T2 in an OA population : Metrics for reporting data?

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Background

MRI T2 of the knee cartilage has been shown to have a laminar pattern in asymptomatic individuals with longer T2 values observed near the articular surface [1]. Recently, MRI T2 has been shown to be sensitive to many parameters including hydration, macromolecular structure, and tissue architecture *in vitro*. Perturbations of some of these factors leads to increases in T2, and others decreases in T2 [2]. One recent in vivo study found an approximate 4 ms increase in T2 from healthy patients to those with mild osteoarthritis (OA) [3]. However, there was not a significant difference between average T2 in severe OA when compared to mild OA. Another *in vivo* study found a focal increase in T2 in symptomatic volunteers when compared to asymptomatic volunteers [4]. These results contrasted the diffuse increase observed with aging. This study sought to evaluate MRI T2 in patients with documented OA to determine if T2 pattern can give insight into OA severity.

Methods

MRI scans from 21 patients were obtained from the Mechanical Factors in Arthritis of the Knee Study (MAK), a longitudinal study of patients with documented osteoarthritis. As part of this study, radiographic data including Kellgren-Lawrence score and joint space grade were obtained. In addition, dGEMRIC and T2 scans were acquired after the administration of the contrast agent Gd-DTPA. (T2 has previously been shown to not be affected by GdDTPA with clinical doses [5]). T1(Gd) and T2(Gd) maps were generated with a fit routine using Matlab (The MathWorks, MA). After each dGEMRIC and T2 map was made, each was visually inspected and determined to have either a normal (laminar) T2 pattern (T2 score=0) or an abnormal T2 pattern (T2 score=1). Pattern abnormalities included 1) higher T2 along the articular surface, 2) a "mottled" appearance, and 3) visible low or high lesions in the T2 images. Examples are shown in Figure 1. The T2 scores were then analyzed with relation to cartilage disease level as determined by K/L score, Joint Space Grade (JSG), and the level of dGEMRIC, where high dGEMRIC (dGEMRIC score 1) is a dGEMRIC average greater than 400 ms, and low dGEMRIC (dGEMRIC score 0) is a dGEMRIC average less than 400 ms.

Results

Out of the original 21 knees, there were two compartments in each yielding 42 total images, 21 lateral and 21 medial. From those, 2 medials were removed from the data set because they contained no cartilage. Thus there were 21 laterals and 19 medials analyzed. No difference was found between the mean T2 value (average over femoral central compartment) and K/L grade, Joint Space Grade, or dGEMRIC score. The standard deviation of T2 also did not differentiate level of disease as determined by radiography or dGEMRIC (Tables 1-3). When grading the appearance of the T2 patterns, out of 40 images, 9 were read as having a normal T2 pattern, and 31 abnormal T2 pattern. The normal T2 patterns were predominantly found in JSG=0 compartments.

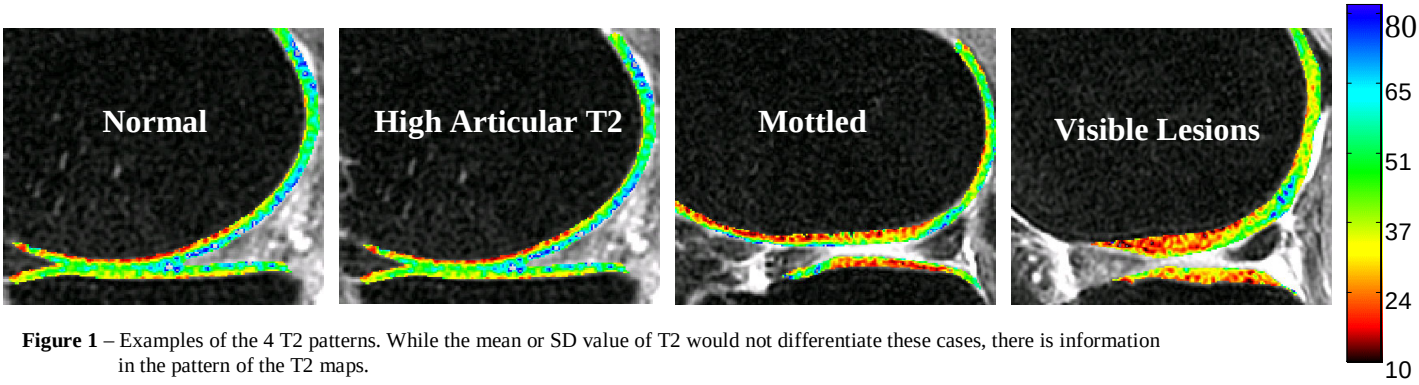

Figure 1 – Examples of the 4 T2 patterns. While the mean or SD value of T2 would not differentiate these cases, there is information in the pattern of the T2 maps.

K/L	Av T2 (ms)	SD T2	n
2	42.2	4.1	18
3	40.1	5.5	14
4	38.0	4.2	8

Table 1: T2 data by K/L.

JSG	Av T2 (ms)	SD T2	n
0	41.0	4.9	26
1	41.3	0.5	3
2	45.3	4.1	3
3	37.6	4	8

Table 2: T2 data by JSG.

dGEMRIC (ms)	Av T2 (ms)	SD T2	n
>400	41.2	4.5	18
<400	40.2	5.1	22

Table 3: T2 data by normal/abnormal dGEMRIC.

Discussion/Conclusions

Indices relating to cartilage health have historically been denoted by mean value across a region of interest. In the case of T2, those reported values have relatively little information regarding the state of disease since the mean values average out the variation across the cartilage that contains the information regarding degeneration. An alternate is to average the T2 value as a function of distance from the articular surface. However, this might not easily distinguish a normal level of T2 from a "mottled" T2 appearance. In addition, in OA subjects there is a fair amount of variation in cartilage thickness, which would need to be taken into account. The striking pattern differences and strong focal lesions present in T2 images of OA cartilage motivate the need for qualitative grading of patterns or more sophisticated analysis schemes if information is to be derived from T2 maps.

References

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