Results: 3D fast T1 mapping sequence measurements correlated well to previously validated sequence measurements (Pearson regression coefficient R2 = 0.958). Radial data was stratified by overall dGEMRIC score (mean of 9 radial dGEMRIC indices) into 4 arthritis grades: grade 3 (n = 5, mean = 293 ms), grade 2 (n = 10, mean = 380 ms), grade 1 (n = 10, mean = 488 ms), and grade 0 (n = 10, mean = 597 ms). A consistent pattern was observed in which the highest dGEMRIC index occurring in the superior regions of the joint cartilage in the grade 0−2 hips: mean superior and superior-posterior dGEMRIC indices were significantly greater than overall dGEMRIC scores ($p < 0.05$). In grade 3 hips, an inverted pattern of GAG distribution was observed: superior regions displayed significantly lower dGEMRIC indices in comparison to overall dGEMRIC scores ($p < 0.05$) (Fig. 2). Spearman's regression analysis revealed a significant correlation between morphological characterization of cartilage damage and dGEMRIC index for local radial segments ($p < 0.01$).
Conclusions: Using a 3D fast T1 mapping dGEMRIC method to assess the GAG content in local cartilage segments around the acetabulum in vivo, we have reproduced the charge density distribution reported in previous histological studies. 3D dGEMRIC is a powerful diagnostic tool and combined with morphologic assessments will enable the in vivo characterization of cartilage degradation in early osteoarthritis in future long-term studies.

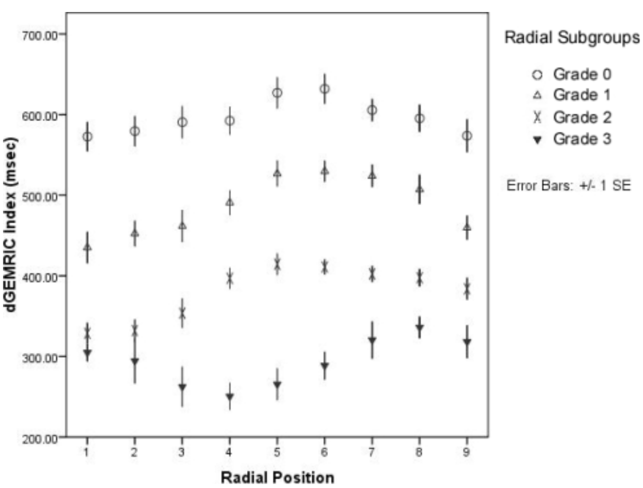

Figure 2.

404 IMPROVED CARTILAGE-JOINT CONTRAST IN DOUBLE ECHO STEADY STATE (DESS) MAGNETIC RESONANCE (MR) IMAGING WITH THE USE OF GEOMETRIC-MEAN RECONSTRUCTION OF DUAL-ECHO IMAGES

K.T. Bae, S. Park, H. Shim, C-H. Moon, K. Kwoh. *University of Pittsburgh, Pittsburgh, PA, USA*

Purpose: Improved cartilage-joint tissue contrast in MR imaging is highly desired for accurate segmentation and quantification of cartilage in osteoarthritis. In the present implementation of Double Echo Steady State with Water Excitation (DESSwe) knee MR imaging (e.g., the Osteoarthritis Initiative (OAI)), each DESSwe image is reconstructed as the arithmetic mean of the first and second (double) echo images. In theory, the geometric mean reconstruction of DESSwe MR imaging is superior to the arithmetic mean reconstruction for the enhancement of cartilage-joint tissue contrast. Thus, the purpose of this study was to compare the image quality, specifically the contrast of the knee cartilage-joint tissue interface, between the geometric- and arithmetic-mean reconstructions of DESSwe images.
Methods: The raw MR data acquired from recent DESSwe MR imaging of six knee studies were saved offline. From each raw dataset, the first and second echo images were individually reconstructed using MatLab Fast-Fourier-Transfer software. Two sets of DESSwe images were reconstructed from the double-echo images at each slice position: one set corresponding to the geometric-mean (GM) and the other set corresponding to the arithmetic-mean (AM) of the double-echo images. Signal intensities were measured over various regions (bone, cartilage, meniscus, joint fluid, and background air) at a mid-slice of the GM and AM images. Signal-to-Noise (SNR) values of the bone, cartilage, meniscus, and joint fluid were calculated. From these, Contrast-to-Noise (CNR) values of the cartilage to the adjacent structures (bone, meniscus, and joint fluid) were computed. Differences in SNR and CNR values between the GM and AM images were evaluated using paired t-test. In addition, qualitative assessment of the image quality and cartilage tissue contrast was performed.
Results: In all tissue components, SNR of the GM images was consistently lower than that for the AM images (GM, AM): (1.4, 1.7) for bone, (13.3, 14.9) for cartilage, (5.8, 8.1) for meniscus, (23.3, 23.7) for joint fluid ($p < 0.01$). The cartilage-bone CNR was also slightly lower on the GM than AM images (11.9 ± 2.7 versus 13.3 ± 2.9, $p < 0.01$). However, the CNR of the cartilage-to-joint was higher for the GM than AM images: (7.5 ± 2.3 versus 6.8 ± 2.0, $p < 0.01$) for cartilage-meniscus and (9.9 ± 3.8 versus 8.7 ± 3.7, $p < 0.01$) for cartilage-joint fluid. Qualitative assessment correlated well with quantitative results. Theoretical and mathematical simulation analysis is currently underway.
Conclusions: MR signal contrast between the knee cartilage and joint tissues, which is required to be high for accurate segmentation and quantification of cartilage, was improved, when DESSwe knee images were reconstructed as the geometric-mean of the first- and second-echo images, compared to the arithmetic-mean reconstruction.

405 WHAT IS THE MOST ACCURATE MRI APPROACH TO ASSESS SYNOVITIS AND/OR EFFUSION IN KNEE OA?

D. Loeuille[1], N. Saulière[1], J. Champigneulle[1], A. Blum[2], A. Rat[1], J. Pourel[1], I. Chary-Valckenaere[1]. [1]*CHU, Vandoeuvre-les-Nancy, FRANCE,* [2]*CHU, Nancy, FRANCE*

Purpose: To compare, three different scoring systems on MRI to assess synovial membrane (SM) inflammation and joint effusion with microscopic examination of synovial membrane biopsies as gold standard for SM inflammation and joint volume measurement (JVM) as gold standard for effusion.
Methods: Patients fulfilling ACR criteria for knee OA and requiring joint lavage, were evaluated for pain (VAS), function (Lequesne's functional score) and MRI features. On MRI, SM inflammation and joint effusion were studied on three different MRI approaches: (1) WORMS (non injected images), (2) MRI synovitis total score (T1 injected images) and (3) MRI effusion score (non injected images). On axial T2 images, this last score effusion was graded on a four-step scale (grade 0 = normal to grade 3 = large effusion defined by capsular distention) on three regions of interest: (1) in the suprapatellar pouch and (2,3) in lateral and medial recesses. The effusion score was the sum of the three compartments and varied from 0, absence of effusion, to 9 severe effusion in the knee. JVM was obtained by arthrocentesis and microscopic inflammation of SM samples (n = 86) was scored on six classical parameters.
Results: We found an excellent correlation between WORMS and MRI effusion score ($r = 0.82$, $p < 0.001$) and moderate correlation between WORMS and MRI synovitis total score and MRI effusion score ($r = 0.54$, $p = 0.016$; $r = 0.56$, $p < 0.001$) respectively. JVM was correlated to disability but not to pain. SM inflammation on microscopic analysis and MRI scores were not related with pain or disability. WORMS and MRI effusion score were well correlated with JVM ($r = 0.57-0.60$, $p = 0.0006$) but not with microscopic SM inflammation score. Only MRI synovitis total score correlated with microscopic SM inflammation score ($r = 0.46$, $p = 0.01$). All MRI scoring methods were highly reproducible (ICC intra and inter observer = 0.73−0.98).
Conclusions: In knee OA, only JVM was related to disability while SM inflammation (microscopic and MRI data) was not related to pain or disability. Considering microscopic analysis as gold standard, only MRI total synovitis score performed on injected images was correlated with SM inflammation. With JVM as gold standard, both WORMS and MRI effusion score were correlated with joint effusion.

406 COMPARISON OF X-RAY AND MRI IN THE DETERMINATION OF OA PROGRESSION IN THE KNEE MEASURED AT A FIXED LOAD-BEARING POSITION IN THE MEDIAL COMPARTMENT

T. Lacey[1], A. Brett[1], T.G. Wiiliams[2], A.J. Holmes[3], G.R. Vincent[4], M.A. Bowes[4]. [1]*Optasia Medical Ltd, Cheadle, UNITED KINGDOM,* [2]*University of Manchester, Manchester, UNITED KINGDOM,* [3]*AstraZeneca, Macclesfield, UNITED KINGDOM,* [4]*iMorphics Ltd, Manchester, UNITED KINGDOM*

Purpose: Radiographic minimum Joint Space Width (minJSW) is the primary structural endpoint used as an indirect measure of articular