T2-relaxation Time Measurement of Magnetic Resonance Imaging for Evaluation of Nucleus Pulposus Degeneration

K. S. Choi[1], H. J. Shin[1], S. H. Kim[1], C. S. Park[2], Y. J. Lee[1], O. J. Shin[3], C. K. Eun[4], J. W. Shin[1], C. W. Mun[1,2]

[1]Biomedical Engineering, Inje University, Gimhae, Kyongnam, Korea, Republic of, [2]Graduate School of Medical Imaging Science, Inje University, Gimhae, Kyongnam, Korea, Republic of, [3]Radiology, Pusan Paik Hospital, Busan, Korea, Republic of, [4]Diagnostic Radiology, Medical School, Inje University, Busan, Korea, Republic of

Introduction

Degenerative disc disease induces low back pains and limited mobility due to dehydration and becoming fibrous tissue of the intervertebral disc. Usually, NP in degenerative disc become dehydrated and disorganized in pathology. Some researchers have studied a surgical procedure to regenerate NP with nanofiber-based scaffold inserted in degenerative disc. In this study, we investigated the assessment possibility of the regenerative change of NP using T2 analysis of MRI for in vitro pig's disc samples.

Methods

Two degenerated (nanofiber, defect) and one intact (normal) discs of pigs in vitro intervertebr were prepared. Nanofiber scaffold was fabricated utilizing electrospinning technique and wa inserted into one (nanofiber) of two degenerated discs to induce regeneration. The discs we cultivated for 10 days with DMEM-12 (FBS 20%) with 360-410 mOsm/kg to prevent swelling of dis and improve cell metabolism in 6-well tissue culture plates. MRI scans were performed in Sig EchoSpeed 1.5-T MRI system (Lx9.1, GE, MI, USA). Six images were obtained from spin ech sequences with various TEs. Imaging parameters were TR=4000msec, FOV=12cm, imag size=256x256 and thickness=2mm. T2 values were calculated pixel by pixel and T2-map image were generated using Matlab (Mathworks, ver 6.5) programs developed by authors. Hand-mad small rf coil with I.D.=10□ and L=15□, shown in Fig 1, was used to improve SNR and reliability measured data.

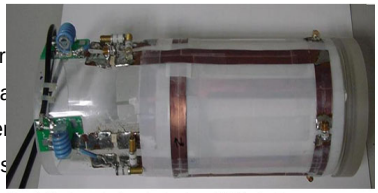

Fig. 1. Photograph of quadrature typed Tx/Rx rf coil

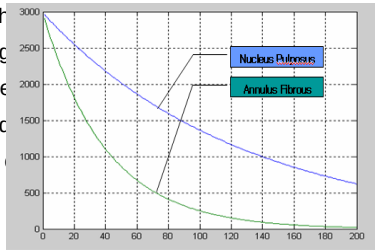

Fig. 2(a) Calculated T2 curves of NP and AF for normal disk

Results

Fig 2(a) shows that T2 values of NP and AF are 80.22 ±15.02 ms and 24.26 ±6.7 ms, respectivel For normal and defect discs, 134.38±20.80 / 80.22 ±15.02 ms in NP and 29.01±6.59/35.97±4.85 m in AF. And the difference of T2 values between NP and AF was the largest when TE was 70ms nanofiber. Fig 2(b) showed the calculated T2 curves of NP for all specimens. The difference of T value between nanofiber and defect was low. And T2 value difference in NP was maximized whe TE was 120ms. And T2 map of each disc was represented in color image. Both signal intensity ar T2 map of normal disc were higher than that of the others (Fig 2(c), Fig 2(d)).

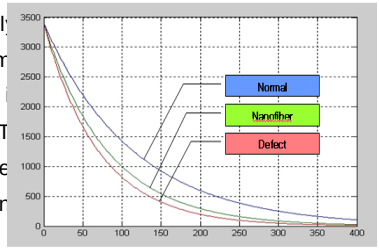

Fig. 2(b) Calculated T2 curves of NP for normal, nanofiber and defect discs

Discussion & Conclusion

From T2 analysis, the contrast between NP and AF was maximized at TE = 70ms in nanofiber dis case. Moreover the best contrast image from NP of all specimens was obtained when TE wa 120ms. The evaluation of nucleus pulposus regeneration using T2 map was the similar trend to th of signal intensity. However T2 map may be more useful to evaluate disc degeneration than sign intensity. Image contrast optimization using T2 curve and T2 map technique may provi advantages to evaluate disc regeneration in the field of tissue engineering. We found that T analysis provides a useful diagnosis tool to evaluate the NP regeneration for effective clinic application. In this study, we found that the improvement of SNR was achieved using hand-mad small rf coil in comparison to the commercial extremity coil (knee coil).

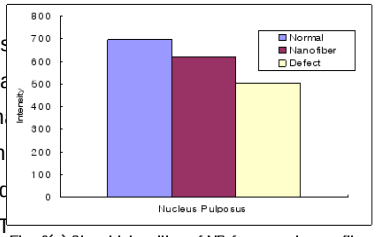

Fig. 2(c) Signal intensities of NP for normal, nanofiber and defect discs in T2-weighted MRI

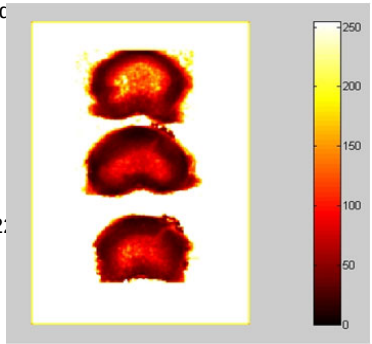

Fig. 2(d) T2 map image for normal, nanofiber and defect discs (form top)

References

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