

Feasibility of High Resolution T2 and T2* mapping of Metacarpophalangeal Joints in Children at 3T

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Introduction

Juvenile idiopathic arthritis (JIA) is a common disease affecting approximately one in 1,000 children [1]. T2 and T2* mapping are quantitative MRI methods, which can detect the changes in macromolecular composition of the cartilage, i.e. proteoglycan matrix and collagen fibers. T2 mapping can be routinely performed for the cartilage in large joints and it has been shown that the change in T2 relaxation time is more sensitive in detecting of early degeneration than conventional MRI which only shows morphologic changes. However, there has been few report of T2 mapping for smaller joints because of the technical challenge although they are also clinical important. Metacarpophalangeal joints (MCPJs) are commonly affected in children with JIA and can cause long-term disability [2]. Our goal is to evaluate the feasibility of T2 and T2* mapping of the MCPJ cartilage for monitoring early damage in children with JIA.

Methods

With IRB approval, 7 healthy children (age 6-13 years) without any history of joint disease and 5 children (age 6-13 years) with JIA involving the MCPJ were enrolled in the study after written consents were obtained. For each subject, sagittal T2 and T2* maps of four MCPJ cartilage were obtained on a 3.0T MRI system (Siemens TIM Trio VB15) with an 8 channel wrist coil (Invivo Corp). For T2 mapping, eight images with TE ranging from 11.5ms to 80.5ms were acquired using a multi-echo SE sequence with spatial resolution of 0.2mm x 0.2mm x 3mm, TR = 1sec and TA of 7:18. For T2* mapping, eight images with TE ranging from 4.11ms to 45ms were acquired using a multi-echo GRE sequence with spatial resolution, TR = 250ms and TA of 3:38. In addition to T2 and T2* mapping, high resolution T1w and PDw anatomical images were also acquired in coronal plane. The total scan time is about 15 minutes.

Figure 1 shows typical color coded T2 and T2* maps over-laded on T2 or T2* weighted anatomical images from the same acquisition. The mean T2 and T2* values of each MCPJ cartilage were measured from the T2 and T2* maps after the cartilage region was segmented by manually tracing the boundary on the T2 weighted image which provides best delineation of cartilage with surrounding tissue. Also, for each cartilage, T2 and T2* profiles at 0 and ± 30 degree with respect to the joint axis were measured and scaled by the cartilage thickness.

Results

The overall average cartilage T2 and T2* values of MPCJ joints are 42.6 ± 5.5 msec and 20.9 ± 5.1 msec. The average T2 profiles along the thickness of MPCJ cartilage are consistent between subjects, showing a decrease of T2 values from the articular surface to middle of cartilage and rise near the osteochondral junction. Such profile is also consistent with the T2 profile in the cartilage of femur head demonstrated in other studies [3]. Such pattern is not apparent in the T2* profiles. The inter-joint and inter-subject coefficient of variation (CV) of average T2 range from 0.114 - 0.141 and 0.151-0.172, while inter-joint and inter-subject CV of average T2* range from 0.184 - 0.313 and 0.192 - 0.277.

Discussion

High resolution T2 and T2* mapping of MCPJ cartilage is feasible in children and therefore can potentially provide useful information for monitoring biochemical changes in cartilage caused by diseases such as JIA. The increase of T2 near the osteochondral junction is unique to children and likely reflect the secondary physis. Although T2* mapping offers higher SNR and shorter scan time, its diagnostic value may be less than T2 mapping due to larger variability. Further analysis that includes clinical history of JIA patients will be performed to evaluate the diagnostic values of MCPJ T2 and T2* mapping.

References

1. Schneider R, et al. *Rheum Dis Clin N Am* 28 (2002) 503-530
2. Glueck D, et al. *J Am Acad Orthop Surg* 13 (2005) 254-266
3. Kim HK, et al. *AJR* (2010) 195:1021-1025

Figures

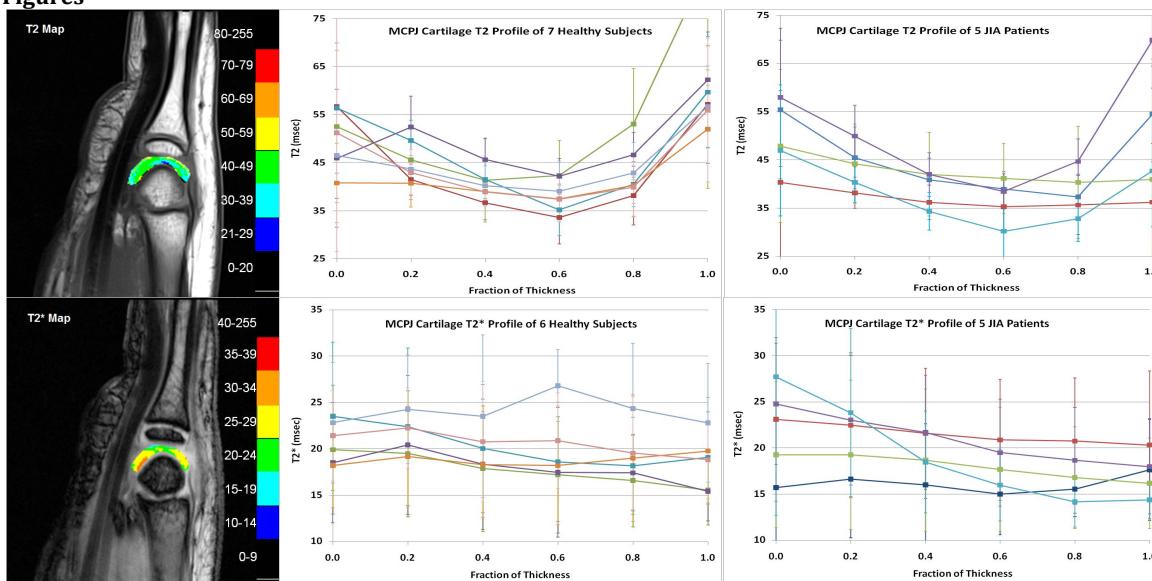


Figure 1: The left column displays the typical cartilage T2 and T2* maps of the same joint with color palettes showing the corresponding T2 and T2* values in msec. The middle column are the averaged T2 and T2* profiles for each healthy subject with the error bars indicating standard deviation, while the right column are the profiles for JIA patients.