissue hydration. This study tests the hypothesis that OCT correlates with T2 and UTE-enhanced T2* MRI, and that these imaging modalities are sensitive to early cartilage matrix degeneration.

Methods: Thirty-six study areas (SA) were identified using a coring device on five human tibial plateaus obtained through institutional and IRB approved protocols. Each plate was mounted on a plate with MRI lucent fiducial markers to allow precise spatial registration of study locations across imaging modalities. Quantitative T2 and UTE-enhanced T2* images were acquired on a clinical 3T MRI scanner and maps were generated using MRImapper software. Study areas were imaged using a custom OCT scanner and graded as follows: A-obvious birefringence, B-no birefringence, C-subsurface voids and/or irregular surface. Cores were harvested and processed for type II collagen content, histology and polarized light microscopy (PLM) assessment using a grading scale developed by David-Vaudey, et al (Magn Reson Imaging, 2004).

Results: Cartilage matrix degeneration determined by PLM increased with increasing OCT grade (p<0.001), increasing T2 value (p=0.007), and decreasing UTE-enhanced T2* value (p=0.009, Fig. 1). Deep T2 values increased with increasing OCT grade (p=0.01) while deep UTE-enhanced T2* relaxation time decreased with increasing OCT grade (p=0.02). SA without OCT birefringence showed 50% higher deep T2 values (p=0.012) and 37%

Figure 1. Comparison of OCT grade to PLM and MRI. a–c) Representative OCT images of cores with grades A–C. d–i) PLM images from OCT grades A–C demonstrating increasing matrix degeneration. j–l) UTE-enhanced T2* images showing decreasing relaxation time with increasing OCT grade. m–t) T2 images demonstrating increasing T2 relaxation time with increasing OCT grade.
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 DXA 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.

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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.