Quantitative 3D- $T1_\rho$ weighted MRI of lumbar spine at 3.0T.

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Introduction

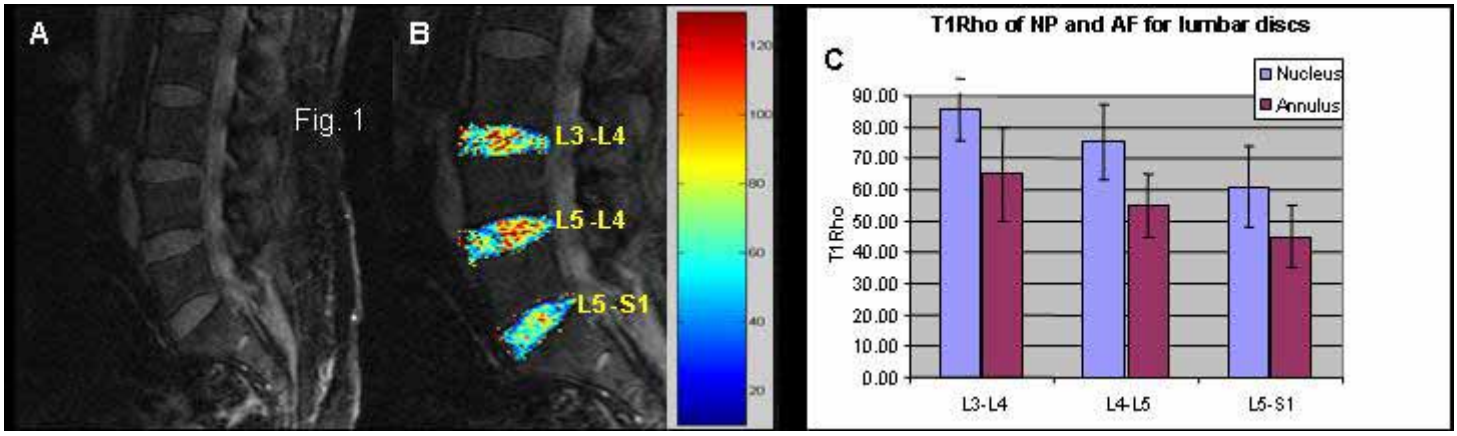
Low back pain and intervertebral disc (IVD) disorders are major public health problems that cause individual suffering and tremendous economic cost. In the western countries, 75-80% of people are affected by low back pain at some point during their lifetime [1, 2]. Disc degeneration has been implicated as a major etiological component of low back pain [3], a condition with tremendous disability, activity limitation, and economic loss. Macromolecular composition, water content and structural changes in the disc are important determinants of the IVD disorders. The earliest biochemical changes in the disc are loss of glycosaminoglycan (GAG) and decrease in water content with some structural changes (denaturation) of collagen. Therefore, precise, quantitative knowledge of GAG will not only improve the fundamental understanding of disc function, but may also have diagnostic and predictive value in the clinical evaluation of the IVD disorders associated with degeneration. Previous studies have quantified $T_{1\rho}$ relaxation time in intervertebral disc specimens [4] as well as *in vivo* [5] by 2D-$T_{1\rho}$ MRI. However, to the best our knowledge, no *in vivo* 3D-$T_{1\rho}$ quantitation of lumbar disc have been reported. The purpose of this study is to demonstrate the feasibility of 3D-$T_{1\rho}$ relaxation mapping in the lumbar spine, employing *in vivo* MR imaging at 3T clinical scanner.

Methods

Five asymptomatic volunteers (mean age= 30years, age range 22-38 years) were recruited. All MRI experiments were performed on a 3.0T clinical MR scanner (Magnetom Trio scanner, Siemens Medical Solutions, Erlangen, Germany) employing 8-channel phased array receiver spine coil (body coil was used as the transmitter). 3D-$T_{1\rho}$-weighted sagittal images were acquired with a 3D GRE sequence with $T_{1\rho}$ magnetization preparation (TR/TE=175,2.2 ms; flip angle, 26°; total number of sections, 16; section thickness, 3 mm; matrix size, 256x256; bandwidth 350 Hz/pixel; one signal acquired; FOV=20x20 cm). The magnetization preparation is achieved by using a "self-compensating" spin-lock pulse-cluster which minimizes the effects of B_1 field inhomogeneities (duration of each 90° pulse=200μs; the amplitude of the spin-lock pulse=250Hz). In order to construct $T_{1\rho}$ map, four 3D-$T_{1\rho}$-weighted images were acquired with TSLs (length of the spin-lock pulse) of 2, 10, 20, and 30 ms. The total acquisition time for 3D-$T_{1\rho}$ map is ~24 minutes. The reproducibility of $T_{1\rho}$ maps of NP and AF were investigated.

Results and Discussion

Fig.1A displays a slice from a representative 3D-$T_{1\rho}$-weighted image obtained on a healthy volunteer. $T_{1\rho}$-maps of the lumbar discs were overlaid on the same slice and displayed in Fig.1B. Comparison of quantitative relaxation times in nucleus pulposus (NP) and annulus fibrosus (AF) as a function of disc location can be seen in Fig.1C. The median $T_{1\rho}$ values of NP and AF of the lumbar discs are spatially dependent and statistically significant (relatively higher at L3-L4 and lower at L5-S1 location) within the lumbar region as shown in Fig.1C.



Conclusion

The preliminary results demonstrate the feasibility of 3D-$T_{1\rho}$ MRI for *in vivo* quantitation of lumbar spine at a 3T clinical scanner. The median $T_{1\rho}$ value in the NP is significantly higher than that of AF. Furthermore, spatial heterogeneity of $T_{1\rho}$ among S1-L5, L5-L4 and L4-L3 were observed on all five volunteers and this may be due to the variations in biochemical content (mainly GAG), load distribution and water content. These results demonstrate that it is possible to quantify 3D-$T_{1\rho}$ MRI of lumbar spine *in vivo* without exceeding the RF power deposition at 3T clinical scanner.

References

1).Andersson, GB., Acta Orthopaedica Scandinavica. Supplementum., 1998. **281**: p. 28-31.2).Andersson, GB, Lancet., 1999. **354**(9178): p. 581-5. 3).Herzog, R. et al,. American Academy of orthopaedic Surgeons, Rosemont, IL.,1996: p. 385-405. 4) Regatte, RR et al. 12th ISMRM, 2004: P1544. 5) Blumenkrantz G et al , 13th ISMRM 2005: P809.