

Evaluation of Articular Cartilage in Patients with Osteochondrosis Dissecans by Morphological MRI and Quantitative T2 and T2* Mapping at 3.0 Tesla

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Purpose/Introduction: One still unsolved problem in the treatment of patients, suffering from osteochondrosis dissecans (OCD) of the talus, is the identification, who would benefit from surgical treatment rather than conservative management. Decision pro or contra surgery (most often microfracture) is mainly based on clinical symptoms like pain and the stage of the disease on standard MR. With the help of biochemical MR-Imaging an improved staging of OCD with respect to the integrity of the overlying articular cartilage may be possible. T2/T2* mapping have already shown promising results in the detection of early cartilage changes[1] and in the evaluation of the maturation process of cartilage repair tissue[2, 3]. The purpose of our study was to perform an in vivo evaluation comparing the overlying articular cartilage in patients suffering from OCD in the talocrural joint and healthy volunteers using T2/T2* mapping at 3.0 Tesla.

Material and Methods: Ten patients (mean age: 27.3) with OCD on the medial side of the talar dome and 9 healthy age matched volunteers (mean age: 28.3) were enrolled. MR imaging was performed on a 3T MR scanner (Magnetom Trio, Siemens Medical Solutions, Erlangen, Germany) with a gradient strength of 40 mT/m, using a flexible multi-element, 8-channel coil (Noras, Hoechst, Germany). MR sequences, for morphological imaging and localisation of anatomical site of the lesion consisted of a proton-density (PD) TSE sequence (TR/TE 2100/26, flip angle 160°, FoV 100x100mm, pixel matrix 320x320; voxel size 0,3x0,3x3mm; 12 slices; total scan time 6.3min) (Figure 1a) and an isotropic 3D GRE (TrueFisp) sequence

(TR/TE 8.86/3.82; flip angle 28°; FoV 160x160mm; voxel size 0.4x0,4x0.4mm; 320 slices per slap; total scan time 9.33min).

T2 relaxation times were obtained from T2 maps, reconstructed from a sagittal multi-echo spin-echo sequence with a TR of 1000ms and six echo times (TE) of 13.8ms, 27.6ms, 41.4ms, 55.2ms, 69.0ms and 82.8ms. FoV was 160x160 mm, pixel matrix 384x384, and voxel size 0.4x0.4x3mm. Flip angle 180°, bandwidth 228 HZ/pixel, with 11 slices and total acquisition time of 6:52 min (Figure 1b).

T2* maps were constructed using a GRE acquisition with a TR of 500ms and six TEs of 4.18ms, 11.32ms, 18.46ms, 25.60ms, 32.74ms, and 39.88ms. FoV, matrix size, voxel size and slice thickness were kept consistent for the T2 and T2* measurements. Flip angle 60°, bandwidth 260 HZ/pixel, with 11 slices and total acquisition time of 3:26 min. T2 and T2* maps were obtained using a pixel wise, monoexponential, non negative least squares (NNLS) fit analysis.

A region of interest (ROI) analysis was manually performed within the cartilage overlying the OCD-lesion and within a region of morphological normal-appearing cartilage (Reference area within the same patient). Furthermore ROIs were positioned on the medial side of the talar dome in healthy volunteers (Reference Volunteer). A student's t-test was performed to compare the mean T2 values of the cartilage layer above the OCD and the reference sites.

Results: The mean T2 relaxation time values for the cartilage layers overlying the OCD were 44.2ms (SD 6.6) for T2 mapping and 16.3ms (SD 3.2) for T2* mapping. The control cartilage revealed significantly lower meanT2 (31.4ms; SD 3.6; p < 0.01) and T2* values (12.1ms; SD 2.1; p < 0.01). The difference between the cartilage layer affected by the OCD and the T2/T2* values found in healthy volunteers was also significant (T2 29.8ms, SD 5.7, p < 0.01)/ (T2* 11.8ms, SD 2.8, p < 0.01). Healthy volunteers and cartilage control sites in patients did not reveal a significant difference, neither for T2 values (p = 0.443) nor for T2* values (p = 0.747) (Figure 2).

Conclusion: The collected data suggest that, although the articular cartilage above an OCD often seems morphologically to be intact, changes in the structural integrity of the collagen matrix and in the cartilage water content have already taken place. Thus, measuring the mean T2 and T2* values could be a promising, non invasive diagnostic method for the assessment of biochemical condition of the articular cartilage above the OCD in the talocrural joint and may improve staging of OCD. It may also be a powerful tool in the monitoring of OCD after surgical interventions.

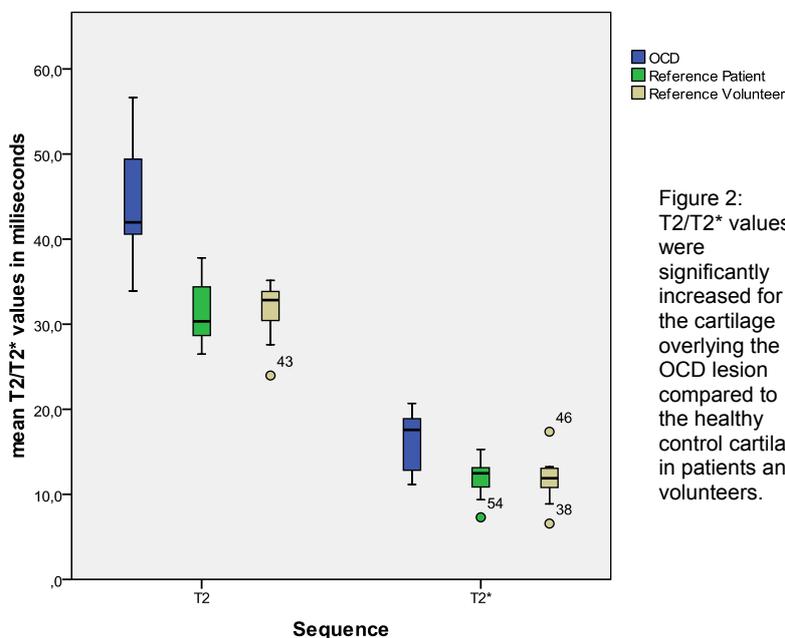
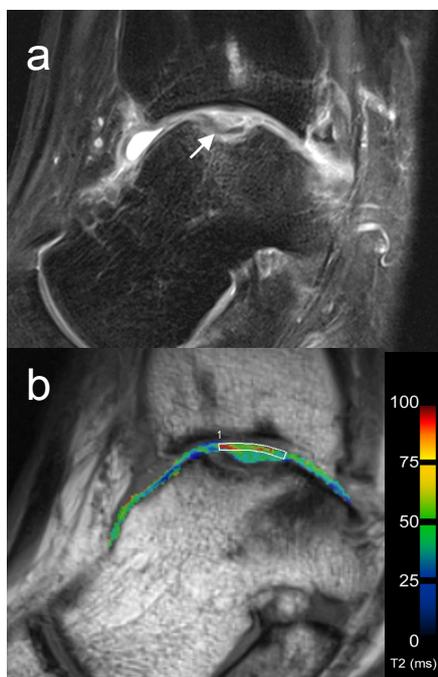


Figure 2: T2/T2* values were significantly increased for the cartilage overlying the OCD lesion compared to the healthy control cartilage in patients and volunteers.

Figure 1: (a) sagittal PD TSE image of OCD (arrow); (b) corresponding T2 map of the same patient.

[1] Li, X., et al., Osteoarthritis Cartilage, 2007. 15(7): p. 789-97; [2] Quirbach, S., et al., Skeletal Radiol, 2009. 38(8): p. 751-60; [3] Welsch, G.H., et al., J Magn Reson Imaging, 2008. 28(4): p. 979-86.