Regional Analysis of Cartilage T2 Changes in the Knee after Running

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Introduction: An emerging hypothesis in the pathogenesis of osteoarthritis (OA) is that cartilage adapts to local biomechanical forces and damage occurs when changes in joint stability or biomechanical loading expose cartilage to forces that exceed the structural properties of the tissue (1). To test this hypothesis it is necessary to develop non-invasive methods to measure regional functional response of cartilage to activities of daily living. Previously we have shown that cartilage T2 maps were sensitive to change in articular cartilage structure after running (2). The purpose of this study is to measure regional variation in cartilage T2 response for normal subjects after running.

Methods: Regional changes in knee cartilage T2 before and after 30 minutes of running were evaluated in 35 healthy volunteers age 18 to 55. Quantitative T2 maps were obtained using a Bruker 3T MR spectrometer, a 24 cm gradient insert, and 15 cm linear Litz coil (Doty Scientific). Sagittal T2 maps of the femoral tibial joint were calculated from a 6 section, 12 echo sequence with TR/TE = 1500/9-106 ms, 4 mm section thickness, 384x384 matrix and a 12.75 cm field of view (FOV). Cartilage T2 maps and profiles of weight-bearing femoral/tibial cartilage were generated using automated subroutines in CCHIPs/IDL software (2). Cartilage was divided into 3 zones (deep, middle, and superficial) based on depth from articular surface. Cartilage T2 before and after running for each of these zones was compared for each location listed in *Figure 2* using a paired t-test, and between locations using 1-way ANOVA. A p-value < .05 was considered statistically significant.

Results: As demonstrated in *Figures 1&2,* running decreases T2 of the superficial cartilage zone, (range: -0.8 ms to -3.6 ms). Particularly with respect to femoral cartilage, this change occurs uniformly within the joint. Similar results were observed for the middle cartilage zone (not shown). No statistically significant change in cartilage T2 was observed in the deep cartilage zone.

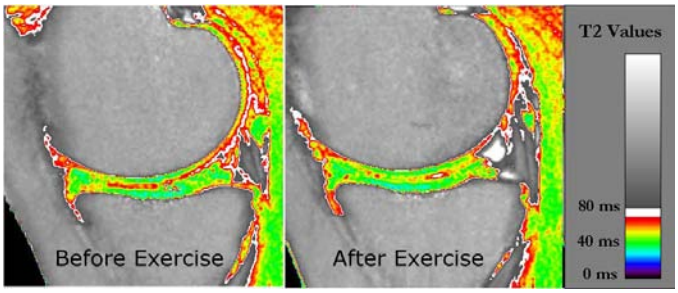

Figure 1: Cartilage T2 maps obtained before and immediately after 30 minutes of running. Running produces a decrease in superficial cartilage T2 as indicated by a loss of red pixels on the *after exercise* T2 map

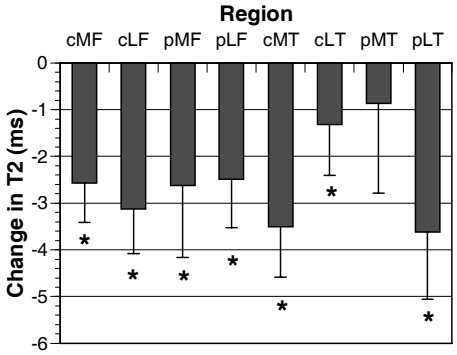

Figure 2: Change in **superficial** cartilage T2 after running based on location in the femoral/tibial joint (mean values for all subjects ± SEM): central medial femoral condyle (**cMF**), central lateral femoral condyle (**cLF**), posterior medial femoral condyle (**pMF**), posterior lateral femoral condyle (**pLF**), central medial tibia (**cMT**), central lateral tibia (**cLT**), posterior medial tibia (**pMT**), and posterior lateral tibia (**pLT**). All locations with the exception of the pMT region demonstrated a statistically significant decrease in cartilage T2, with no statistically significant difference between locations. Similar findings were observed for the middle zone of cartilage

Discussion: Current thinking is that approximately 80% of the weight-bearing load is carried in the medial compartment of the knee, which likely contributes to higher prevalence of medial compartment OA. While greater compressive stress may be applied to the medial compartment, results of this study suggest tissue strains as indicated by zonal cartilage T2 measurements are quite uniform throughout the joint. Regional information on cartilage biomechanics will be valuable in understanding the role of internal soft tissue derangements in altering cartilage loading during physical activities.

References:

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