Does cartilage transplantation harm or regenerate adjacent cartilage ? A longitudinal study

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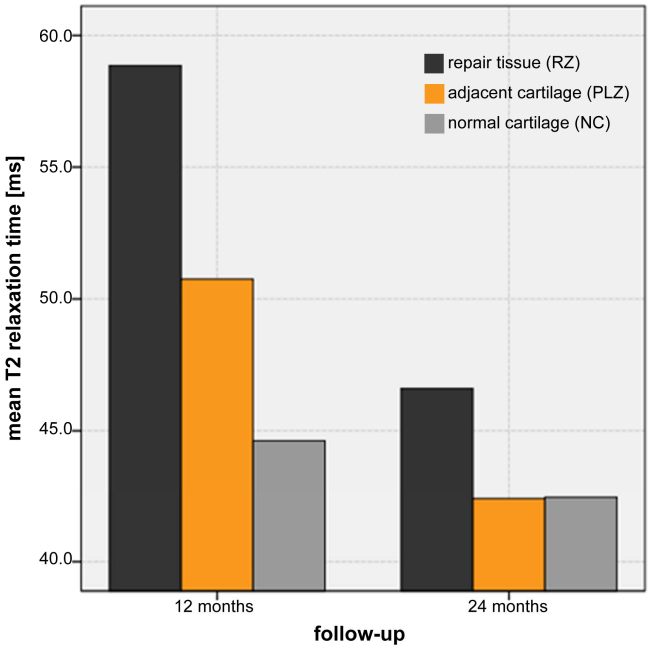
Target audience: Musculoskeletal radiologists and physicists

Purpose: Matrix-associated autologous chondrocyte transplantation (MACT) is a method of replacing degenerated cartilage with autologous material [1]. The repair tissue is often hyaline-like and clinical outcomes have been promising [2]. However, the effect of the procedure on the surrounding cartilage remains to be investigated. T2-mapping is sensitive to early cartilage degeneration [3]. In this study, the integrity of cartilage adjacent to MACT repair tissue was assessed with zonal T2-mapping.

Methods: This study comprised the MRI examinations of 26 knees on a 3T MR scanner (Magnetom TimTrio, Siemens Medical Solutions, Erlangen, Germany) at 12 and 24 months after MACT. The study included 18 male and 8 female subjects, with a mean age of 29.6 years at the time of surgery. The location of the MACT included nine patellae, nine medial femoral condyles, six lateral femoral condyles, and two trochleae. A morphological PD-TSE sequence (TE=38ms, TR=2400ms, FOV=120x120mm²) and a multi-echo spin echo T2-mapping sequence (TE=13.8ms; 27.6ms; 41.4ms; 55.2ms; 69ms; 82.8ms, TR=1200ms, FOV=160x160mm²) were obtained using an eight-channel knee array coil (Invivo, Gainesville, FL, USA). T2 maps were reconstructed on-line using a pixel-wise, mono-exponential, non-negative least squares (NNLS) fit analysis (MapIt, Siemens Medical Solutions, Erlangen, Germany). ROIs were drawn by hand to obtain the mean T2 relaxation times of the repair tissue zone (RZ), the peri-lesional zone (PLZ), and the normal hyaline cartilage (NC) as a reference. The PLZ was defined as the two cartilage regions adjacent to the transplant spanning seven millimeters on each side. A precondition was its morphological integrity. Zonal evaluation was performed by placing one ROI in the superficial half and one in the deep half of the cartilage region. A two-way repeated measures ANOVA with Bonferroni corrected post-hoc tests was performed to detect differences between the regions and layers and between the two time points.



Results: In the examination 12 months after MACT, the mean T2 relaxation times were 50.0 ms in the PLZ, 44.4 ms in the NC, and 57.7 ms in the RZ. The differences of those values were significant between all regions (all $p<0.001$). The analysis 24 months after MACT, however, showed no significant differences between the regions ($p=0.148$ for the main effects). Mean T2 relaxation times of 42.9 ms in the PLZ, 42.4 ms in the NC, and 46.8 ms in the RZ were observed (Figure 1). The T2 value reduction between the two time points in the PLZ (7.0 ms) was significantly higher than in the NC (1.9 ms) ($p=0.004$) and significantly lower than in the RZ (10.8 ms) ($p=0.043$). The T2 values in the superficial layer were significantly higher than in the deep layer in all regions at both time points ($p<0.001$ for the main effects). No influence of the region on the layer or vice versa could be shown. The interaction between the main effects region and layer was $p=0.276$ at the 12-month follow-up and $p=0.631$ at the 24-month follow-up.

Discussion: The results indicate that the PLZ shows early degenerative changes one year after MACT. Two years after the procedure, a normalization of the T2 values in the PLZ can be observed.

Conclusion: If early degeneration surrounding the transplant was already present at the time of MACT, it can be speculated that the repair surgery will have a positive influence on the adjacent cartilage.

References:

[1] M. Brittberg, A. Lindahl, A. Nilsson, C. Ohlsson, O. Isaksson, L. Peterson. Treatment of deep cartilage defects in the knee with autologous chondrocyte transplantation. N Engl J Med. 1994; 331: 889-895.

[2] L. Peterson, M. Brittberg, I. Kiviranta, E.L. Akerlund, A. Lindahl. Autologous chondrocyte transplantation. Biomechanics and long-term durability. Am J Sports Med. 2002; 30: 2-12.

[3] T.J. Mosher, B.J. Dardzinski. Cartilage MRI T2 relaxation time mapping: overview and applications. Semin Musculoskelet Radiol. 2004; 8: 355-368.