differences between the two groups at baseline ($P < 0.05$) and two more showed a trend towards significance ($P = 0.06$). Modes which were associated with typical OA characteristics (such as osteophytes and joint space narrowing) were significantly correlated with KL score ($P \leqslant 0.001$). In addition, for Mode 2, which showed changes in the shape of the femoral head and neck but not in joint space or osteophytes, the correlation remained significant after adjustment for KL score ($P = 0.03$).
Conclusions: This study validates our previous finding that radiographic shape differences in the proximal femur, measured by ASM, may help identify early OA patients who are at greater risk of requiring a THR. The association with disease exists after adjustment for radiographic change as assessed by KL score. The shape of the joint may be quantified using an extended 44-point ASM which, besides generating a measurement equivalent to the KL score but on a continuous scale, provides additional information not captured by KL scoring. ASM may provide a valuable imaging biomarker in the early diagnosis of OA, as well as a valuable biomarker for patient selection and stratification in OA clinical trials.

411 LONGITUDINAL CHANGES IN THE SPATIAL DISTRIBUTION OF CARTILAGE MR T_2 IN A SUBSET OF PATIENTS FROM THE OSTEOARTHRITIS INITIATIVE

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Purpose: The Osteoarthritis Initiative (OAI) is a multi-center, longitudinal study aimed at assessing biomarkers in osteoarthritis (OA) including those derived from magnetic resonance (MR) imaging. The purpose of this study is to examine the spatial distribution of cartilage MR T_2 in a subset of patients from the OAI at baseline and at 1-year follow-up using grey level co-occurrence matrix (GLCM) texture parameters.
Methods: Thirty subjects from the OAI were included in this study, and representative MR data were analyzed from fourteen subjects with radiographic OA at baseline (mean age = 57±11.2 years, Kellgren-Lawrence grade = 2–3, right knee, progression cohort). MR images including sagittal 3D DESSwe (TR = 16.3 ms, TE = 4.7 ms, interpolated in-plane resolution = 0.365×0.365 mm, slice thickness = 0.7 mm) and sagittal 2D MSME (TR = 2700 ms, TE_1-TE_7 = 10–70 ms) images from baseline and 1-year follow-up were analyzed in this study. Articular cartilage was segmented from the DESSwe images in six regions: medial and lateral tibia, medial and lateral femur, trochlea, and patella using a spline-based, semi-automatic technique. 3D cartilage thickness was calculated from the DESSwe segmentations. The 2D MSME images were used to generate T_2 maps assuming mono-exponential signal decay. Using the MSME first echo and DESSwe to compute a rigid-body transformation, T_2 maps were registered to the DESSwe images, and the segmented regions of interest were superimposed on the registered T_2 maps. Median cartilage T_2 was calculated in each region. A GLCM was calculated for each cartilage region and used for texture analysis. GLCM texture parameters including entropy, contrast, and homogeneity were calculated at 0 degrees (corresponding to the anterior-posterior axis), 45 degrees, 90 degrees (corresponding to the superior-inferior axis), and at 135 degrees, with 1 pixel offset. Differences in cartilage thickness, median cartilage T_2, and GLCM texture parameters were assessed by paired Student's t tests.
Results: Longitudinal decreases in mean cartilage thickness (in the lateral femur (−1.49%), medial femur (−0.78%), medial tibia (−4.21%), and trochlea (−1.71%)), and in median cartilage T_2 (in all cartilage regions) were evident but insignificant ($p > 0.05$), which was consistent with previous publications. Texture analysis of cartilage T_2 using GLCM showed significant ($p < 0.05$) increases in contrast and entropy, and significant ($p < 0.05$) decreases in homogeneity (Table 1).

Table 1

Cartilage parameter	Longitudinal trend	Cartilage region	Orientation (degrees)	Significance
GLCM T_2 contrast	Increase	Lateral femur	0, 45, 90	$p < 0.05$
		Trochlea	0, 45	
GLCM T_2 homogeneity	Decrease	Lateral femur	0, 45, 90	$p < 0.05$
		Lateral Tibia	90	
GLCM T_2 entropy	Increase	Lateral femur	0, 45, 90, 135	$p < 0.05$

Conclusions: The results of this study indicate that the spatial distribution of cartilage T_2 in patients with radiographic knee OA changes longitudinally, as evidenced by significant increases in GLCM contrast and entropy, and significant decreases in homogeneity. While global-scale parameters including cartilage thickness and median cartilage T_2 did not change significantly, focal-scale GLCM parameters showed significant changes. These results suggest that the changes in the extracellular matrix are spatially heterogeneous throughout degenerated cartilage, and may precede global cartilage loss, as demonstrated in a small subset of subjects from the OAI dataset.

412 THREE DIMENSIONAL BONE MINERAL DENSITY MEASURES USING COMPUTED TOMOGRAPHY TOPOGRAPHIC MAPPING OF SUBCHONDRAL DENSITY (CT-TomasD) IN OSTEOARTHRITIC AND NORMAL TIBIAE: PRECISION, COMPARATIVE ASSESSMENT & PRELIMINARY FINDINGS

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Purpose: In-vivo imaging studies examining direct associations between increased proximal tibial bone mineral density (BMD) and knee osteoarthritis (OA) offer conflicting results. This may be due to limited two dimensional capabilities of current in vivo imaging tools used to assess BMD (principally dual-energy x-ray absorptiometry), or selected analysis regions containing subchondral cortical and/or trabecular bone demonstrating increasing and/or decreasing BMD during different stages of OA progression. Our objectives were to (1) assess precision of current and novel in vivo three dimensional quantitative computed tomography (QCT) imaging techniques capable of assessing subchondral cortical and/or trabecular bone (CT-OAM & CT-TomasD), and (2) investigate ability of imaging techniques to distinguish subchondral bone properties in OA and normal cadaveric tibiae.
Methods: Eight intact cadaver knees from five donors (4M:1F; age: 77±10) were repositioned and scanned three times using QCT (Toshiba 64 Aquilion; Mindways BMD Spine Phantom; 0.5 mm isotropic resolution, 0.15 mSv dosage). BMD was assessed using (1) computed tomography absorptiometry (CT-OAM) which uses maximum intensity projections to assesses peak density values within subchondral bone, and (2) our novel computed tomography topographic mapping of subchondral density (CT-TomasD) technique, which uses surface projections to assess both cortical and trabecular bone density at specific depths from the subchondral surface. Average BMD at normalized depths of 0–2.5 mm, 2.5–5.0 mm, and 5.0–10 mm from the surface were assessed using CT-TomasD. Regional analyses were performed consisting of: (1) M/L BMD ratio, and (2) BMD of a 10 mm diameter core identified as having the maximum regional BMD. Precision was assessed using coefficients of variation (CV%). Each bone was assessed for OA (BAM) by examination of the CT images, and categorized using a modified-KL scoring system: Normal (mKL = 0); Early-OA (1–2); and Late-OA (3–4).

Table 1: OA results expressed as standard deviations (SD) above/below normal BMD results

	M/L BMD Ratio				Max Core (K2HPO4 mg/cm3)			
	CT-OAM	CT-TomasD			CT-OAM	CT-TomasD		
	Peak	0–2.5 mm	2.5–5 mm	5–10 mm	Peak	0–2.5 mm	2.5–5 mm	5–10 mm
Precision (CV%)	1.9%	1.9%	2.4%	2.8%	2.3%	1.3%	2.7%	4.2%
LateOA (Valgus)	−2.7 SD	−4.8 SD	−4.5 SD	−3.4 SD	+0.2 SD	+2.7 SD	+5.2 SD	+8.8 SD
LateOA (Varus)	+2.5 SD	+5.3 SD	+4.6 SD	+4.1 SD	+0.9 SD	+2.0 SD	+2.5 SD	+1.0 SD
EarlyOA (Neutral)	−0.2 SD	−0.5 SD	−1.8 SD	−0.5 SD	+2.7 SD	+3.5 SD	−1.5 SD	−2.6 SD
Normal (n = 5)	1.06	1.09	1.22	1.14	957 (89)	631 (62)	494 (68)	248 (31)
(SD)	(0.06)	(0.06)	(0.11)	(0.10)