T2 relaxation time of matrix-based autologous chondrocyte transplantations (MACT) and corresponding healthy cartilage of the knee – A prospective 2-year follow-up study

A. Horng[1], M. Pietschmann[2], J. Raya[1], P. Mueller[2], M. F. Reiser[1], and C. Glaser[1]

[1]Department of Clinical Radiology, University Hospitals LMU Munich - Campus Grosshadern, Munich, Bavaria, Germany, [2]Department of Orthopedic Surgery, University Hospitals LMU Munich - Campus Grosshadern, Munich, Bavaria, Germany

Purpose: Matrix-based autologeous chondrocyte transplantations (MACT) [1-3], represent a recently developed therapy option for cartilage defects. Follow-ups are challenging as arthroscopy is invasive and thus should be avoided. T2 relaxation time, a quantitative parameter correlated to water content and collageneous architecture of cartilage [4], carries information about microstructural cartilage morphology and is regarded as a potential tool for monitoring rehabilitational changes in MACT [5]. However, as initial experiences are only available from cross-sectional studies [5], this first prospective longitudinal study analyses T2 relaxation time of MACT and cartilage in the other compartments of the operated knee.

Materials and Methods: Postoperative MRIs (after 3mo/6mo/1a/2a) of 12 patients undergoing MACT of the knee (6 medial femora, 6 patellae) were acquired at 1.5T (Magnetom Sonata, Siemens Medical, Erlangen) using a fat-saturated multiecho sequence (TR 3000ms/TE 13.2ms/8 echoes/resolution 0.6²x3mm³) [6]. After data acquisition T2 maps were calculated pixel-wise using the Marquard-Levenstein-algorithm (exponential fit) for MACT, the opposing cartilage (oppCart), as well as the contralateral healthy patello-femoral and femoro-tibial cartilage (conCart). For each cartilage plate global T2 (average T2 value of complete lesion/healthy area) and regional T2 (T2 value after division into superficial/deep layer) were calculated (figure 1). Statistics were performed using the paired t-test (Excel 2007, Microsoft Cooperation, Redmond, WA, USA). Clinical status was recorded by an orthopedic surgeon using the IKDS.

Results: Average global T2 (3mo/6mo/1y/2y) were 49.4/43.8/39.8/33.3ms for MACT, 36.7/34/33/31.7ms for its opposing cartilage, 34.8/33.7/33.2/32ms and 31.9/31.9/32.3/30.2ms for the corresponding contralateral compartments. The longitudinal T2 decline was significant for MACT (3mo-2y 32.7%, table 1), as were T2 differences compared to the cartilage of contralateral compartment up to 1y (all $p<0.001$) (figure 2). After 2y no difference was detectable between MACT and non-operated cartilage. Regional T2 values revealed that the MACT lacked zonal differentiation even after 2y. Subtle transient postoperative T2 time changes were seen within the cartilage opposite to MACT, possibly due to adaptive postoperative loading ($p<0.04$). This was not observed in the healthy, non-operated, compartment. IKDS showed a mean improvement of 38.8% after 1 year.

Conclusion: Data supports the clinical experience of continuous remodelling of MACT for at least 1-2y after operation before reaching normal preoperative T2 values. Lack of zonal differentiation in MACT even after 2y might be a consequence of the matrix-based technique or related to further ongoing remodelling. Transient T2 alterations in the cartilage opposite to MACT might be due to operational trauma or biomechanical changes in the joint. In summary T2 imaging provides a potential quantitative tool for postoperative monitoring of cartilage repair and might contribute to predict its posttherapeutical evolution.

Table 1: Change of T2 relaxation time of MACT and its opposing cartilage layer over 2 years

Time range	MACT			Opp Cart		
	absolute (ms)	relative (%)	significance p	absolute (ms)	relative (%)	significance p
3mo-6mo	5.6	11.4	0.059	2.7	7.4	0.095
6mo-1y	4.1	9.3	0.003	1.1	1.5	0.311
1y-2y	6.5	16.3	0.000	1.3	4	0.041
3mo-2y	16.1	32.7	0.000	5.1	13.8	0.005

Figure 1: Segmentation scheme

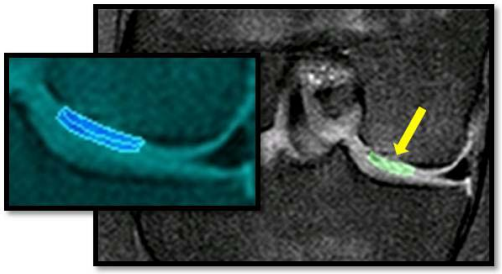
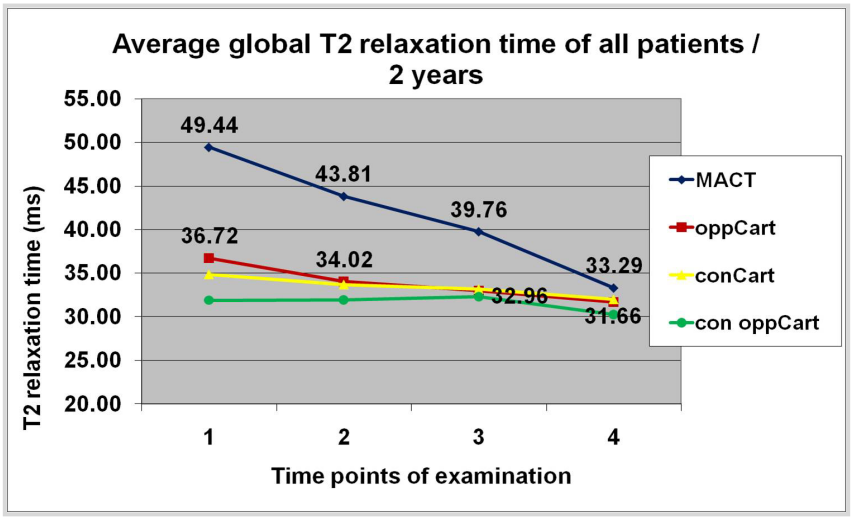


Figure 2: Longitudinal evolution of global T2



Literature:

1. Brittberg et al, N Engl J Med 1994
2. Erggelet et al, Arthroscopy 2003
3. Marcacci et al, Clin Orthop Relat Res 2005
4. Mosher et al, Semin Musculoskelet Radiol 2004
5. Trattnig et al, Invest Radiol 2007
6. Mendlik et al, Invest Radiol 2004