# THE APPLICATION OF MAGNETIZATION TRANSFER RATIOS AND T2 RELAXATION TIME TO PATELLAR ARTICULAR CARTILAGE AT 3T

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signal

**Introduction:** Magnetic resonance imaging (MRI) has been established as the standard cartilage imaging modality, and techniques have been developed and optimized to visualize cartilage morphology and to analyze its biochemical composition [1]. T2 mapping technique, which assesses the loss of collagen matrix integrity and increase in water content is currently recognized and there are many studies report that it is sensitive technique for detecting changes in collagen components of cartilage [2]. In comparison, magnetization transfer ratio (MTR) is less commonly cited although it is a biochemical analysis technique based on structure and concentration of the collagen matrix in cartilage [3, 4]. And there are even fewer studies on the combined use of both [5]. The aims of this study are to compare T2 relaxation time and MTR and determine whether MTR map is useful to depict degeneration of patellar articular cartilage as well as T2 map or not.

**Methods:** Experiment- 19 volunteers (7 men, 12 women, range 21-57 yrs, mean age 40.1 years), were imaged on a 3.0-T GE Twin Speed MRI scanner, HDx 14.0 (General Electric Healthcare, Waukesha, WI, USA) using an 8-channel transmit/receive phased array knee coil (HD TR knee coil PA: General Electric Healthcare, In vivo Corporation, Gainesville, FL, USA). Fast spin-echo T2-weighted spin-echo with fat suppression (FS-FSET2), MTR mapping, and T2 mapping were acquired (Fig. 1, 2). The sequence parameters for the FS-FSET2 sequence were as follows: TR/TE=2675/50, 320×256 matrix, 16cm FOV, 4.0mm slice thickness, 2 average, ±31.25 kHz bandwidth, 30 axial sections, and scan time 2 minutes 42 seconds. The sequence parameters for 3D-SPGR were as follows: TR/TE=35/14, 15° flip, 256×160 matrix, 16cm FOV, 1.0mm slice thickness, 1 average, ±31.25 kHz bandwidth, fat suppression, 72 axial sections, and scan time 8 minutes 9 seconds. The sequence parameters for T2 mapping were as follows: TR/TE=1000/7.7, 256×160 matrix, 16cm FOV, 3.0mm slice thickness, 1 average, ±31.25 kHz bandwidth, 14 axial sections, scan time 2 minutes 10 seconds. Magnitude of MT pulse was 1200 Hz frequency offset, flip angle 670, and duration of 9928 microsecond. 1st level SAR limitations were used.
Image Evaluation- 3D-SPGR images with and without MT pulse were transferred to a workstation (Advantage Windows 4.4, GEHC, Waukesha, WI) to calculate MTR map. The patellar cartilage was divided into three parts (medial facet, median ridge, and lateral facet) and they were graded with a modified Noyes scoring system [6]. We totally evaluated MTR and T2 relaxation time at 57 individual parts (grade 0; N=8, grade 1; N=17, grade 2; N=11, grade 3; N=18, grade 4; N=3). We analyzed a correlation of MTR with T2 relaxation time about the followings; 1) at all parts except for grade 4 because of complete loss of articular cartilage, 2) at each part of grade 0, grade 1, and grade 2. The Spearman correlation coefficient was used to evaluate the strength of the correlation between T2 relaxation time and MTR.

**Result:** 1) There was a good negative correlation between T2 relaxation time and MTR on 54 parts ($P < .001$, r = -0.640, Fig. 3). 2) There were good negative correlations between T2 relaxation time and MTR at grade 0 ($P < .05$, r = -0.873), grade 1 ($P < .05$, r = -0.576), and grade 2 ($P < .05$, r = -0.645), respectively, however, no correlation between them at grade 3 (NS, r = -0.033).

**Conclusion:** We compared T2 relaxation time and MTR of patellar articular cartilage and there was good negative correlation between them at grade 0, grade 1, and grade 2. The reasons why there was no correlation between T2 relaxation time and MTR at grade 3 could be several possible causes, that is, dense of collagen fibers due to mechanical compression and the distance of between the free water and collagen fiber-bound water etc. MTR map could be useful to depict early degeneration of cartilage as well as T2 mapping and has potential as an adjunct to T2 relaxation time in the early diagnosis of OA.

**Reference:** [1] Link et al. Eur Radiol, 2007; 17: 1135-46. [2] Nieminen et al. MRM, 2001; 46: 487-93. [3] Seo et al. Radiology, 1996; 201: 525-30. [4] Gray et al. MRM, 1995; 34: 319-25, [5] Yao et al. Skeletal Radiol, 2009; 38: 1055-62. [6] Noyes et al. Am J Sports Med, 1989; 17: 505-513.

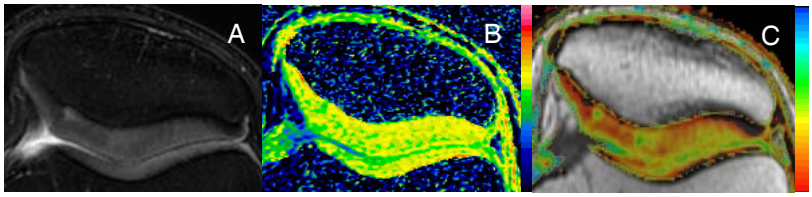


**Figure 1.** 31-year-old male
Patellar cartilage is considered grade 1 chondromalacia at three parts on FS-FSET2 (A). The MTR of lateral facet, median ridge, and medial facet were 60.2, 58.1, and 56.2, respectively (B). The T2 relaxation time of lateral facet, median ridge, and medial facet were 32.5, 40.1, and 39.4, respectively (C).

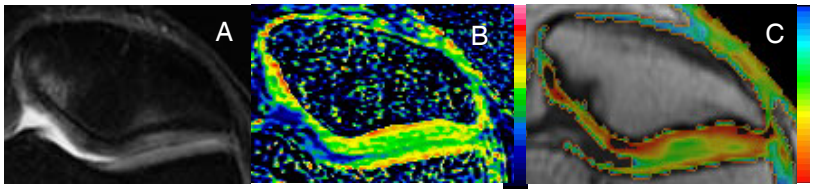


**Figure 2.** 57-year-old female
Patellar cartilage is considered grade 3 chondromalacia at three parts on FS-FSET2 (A). The MTR of lateral facet, median ridge, and medial facet were 54.7, 50.9, and 55.0 respectively (B). The T2 relaxation time of lateral facet, median ridge, and medial facet were 44.9, 42.0, and 40.1 respectively (C).

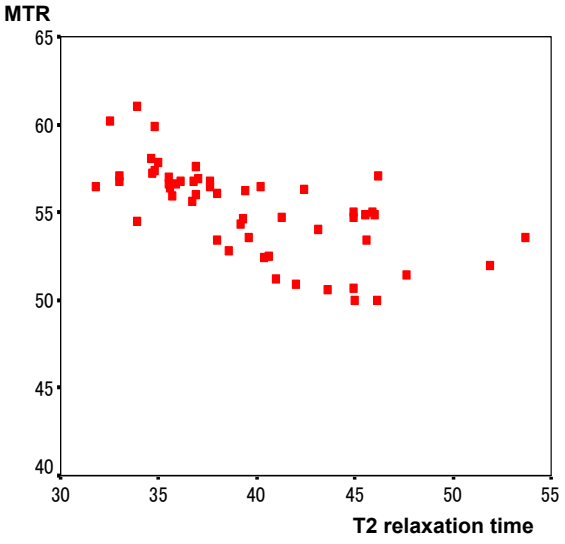


**Figure 3.** Graph shows correlation between T2 relaxation time and MTR on 54 parts. The Spearman correlation coefficient was -0.640 ($P < .0001$), which is indicative of statistically significant good negative correlation between the variables.