Quantifying the Progression of Osteoarthritis with MRI: Quantitative T2 Changes in Articular Cartilage over a 2 year time period.

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Introduction:

Osteoarthritis, a major cause of morbidity and lost productivity in the workforce, results in articular cartilage destruction, with the knee being a particularly susceptible site (1, 2). Magnetic resonance imaging (MRI) has evolved as an important modality in the assessment of articular cartilage. (3) Previous studies have suggested that alterations in cartilage water content occur prior to irreversible cartilaginous destruction (4, 5). The purpose of our study was to determine if significant changes could quantitatively be appreciated between healthy subjects and patients with osteoarthritis (OA) by retrospectively comparing T2 maps in 3 locations (medial femoral cartilage (MFC), lateral femoral cartilage (LFC), and patellar cartilage (PFC)) at the time of initial baseline MRI and at a 2 year follow-up encounter.

Materials and Methods:

Twenty-six subjects (mean age 54±9 years) were equally chosen from the incidence (healthy subjects) and progression (patients with osteoarthritis) cohorts of the Osteoarthritis Initiative project. This project encompasses a multi-center, longitudinal, prospective observational study of knee OA. All images are obtained on a 3 Tesla Siemens Trio scanner (Siemens Medical Solution, Malvern, PA). As part of this project, multi-echo spin-echo images are obtained with the view of capturing T2-information from the cartilage. This sequence obtains seven echoes from 10ms -70ms, separated by 10ms each, at a TR of 2700 ms, covering the whole knee. Images from this acquisition obtained during the enrollment year and two years following were obtained (mean time between enrollment scan and the two year scan was 2.096±0.02 for the incidence and 2.04±0.04 for the progression group). T2 maps were generated from the multi-echo images by discarding the first echo to minimize stimulated echo effect using customized software. The T2-maps thus generated were transferred to a TeraRecon workstation. Regions of interest (ROI's) were drawn on the MFC, LFC, and PFC, as these regions have been implicated for early changes towards progression to osteoarthritis. A two-sample t-test was then performed (a) to assess whether there was a significant difference in the T2 values between the incidence group and the progression group at the two time points, (b) to assess whether there were any significant changes among the incidence group over the two years, and (c) to assess the extent of changes among the progression cohort over the two years.
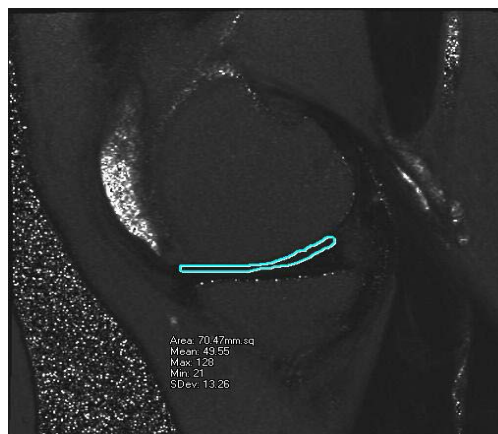

Figure 1: Example of ROI drawn on MFC.

Results:

Although both groups exhibited an increase in T2 values in all of the three examined locations, these changes were not significant in the LFC and PFC. Both the groups showed an increase in T2 values in the MFC, with the progression group showing a significant increase by about 18% (p<0.02), from 53.07 ms to 62.5 ms, over the two year period.

	T2-values, ms			
	Incidence @ enrollment	Incidence @ 2 yrs	Progression @ enrollment	Progression @ 2 yrs
LFC	49.47±4.6	51.95±6.3	52.31±7.4	53.31±6.5
PFC	52.59±5.1	53.15±4.9	55.28±3.8	55.75±6.1
MFC	56.01±5.3	60.27±5.8	53.07±4.2	62.5±5.4

Figure 2: T2 values in the LFC, PFC, and MFC in the incidence and progression cohorts during at enrollment and subsequent follow-up examination.

Discussion and Conclusion:

As medical and surgical therapies for cartilage disorders have become available, MRI has evolved as an important modality in the characterization of articular cartilage abnormalities, such as seen in osteoarthritis. New applications of existing MR techniques may enable quantitative characterization of articular cartilage abnormalities before morphologic changes are evident. Even though the initial T2 values of the progression and incidence cohorts were comparable, the rate of change of the T2 values in the progression cohort was greater, and this could potentially be used as a quantitative imaging marker to guide therapeutic decisions at an earlier stage. Additional work is however required to determine whether this rate of change could have clinical implications in predicting those individuals most likely to develop advanced osteoarthritis.

References:

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