Effect of Training on Cartilage T2 Changes after Running

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Introduction: A major goal of cartilage research is to understand the role of biomechanics in cartilage physiology and early osteoarthritis. Presently this research is limited by the inability of animal models to replicate the biomechanical properties of the human joint. Preliminary feasibility studies have shown that quantitative T2 mapping is sensitive to regional changes in water content and collagen fiber orientation that occur with cartilage compression (1-3), and provide a basis for using MRI to study the response of human cartilage to exercise. The purpose of this study is to determine the effect of long-term endurance training on cartilage T2 response to running compared to sedentary controls.

Methods: Quantitative T2 maps of 20 trained marathon runners and 10 sedentary controls subjects (*Table 1*) were obtained at baseline and within 10 minutes after completing 30 minutes of running exercise. 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, 384 x 384 matrix and a 12.75 cm field of view. A leg holder attached to the gradient/coil set allowed rapid and reproducible positioning of subjects for pre and post exercise scans. Cartilage T2 maps and profiles were generated using automated subroutines in CCHIPs/IDL software. Pre and post exercise T2 profiles of weight bearing femoral and tibial cartilage were normalized for thickness to allow comparison using a 2-tailed paired t-test with a p value <.05 considered a statistically significant change. The pre exercise T2 profile was subtracted from the post exercise T2 profile to determine regional difference in T2 following exercise (*Figure 1)*.

Table 1: Mean demographic data for trained and control subjects. Years = average years of training, BMI = Body Mass Index

AVERAGES	AGE	Male	Female	Miles/week	Years	BMI
TRAINED	38.9	10	10	22.9	7.3	23.0
CONTROLS	38.8	3	7	1.0	<1 year	24.7

Results: After running, 29 of 30 subjects demonstrated a decrease in the T2 of superficial weight-bearing femoral cartilage, and 28 of 30 had a decrease of T2 in superficial tibial cartilage. As shown in *Figure 1*, sedentary controls had a statistically significant decrease in T2 of the superficial 30% of femoral and tibial cartilage after running (p<.05). For marathon runners the decrease in T2 was larger and involved the superficial 50% of femoral, and superficial 40% of tibial cartilage.

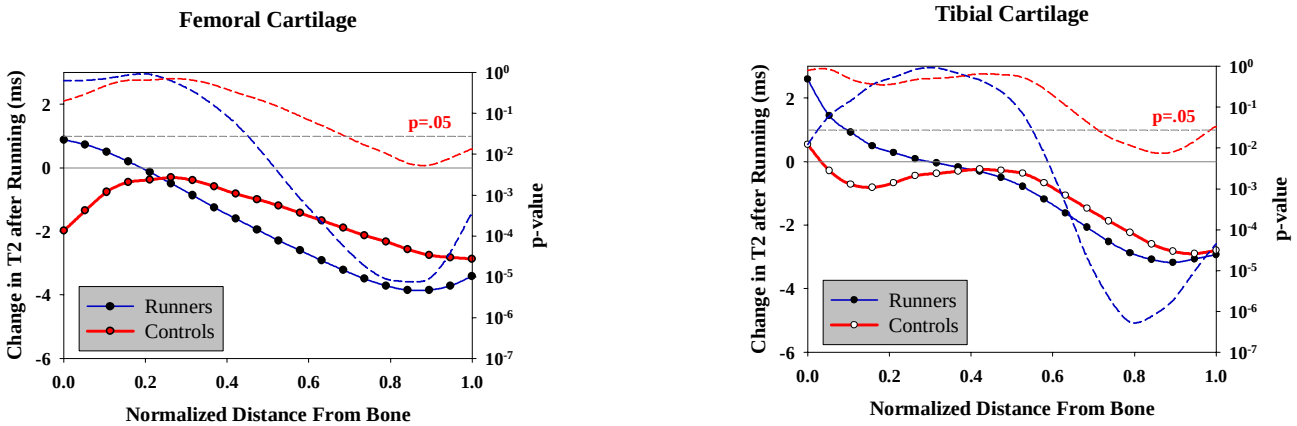

Figure 1: Δ *T2 profiles*: Average change (*post exercise – pre-exercise*) in T2 of articular cartilage after 30 minutes of running is presented for marathon runners, and sedentary controls as a function of normalized distance from bone. P-value profiles (*right axis*) refer to a paired t-test comparison of pre and post running T2 values for marathoners (---) and controls (---). For marathon runners, a statistically significant (p<.05) drop in T2 occurs in the superficial 50% of femoral and 40% of tibial cartilage. For sedentary controls, the decrease in T2 after running is smaller, and confined to the superficial 30% of cartilage.

Discussion: Previously Liess *et al* demonstrated changes in bulk patellar cartilage T2 in response to deep knee bend exercise that they attributed to change in water content (2). Our results demonstrate a statistically significant decrease in superficial femoral/tibial cartilage T2 with running. This regional response is consistent with prior *ex vivo* studies demonstrating tissue consolidation during compression is limited to superficial cartilage, with little fluid flux occurring in deeper layers (4). The decrease in superficial T2 is likely related to lowering of cartilage water content, and/or changes in collagen fiber orientation as a result of compression, and is consistent with observations previously reported with excised specimens (3,5). In our study, the change in T2 is greatest in femoral cartilage of marathon runners. This may reflect differences in cartilage loading between runners and controls due to differences in gait or level of exercise. Alternatively the larger drop in cartilage T2 in runners suggests greater permeability of the cartilage matrix, which may result in further cartilage damage.

References:

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