

Evaluation of Articular Cartilage of Lumbar Facet Joints with UTE MR Imaging and multi-echo SE T2 mapping techniques

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OBJECTIVE: Degenerative changes in the spine can generally be divided into disc disease and facet arthropathy. While anterior versus posterior degenerative changes can occur in isolation, it is established that disc disease with disc space narrowing can result in higher load applied to the facet joints (FJs) ultimately affecting the composition and integrity of the articular cartilage. The aim of this examination was to qualitatively and quantitatively evaluate the morphology and biochemical integrity of the articular cartilage of the lumbar FJs in cadaveric lumbar spine specimens using standard clinical sequences, UTE MR Imaging and multi-echo SE T2 mapping techniques.

MATERIALS AND METHODS: A cadaveric lumbar spine from T12 to L4 has been examined with a MAYO wrist coil using a 3 T MR system with standard clinical and UTE MR sequences. Visual assessment included structural evaluation, as well as the determination of signs of degeneration. The conventional MR imaging protocol consisted of T1-weighted spin-echo (SE) sequences without fat suppression in the sagittal and axial planes (repetition time/echo time, 700-1075/12.8-13.2 ms; echo train length, 2; slice thickness, 1.5-2.0 mm; interslice gap, 0 mm; field of view, 12.0 – 14.0 cm; data acquisition matrix, 512 x512 pixels; bandwidth, 31 kHz; number of signals acquired, four). Proton-density fat-saturated (PDFS) images were also acquired in the sagittal and axial planes (repetition time/echo time, 1925-2300/13.3-13.4 ms; echo train length, 7; slice thickness, 1.5 mm; interslice gap, 0 mm; field of view, 12.0 – 14.0 cm; data acquisition matrix, 512 x 448 pixels; bandwidth, 31 kHz; number of signals acquired, 4/6). The basic pulse sequence for the UTE MR Imaging employed a half radiofrequency (rf) excitation followed by radial imaging of k-space in one direction. This was followed by the other half rf excitation with the gradient reversed, and repeated radial mapping of k-space. The two sets of images were added to give a single radial line of k-space, and the process was repeated through 360° in 511 steps. Sagittal and axial UTE images, with and without fat suppression were obtained using the following parameters: repetition time: 400-475 ms; echo time: 0.012- 6.6 ms; NEX: 2; slice thickness: 1.5 mm; interslice gap: 1.5 mm; data acquisition matrix: 512 x 511; flip angle: 60°; bandwidth: 50 kHz; FOV: 12-14 cm. To measure T1 values in articular cartilage of the lumbar FJs a short 90° square pulse with a duration of 232 μ s, combined with a dephasing gradient, was followed by UTE acquisition at a series of saturation recovery times (TSRs) to detect the recovery of the longitudinal magnetization of short T2 tissues. To measure T2* values in the FJs cartilage, TE's of 8 μ s, 0.3, 1, 4, 10 ms were used with a TR of 300 ms. Quantitative evaluation included T1 and T2* measurement. Multi-echo SE T2 mapping was performed using a constant TR of 2000 ms, varying TE's ; 7.5-.60ms; NEX:1; slice thickness: 2mm; interslice gap: 0.4mm; acquisition matrix: 320x256; flip angle: 90°; bandwidth 50kHz, FOV 12cm.

RESULTS It was readily observable on the left FJ that there was increased vague hypointensity on the posterior aspect subchondral articular plate on UTE subtraction images (Fig 1. The color-coded T2 relaxation time map demonstrated variations in T2 relaxation time values between right and left FJ cartilages. Mean T2 values of the superficial layer of the cartilage of both FJs obtained from curve fitting values were calculated 53 ms on the left abnormal side and 40ms on the right normal side (Fig 2). T2* value of the calcified layer of the cartilage on the abnormal left side and normal right side were calculated as 6.8 ms and 2.1 respectively (Fig 3).

CONCLUSION-DISCUSSION: A quantitative evaluation of biochemical composition and integrity of the facet joint's cartilage and capsule extensions is possible and might be useful for clinical examinations for patients with lower back pain. Findings in this cadaveric specimen show increase in both T2* values of the calcified cartilage as well as in T2 values of the superficial cartilage in the setting of degeneration.

REFERENCES: (1)Benjamin M et al. J Magn Reson Imaging 2007 (2) Robson MD, et al. J Comput Assist Tomogr 2003

