T2 and T2* mapping of the human femoral-tibial cartilage at 1.5 and 3 Tesla

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Introduction:

Alterations in cartilage matrix architecture lead to changes in T2 relaxation times due to modified interactions between dipolar water protons within the collagen matrix. Therefore, the T2 relaxation time serves as a sensitive parameter for evaluation of early degenerative articular changes

Since T2* is even more sensitive to B_0 field inhomogeneities T2* mapping seems to be promising in the assessment of subtle disorders in cartilage structure.

The aim of this study was the evaluation and comparison of the spatial variation of T2 and T2* in human articular cartilage at 1.5 and 3 Tesla.

Methods:

Quantitative in vivo T2 maps of the femoral-tibial joint were obtained in eight asymptomatic male volunteers at 1.5T and 3T (Siemens, Medical Solutions, Erlangen, Germany). Identical sequence parameters were applied on both units (spin echo sequence with 32 different echo times ranging from 10 - 320 ms, gradient echo sequence with 16 different echo times ranging from 5 – 79 ms).

Relaxation time maps were calculated on a pixel-by-pixel basis for the whole circumference of the femoral cartilage at the sagittal plane. A semiautomatic segmentation was implemented. The cartilage was divided into 36 sectors and the angle of each cartilage layer was determined with respect to the B0 field (see. Fig.1).

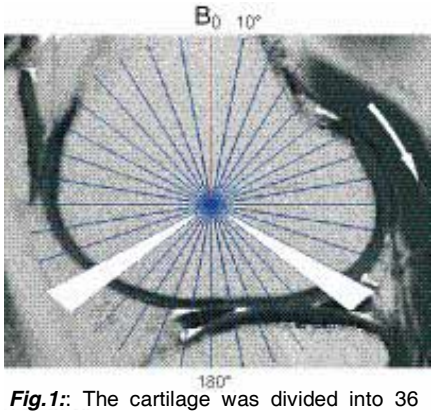

Fig.1:: The cartilage was divided into 36 sectors and the angle of each cartilage layer with respect to the B0 field was clockwise determined. Sectors 55°to B0 were marked white.

Results:

At both field strengths the T2 maps revealed a characteristic distribution pattern in all volunteers. Slightly increased T2 values were observed in the ventral sectors compared to the dorsal sectors (46.8±4.7ms vs. 45.5±5.7ms at 3T; 45.0±3.7ms vs. 42.8±5.7 ms at 1.5T). In sectors orientated 55° to B_0 ("magic angle") significantly longer T2 values were detected compared with the neighboured sectors (53.1±1.3 ms vs. 47.8±1.7 ms at 3T; 50.6±2.3 ms vs. 43.8±2.0 ms at1.5T).The "magic angel" effect could also be verified in T2* maps (29.1±2.1 ms vs. 21.8±3.97 ms at 3T; 27.0±3.55 ms vs. 23.6±1.89 ms at 1.5T), (see Fig.2). The "magic angle" effect increased with the static magnetic field strength. Additionally, characteristic T2 as well as T2* profiles within the cartilage layer could be shown.

Sectors	55° toB0	neighboured	55° toB0	neighboured
3 T	53.1±1.3	47.8±1.7	29.1±2.1	21.8±3.97
1.5 T	50.6±2.3	43.8±2.0	27.0±3.55	23.6±1.89

Tab.1: T2 and T2* values (mean ± SD) in ms at 1.5 and 3 Tesla in the sectors orientated 55° to B0 compared to the neighboured sectors.

Conclusion:

The "magic angle" effect proved not only in T2 but also in T2* maps increases with the magnetic field strength which has to be considered in high field cartilage imaging. Especially T2* mapping for the detection of early cartilage degeneration seems to be promising.

References:

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3. **Mosher T.J**. et al., AJR 2001;177: 665-669

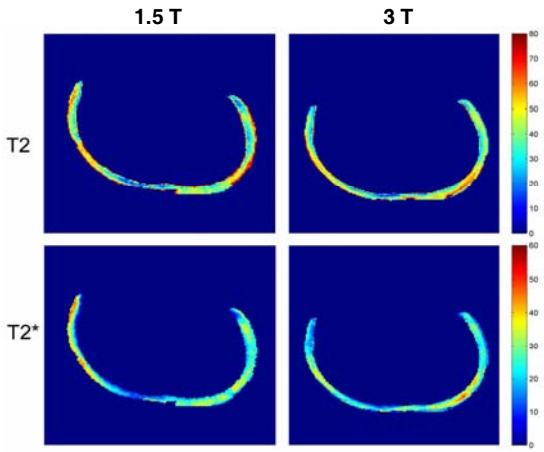

Fig.2: Illustrates the color coded T2 and T2* map of the femoral cartilage sagittal section obtained from a representative volunteer. In analogy to the T2 map increased T2* values at 55° to B0 field are visible.