# Effect of tear of the medial meniscus on T2 relaxation time of articular cartilage

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## INTRODUCTION

A tear in medial meniscus of the knee increases the risk of medial osteoarthritis (OA) progression [1]. T2 relaxation time correlates with collagen content [2] and water content [3] of cartilage, as well as with the integrity [4] and arrangement [5, 6] of the collagen network. It may provide a sensitive tool to detect early degenerative changes in articular cartilage before they are seen in clinical MRI. In the present study, we aimed to assess the influence of meniscal tear on T2 relaxation time of femoral and tibial cartilage.

## MATERIALS AND METHODS

Twenty patients (17 male, 3 female; mean age 30 yrs) with a tear in medial meniscus and 20 young asymptomatic controls (10 male, 10 female; mean age 22 yrs) were enrolled in the study. During 2004-2008, 337 patients with knee symptoms were imaged using MRI and T2 mapping. Of these 90 had at least one meniscal tear, and 69 had an isolated medial meniscal tear. Patients with rheumatoid arthritis, spondylarthropathy, oligoarthritis and fracture around the knee were excluded. Twenty youngest adults (over 18 years) of the original cohort were selected to the study, because the meniscal tear is most likely to be of traumatic origin in this age group [7].

MRI was conducted using two GE Signa 1.5T scanners (GE Healthcare, Milwaukee, WI) equipped with a transmit/receive knee coil. T2 relaxation time was determined using a sagittal multi-slice multi-echo spin echo sequence (TR/TE=1000/10-80ms, ETL= 8, FOV=140mm, 256×256 matrix, 0.55-mm in-plane resolution, 3-mm slice thickness) with an improved slice profile. T2 relaxation times were determined from the weight-bearing femoral and tibial cartilage at the center of the medial condyle (Fig. 1). Tibial cartilage was further divided into anterior, central and posterior regions of interest (ROIs). Superficial and deep halves of the cartilage were separately analyzed. The non-parametric Mann-Whitney -test was used to compare the T2 values of the patients with meniscal tears to those of controls.

## RESULTS

A tear in medial meniscus resulted in longer T2 values in all ROIs (5-30% longer than controls). The differences were statistically significant at one out of four superficial cartilage ROIs and all four deep ROIs in the medial compartment as compared to asymptomatic controls (Table 1).

## DISCUSSION

OA of the knee is a major cause of chronic disability. MRI provides an accurate assessment of lesions of the articular cartilage [8]. However, its sensitivity to detect early cartilage degeneration occurring prior to morphological changes is not fully understood. Hunter *et al*. have previously shown that the volume of the cartilage diminishes after meniscal tear [1]. Biochemical MRI techniques, such as T2 and dGEMRIC, can provide information on cartilage macromolecules prior to gross pathological changes. Ericsson *et al*. have reported decreasing dGEMRIC values, reflective of proteoglycan loss, in the medial compartment 1-6 years after medial meniscectomy, indicating an early stage OA [9]. The present study suggests that meniscal tears also affect the internal structure of cartilage. In the present study, T2 differences were observed both in femoral and tibial cartilage of the medial compartment in patients with a medial meniscal tear as compared to asymptomatic control subjects. These findings suggest that meniscal damage affects the collagen network or hydration of adjacent articular cartilage.

OA of the medial compartment is the most common form of knee OA. In a study with histological correlation, T2 relaxation time increased with the severity of OA [10]. Previously, Dunn *et al*. reported a significant increase in T2 values in femoral and medial tibial cartilage in subjects with OA as compared to a group without radiological signs of OA [11].

## CONCLUSIONS

T2 relaxation time mapping is capable of measuring intra-cartilaginous structures non-invasively. A tear in the medial meniscus is related with a significantly longer T2 relaxation time of load-bearing medial articular cartilage as compared to asymptomatic control subjects. It may provide a sensitive tool to detect early degenerative cartilage changes in OA even before they are seen in clinical MRI.

**Table 1**: Comparison of T2 relaxation time for different segments of load-bearing medial tibio-femoral cartilage between patients with medial meniscal tear ($T2_{tear}$) and asymptomatic volunteers ($T2_{control}$). For nomenclature of segments see Fig 1.

| Segment | $T2_{tear}$ (ms) | $T2_{control}$ (ms) | Difference to control (%) | P-value |
|---|---|---|---|---|
| $pcMF_s$ | 45.9±4.1 | 45.0±3.8 | +2.0 | 0.841 |
| $pcMF_d$ | 47.3±4.3 | 39.1±2.7 | +20.9 | 0.000 |
| $aMT_s$ | 46.6±5.8 | 41.9±3.4 | +11.2 | 0.001 |
| $aMT_d$ | 52.3±4.5 | 40.4±2.3 | +29.5 | 0.000 |
| $cMT_s$ | 45.2±4.7 | 43.0±3.3 | +5.1 | 0.086 |
| $cMT_d$ | 44.4±5.0 | 39.3±2.6 | +13.0 | 0.000 |
| $pMT_s$ | 44.4±4.0 | 42.7±2.6 | +4.0 | 0.127 |
| $pMT_d$ | 50.0±4.7 | 40.3±2.9 | +24.1 | 0.000 |

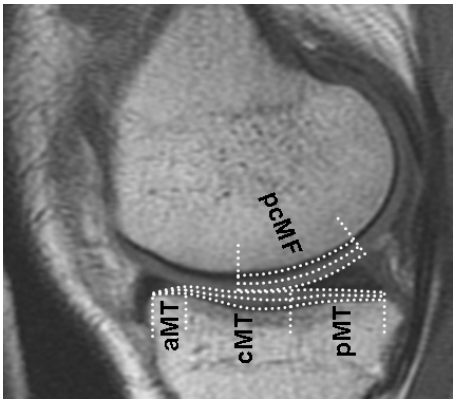


**Fig. 1**: The division and nomenclature of the cartilage segments. Prefixes are "a" for anterior, "c" for central, "p" for posterior, "M" for medial, "F" for femur and "T" for tibia. Suffixes "s" and "d" refer to the superficial and deep halves of cartilage.

## REFERENCES

[1] Hunter DJ et al. Arthritis Rheum. 2006;54:795-801. [2] Fragonas E et al. Osteoarthritis Cartilage 1998;6:24-32. [3] Lüsse S et al. Magn Reson Imaging 2000;18:423–430. [4] Nieminen MT et al. Magn Reson Med 2000;43:676–681. [5] Gründer W et al. Magn Reson Med 1998;39:376-382. [6] Xia Y et al. Magn Reson Med 2002;48:460-409. [7] Mesiha M et al. Am J Sports Med. 2007;35:103-112. [8] Potter H et al. J Bone Joint Surg 1998;80:1276-1284. [9] Ericsson YB et al. 2009;17:565-70. [10] David-Vaudey E et al. Magn Reson Imaging 2004;22:673–682. [11] Dunn TC et al. Radiology 2004;232:592-598.