Purpose: Subchondral cysts are deeply related to the pathogenesis of osteoarthritis (OA), however the factors contributing to cyst formation are not well known. We analyzed the prevalence and distribution of subchondral cysts in relation to subchondral bone microstructure and cartilage attrition using High Resolution peripheral Quantitative CT (HR-pQCT).

Methods: Femoral heads extracted from ten patients with hip OA (age: 73±9, 57-83, all female) were scanned by HR-pQCT at 41 μm voxel size. The number and volume of subchondral cysts and trabecular microstructure in the subchondral bone underlying regions of cartilage loss were measured using bone structure analysis software, and their correlations were analyzed.

Results: The percent volume of cyst formation in subchondral bone regions ranged from 2% to 33% (average 15%), the number from 6 to 87 (26), and the sizes from 1 mm3 to 657 mm3 (37 mm3). There were strong positive correlations between cyst number and bone volume and trabecular thickness (r=0.8, p<0.01).

Conclusions: Large variations were observed in the prevalence and distribution of subchondral cyst, which suggested the existence of various phenotypes according to patient-specific biological reactions. Our results suggest that multiple cyst formation is highly associated with subchondral bone sclerosis. This diverse bone structural changes in OA may become one of the important evaluation items in clinical medicine.

Figure 1. Results of CTM according to osteophyte feature score. There is significant thickening circumferentially around the entire periartricular margin, with up to 40% thicker cortical bone registered for each increase in osteophyte feature score (black arrows). Significance is seen not only at the site of articular marginal osteophytes, but also encroaching the superior surface of the femoral head, suggesting that the phenomenon is more than that explained by the manifestation of osteophytes alone. Significantly thicker bone was also noted at the fovea (white asterisk-another site of periartricular osteophyte formation) and in the anteromedial head-neck cortex (black asterisks-a site preserved with age and increased with weight). Age was associated with thinning of the cortex, except in the medial femoral neck and subtrochanteric region, i.e. at sites stressed in the normal gait cycle. Increasing weight was associated with thicker cortex in these same load-bearing regions.

Conclusion: CTM identified thickening of marginal articular cortical bone and superior subchondral bone plate with worsening radiological disease. Development of the CTM technique has also enabled estimated measurement of hip JSW in 3D for the first time. These are significant steps towards a new imaging biomarker for large joint osteoarthritis and fully automated imaging analysis for disease risk estimation. Regions of interest will now be taken to a prospective setting to test the hypothesis that thicker cortex and subchondral bone plate are predictive of disease initiation and progression. Results have also demonstrated the effects of age and weight on cortical bone distribution in the proximal femur for the first time.
years (± 15.3), mean BMI of 25.8 kg/m² (± 4.7) and 52% female) were acquired on a 3T Signa HDx MR (GE Healthcare, Waukesha, WI) scanner with an 8-channel phased array knee coil. Sagittal cartilage T₁p and T₂ maps were generated using 3D MAPSS mapping techniques (TR/TE = 9.3/3.7 ms; FOV = 14 cm, matrix = 256 × 128 pixels, slice thickness = 4 mm, BW = 31.25 kHz, views per segment = 64, recovery time = 1.5 s, for T₁p; Time of Spin-Lock = 0, 10, 40, 80 ms, spin-lock frequency = 500 Hz; for T₂: prep TR = 4.1, 14.5, 25, 45.9 ms). A fat-saturated T₁-weighted 3D SPGR sequence (TR/TE = 15/6.7 ms, flip angle = 12, FOV = 14 cm, matrix = 512 × 512, slice thickness = 1 mm, bandwidth = 31.25 kHz, NEX = 1) was used for cartilage segmentation.

Five cartilage knee compartment regions of interest (ROIs) (lateral femoral condyle (LFC), medial femoral condyle (MFC), lateral tibia (LT), medial tibia (MT), patella (PAT)) were segmented in a MATLAB (MathWorks, Natick MA) based in-house software package. Compartments were partitioned into a bone and articular layer, using a Euclidean distance algorithm with the same in-house software. A random effects linear regression model adjusting for age, gender, and BMI was performed in JMP software version 8 (SAS Institute, Cary NC).

Results: Statistically significant increases in both T₁p and T₂ (p < 0.01 respectively) relaxation time constants were observed in the MT for the pain group (figures 1 and 2) when compared to the asymptomatic cohort. In analysis of the cartilage layers, MT bone layer T₁p (p < 0.001), MT bone and articular layer T₁p (p < 0.001 respectively), and LT bone layer T₂ (p < 0.05) were also significantly elevated in the pain cohort.

Conclusions: This study shows a significant relationship between knee pain and cartilage T₁p and T₂ relaxation time mapping, metrics for early cartilage degeneration. Subjects reporting moderate to severe knee pain as determined by the WOMAC questionnaire displayed elevated T₁p and T₂ relaxation time constant in the MT, indicating that cartilage degeneration in this compartment may be related to noticeable pain symptoms. Furthermore, the laminar analysis shows that the elevation of T₁p and T₂ in the pain group is more dominant in the bone layer, implying the cartilage and bone interaction may contribute to the association between cartilage degeneration and pain.

Figure 1. – Medial tibia whole compartment and bone layer T₁p for both asymptomatic and arthritic groups. Single asterisk denotes p < 0.05 and double asterisk denotes p < 0.01.

Figure 2. – Medial tibia whole compartment, bone, and articular layer T₂ relaxation time constants for both asymptomatic and arthritic groups. Single asterisk denotes p < 0.05 and double asterisk denotes p < 0.01.

370 SONOGRAPHIC ASSESSMENT OF HYALINE CARTILAGE THICKNESS IN THE KNEE AT DIFFERENT VIEWS DISTINCT FROM THE STANDARD VIEW WITH THE KNEE FULLY FLEXED


Purpose: Studies of cadavers or pathological specimens from post-surgical knee arthroplasty patients have shown that the measurement of femoral articular cartilage thickness (FACT) is accurate and reproducible by ultrasound (US). US can be used in the assessment of the cartilage damage in patients with rheumatic disorders, particularly osteoarthritis of the knee. However, the traditional method of using ultrasound to measure cartilage thickness requires hyperflexion of the knee, which is often a difficult maneuver for these patients. The aim of this study was to find an effective alternative method to measure the FACT by US, using a minimally flexed or an extended knee.

Methods: Twenty right knees from twenty recruited volunteers (13 females and 7 males) with a mean age of 32.6 (range 22-52) years were evaluated by US using a GE Logiq e machine equipped with 8-13 MHz linear transducer. The FACT was measured in transverse view with the knee fully flexed. Two longitudinal views of the medial and lateral femoral condyles (FC) were obtained at the anterior aspect with the knee flexed at 140° and at the posterior aspect with the knee extended (Figure). The intraobserver agreement of the thickest of the FACT measured by a rheumatologist with US experience was assessed in each view in 20 knees. An intraobserver and the interobserver agreement of the different views between two operators was evaluated in 6 knees. Spearman’s correlations were used to assess the correlation between different views. Wilcoxon Signed Ranks tests were used to check for average differences.

Results: Overall, the correlations of other views with the fully flexed (gold standard) view were good (0.85 or higher) for both raters with the exception of the lateral FC in the posterior view of the extended knee. The correlation between the two operators was strong (above 0.95) for all views except the posterior lateral FC (Rho = 0.638, p = 0.173). There were no significant mean differences between fully flexed and the other views within rater, nor for corresponding views between raters. Absolute value differences between views and raters were generally small, except for some larger discrepancies involving the extended lateral view. The mean of thickest FACT was 20 mm (SD 3.79) for the lateral FC and 20.4 mm (SD 3.48) for the medial FC at the standard view. In a longitudinal view with the knee flexed at 140° it was 20.3 mm (3.5 SD) for the lateral FC and 20.3 (3.78 SD) for the medial FC. In the posterior view with the extended knee the mean of the FACT for lateral and medial FC was 19.1 mm (3.9 SD) and 20.7 mm (3.6 SD), respectively.

Conclusions: Sonographic assessment of the FACT using the longitudinal anterior view with the knee at 140° of flexion and at the posterior aspect with extended knee at the medial FC demonstrated good comparability to the gold standard fully flexed knee. Further studies are required to explore the use of these measurements as a surrogate of the standard view in patients with knee osteoarthritis with restricted flexion of the knee.