Lumbar intervertebral disc pathology: Comparison of quantitative T2 mapping with conventional MR at 3.0 Tesla

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Introduction: Herniated discs and annular tears are common findings in the lumbar spine, however their role in pain production is still a matter of discussion.[1,2] The objective of our study is to assess the relationship of morphologically defined lumbar disc pathology with quantitative T2 relaxation time measurements. Evaluation included the following questions: (1) Do the mean T2 relaxation time values in the annulus fibrosus (AF) and the nucleus pulposus (NP) differ between patients with disc herniation, bulging, annulus tears and "normal discs"? (2) Do T2 relaxation time measurements have a predictive value for disc herniation or annulus tears ?

Materials and Methods: Fifty-three patients aged 15-64a (mean: 38a) with single or recurrent episodes of low back pain and no radicular symptoms and no spine injury or surgery in the past were examined on a whole body 3.0T MR (Magnetom Tim Trio, Siemens Medical Systems, Erlangen, Germany) using a phased array spine coil. The ethics commission of the medical university provided ethical approval for this study, and written, informed-consent was obtained from all patients prior to enrollment. We used sagittal T1-FSE, sagittal, coronal and axial T2-FSE for morphological MRI. For T2 relaxation time measurement a multi echo-spin echo sequence was performed with a TR of 1200 msec, TE 13.8, 27.6, 41.4, 55.2, 69.0 and 82.8 msec, pixel matrix 256 x 256, voxel size 0.9 x 0.9 x 5 mm in 10 sagittal slices. T2 maps were obtained using a pixel-wise, mono-exponential non-negative least squares (NNLS) fit analysis. All discs were classified morphologically by two experienced radiologists into the following categories: focal disc herniation (protrusion or extrusion), annular tears, disc bulging and discs without this type of pathology, referred as "normal discs". On sagittal T2 maps regions of interest (ROIs) for the AF were drawn anteriorly and posteriorly in the outermost 20% of the disc on two adjacent slices running through the center of the spine. The space in between was assessed with 3 additional ROIs and defined as the NP (fig.1). The herniated tissue itself was also assessed with a ROI. For statistical analysis paired t-tests, univariate ANOVA and post hoc Tests (Games Howell), logistic regression and discrimination analysis were used. To avoid multicollinearity in regression analysis we performed Pearson's correlation to evaluate if it is reasonable to integrate NP and AF ROIs into summary terms.

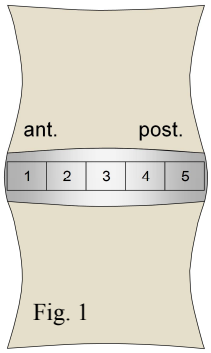

Fig. 1

Results: In 265 analyzed discs we found 39 focal herniations, 10 annular tears, 123 bulging discs and 103 "normal discs" without the previous pathologies (fig.2). Correlation analysis of T2 values showed a good correlation between NP ROIs (ROI 2, ROI 3 and ROI 4, r=0.79, 0.79, 0.60 and Cronbach's alpha 0.88) but no correlation between anterior and posterior AF (ROI 1 and ROI 5, r=0.05). Thus we focused on the evaluation of these 3 disc compartments: anterior and posterior AF and NP. The respective mean T2 values (in ms) for these 3 disc compartments were 39±12 / 70±23 / 118±39 for normal discs, 44±17 / 55±22 / 106±53 for bulging discs, 47±23 / 49±17 / 84±50 for discs with focal herniation and 41±7 / 47±14 / 53±18 for discs with annular tears. There were significant differences in T2 values of the NP between discs with annular tears and all other groups (all p<0.001) and between discs with herniations and all other groups (all p<0.01). There was no difference in NP T2 values between normal and bulging discs (see fig. 3). Normal discs had the highest T2 values in the posterior annulus compared to all other groups (all p<0.001), bulging discs had slightly higher T2 values than herniated discs (p=0.04) and no difference was seen between discs with herniation and annular tears (p=0.96). The T2 values of the anterior annulus were more constant in all groups, only a difference between normal and bulging discs was seen (p<0.01). T2 relaxation time values within the herniated disc material were significantly different to the parent disc with significantly lower T2 values in the herniated disc portion compared to T2 values in NP as well as in the anterior and posterior AF (all p<0.001). The logistic regression showed significant results for ROI 1 and T2 NP for the prediction of an annulus fissure with a specificity of 100%, but the sensitivity was only 15%. The discrimination analysis demonstrated that using ROI 1, NP T2 and ROI 5 in 58.6% of discs bulging and focal herniation could be accurately defined. The highest values could be achieved by the ROI 5 and NP T2 values.

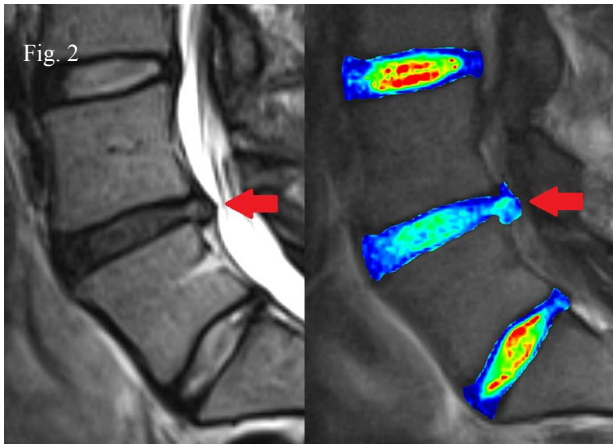
Fig. 2

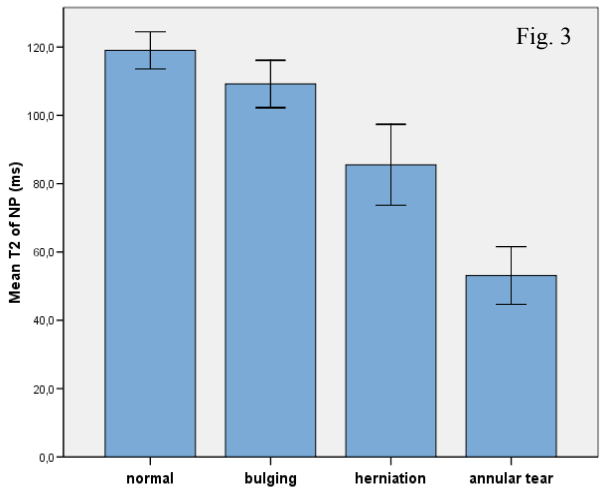

Fig. 3

Discussion/Conclusion: In summary, quantitative T2 mapping in the lumbar spine at 3 Tesla yields additional information about the disc matrix and is a promising noninvasive tool to assess water content and collagen fiber integrity in different disc pathologies. Biochemical MR of the intervertebral disc may provide an early diagnosis of annular tears and disc dislocation and may improve monitoring of different spine therapies.

References: [1]. Kelsey et al, J Chronic Dis 1975; 28:37-50; [2]. Jensen et al, N Engl J Med. 1994 Jul 14;331(2):69-73.