**Introduction** This clinical report assesses the feasibility of 3-D ultrashort echo time enhanced T2* (UTE-T2*) mapping of cartilage in vivo and examines the sensitivity of UTE-T2* to early cartilage degeneration compared to arthroscopic grading as the standard. UTE-T2* mapping is sensitive to changes in short-T2 signal (T2 <10ms) and may provide improved sensitivity to subtle matrix alterations, particularly in deep layers, that are not well captured by standard T2 mapping. A previous in vivo study indicated that UTE-T2* values reflect cartilage collagen matrix structural integrity as determined by polarized light microscopy. We hypothesize that UTE-T2* mapping in vivo is sensitive to earlier degenerative changes of articular cartilage than can be detected with standard T2.

**Methods** UTE-T2* and standard T2 images were acquired on the knees of 10 human subjects on a clinical 3T MRI scanner (MAGNETOM Trio TIM 3T, Siemens Medical Solutions, Erlangen, Germany) using an 8-channel knee coil (In vivo Inc., Gainesville, Florida, USA). Subjects had either degenerative meniscal tear (n=5) or degeneration that is sensitive to the short T2 components not well captured by standard T2 mapping. In this pilot study, UTE-T2* mapping was found to be superior to standard T2 mapping at detecting early cartilage degeneration.

**Results** Comparison of MRI and arthroscopy in 15 study areas across the 5 meniscal injury patients found that UTE-T2* values in deep cartilage layers were significantly higher in softened tissue (arthroscopic grade 1, 27±8ms) compared to firm (arthroscopic grade 0, 16±4ms), p<0.01, Figure 2. UTE-T2* and standard T2 maps were generated with a mono-exponential fitting routine using MRIMapper software (© Beth Israel Deaconess and MIT 2006). Regions of interest (ROIs) were manually segmented from a single section from each knee: on sagittal scans, 3 full-thickness ROIs were segmented in the anterior, central and posterior weight-bearing zones, respectively, from a slice from the center of the medial condyle; on axial scans, 1 full-thickness ROI in the lateral facet was segmented from a slice in the center of patella. Zonal T2 variations were examined by further segmenting and separately evaluating the superficial and deep halves of each full-thickness ROI. UTE-T2* and standard T2 ‘lesions’, identified on the medial facet or central ridge of the patella were separately segmented. Following MRI, the 5 subjects with meniscal tears underwent arthroscopic surgery. Targeted exams were conducted on the central weight-bearing zone of the medial femoral condyle in areas corresponding to MRI ROIs and were evaluated using a modified Outerbridge scale: (0-normal; 1-softening; 2- partial thickness defect, superficial fissures; 3-fissuring to subchondral bone; 4-exposed subchondral bone). Superficial and deep UTE-T2* and standard T2 values were compared to the surgeon’s arthroscopic grade as the standard. MRI values were binned according to arthroscopic grade, and mean UTE-T2* and standard T2 values calculated. 2-tailed t-tests were performed to assess UTE-T2* and standard T2 differences between arthroscopic grades.

**Discussion** This human clinical study shows that 3-D UTE-T2* mapping of articular cartilage is feasible in both axial and sagittal planes in imaging times well-tolerated by patients with knee pain. UTE-T2* mapping captures signal from deep cartilage better than standard T2 mapping, and UTE-T2* values in deep cartilage discriminated between healthy and unhealthy tissue where standard T2 values did not. UTE-T2* mapping in vivo provides a quantitative measure of chondral degeneration that is sensitive to the short T2 components not well captured by standard T2 mapping. In this pilot study, UTE-T2* mapping was found to be superior to standard T2 mapping at detecting early cartilage degeneration.