

EFFECTS OF RUNNING A MARATHON ON dGEMRIC OF THE KNEE

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Background

MRI has the ability to non-invasively monitor the effects of long distance running on cartilage. The dGEMRIC (delayed Gadolinium Enhanced MRI of Cartilage) technique provides an estimate of the distribution of cartilage glycosaminoglycan(GAG).

Objectives

The aim of this study was to observe the effects of running the Boston Marathon on the distribution of glycosaminoglycan(GAG) on knee cartilage by measuring the dGEMRIC index.

Methods

Seven female volunteers, ages 24-39, were imaged at 3T at 4 time points: 3 days prior to the race, then 1 day, 1 week, and 6 weeks after the race. Volunteers were injected IV with 0.2mM/Kg Magnevist (Berlex Imaging, Wayne, NJ) and asked to walk for 10 mins to facilitate contrast penetration into the cartilage. dGEMRIC images were acquired 90 min post injection using a 3D IR sequence with TS/TE = 6.5ms/2.7ms, and TI = 2.1,0.8,0.4,0.2,0.13s. T1(Gd) maps were generated with a pixel-by-pixel 3-parameter T1-fit routine using Matlab(The Mathworks,MA). dGEMRIC index were calculated from the average T1(Gd) values in a region of interest (ROI).

Of the 7 volunteers enrolled, one did not complete the marathon, and one was unable to return for the 1or 6-week follow up imaging session. The post race values were normalized to the pre-race values for the 5 volunteers who completed all time points.

3D rendering of the cartilage surface using the techniques described by Tamez-Pena [1] was applied to 3D dGEMRIC images of the knee. After computing the dGEMRIC Index for each voxel (313 um x 313 um x 3mm) from the 3D SPGR acquisition, the median dGEMRIC Index across the surface normal was mapped into each point of the 3D cartilage surface. To compare several dGEMRIC acquisitions of the same knee measured at different time points, a surface to surface registration algorithm was used to compute the point to point correspondence between dGEMRIC acquisition pairs. The point to point correspondence was then used to generate a 3D delta map of the dGEMRIC data.

Results

Figure 1 shows an example medial condyle section of one volunteer across the 4 time points imaged. Post-race dGEMRIC values of the central femoral condyle (cFC) normalized by their pre-race values of the 5 volunteers who successfully completed the study are shown in Figure 2. The dGEMRIC index of the medial cFC decreased relative to pre-race values at 1 day post-race, returned towards pre-race values at 1 week, and increased to near pre-race values by 6 weeks. The lateral compartment showed similar trends with overall higher values relative to pre-race.

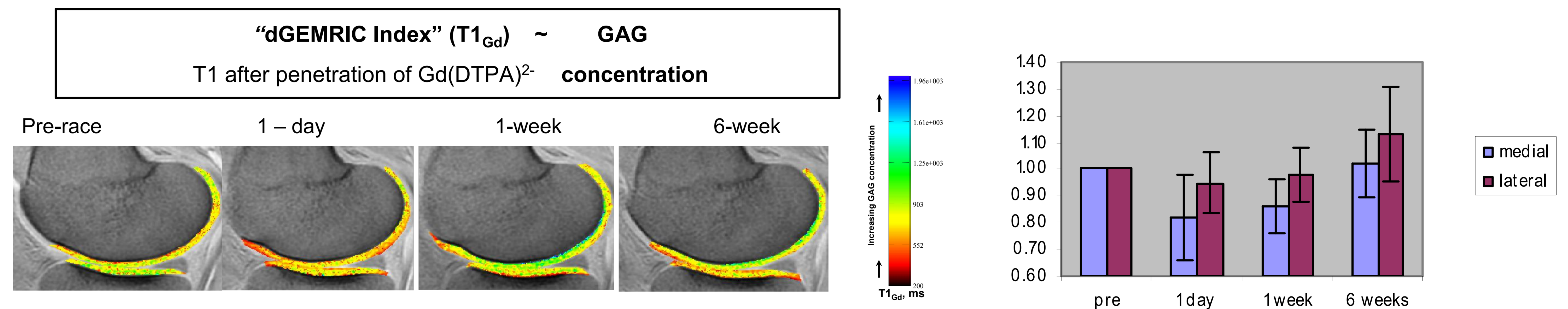
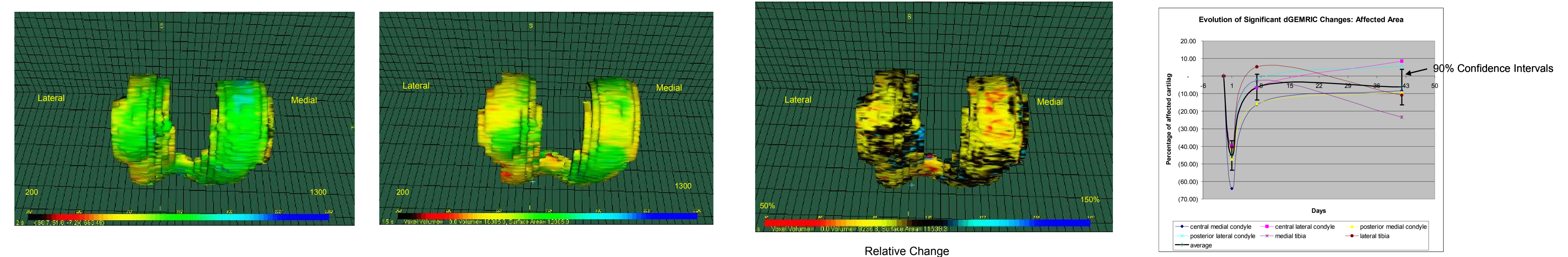


Figure 3 shows the 3D rendering of the femur cartilage of one of the subjects before and after the marathon with its associated delta map. The analysis of the 5 subjects at all time points showed that the delta map techniques have a RMS variability of 32 ms. This variability was used to compute the area of significant dGEMRIC changes (p<0.01) for each subject. Figure 3 also shows the evolution of the aggregated positive and negative changes of the area of affected cartilage after the marathon.



Discussion

The baseline dGEMRIC Indices in these marathon runners were relatively high compared to other studies. This is consistent with prior reports of high dGEMRIC indices in high-performance athletes [2]. This pilot study demonstrated a change in the dGEMRIC Index in the 6 weeks following the running of the Boston Marathon. There was a fair amount of variability in the response of the different runners to the marathon, as indicated by the large standard deviations in Figure 2. Similarly, variability in response to running was seen in an earlier study of serum COMP concentrations [3]. Further studies will be needed to better elucidate the complex system of mechanical events / biologic responses that impact GAG metabolism during and after marathons.

References

1. Tamez-Pena J *et al.* "Knee Cartilage Extraction and Bone-Cartilage Interface Analysis from 3D MRI Data Sets", SPIE, 2004
2. Athlete dGEMRIC
3. COMP