3D SURFACE MAP ANALYSIS OF dGEMRIC CHANGES IN THE KNEE

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Aim

The aim of this study was the application of 3D image analysis techniques to the study of changes in the dGEMRIC (delayed Gadolinium Enhanced MRI of Cartilage) Index distribution in the human knee.

Methods

3D rendering of the cartilage surface using the techniques descried 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. The delta map was averaged across different knee regions; the mean difference and the standard deviation of the difference were calculated. The delta map was also analyzed to extract the area of statistical significant changes between time point pairs. The delta map approach was used to analyze dGEMRIC data from five female marathon runners, ages 24-39, imaged at 3T at 4 time points: 3 days prior to the race, then 1 day, 1 week, and 6 weeks after the race [2]. Three regions were evaluated in each of medial and lateral compartments: the central zone of the femoral condyle, the tibia plateau, and the posterior section of the femoral condyle.

Results

Figure 1 shows the 3D rendering of the femur cartilage of the same subject 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 2 shows the evolution of the aggregated positive and negative changes of the area of affected cartilage after the marathon. The 3D delta map technique measured that approximately 65% of the central medial condyle tissue showed a negative change in the dGEMRIC Index one day after running. After 1 week the affected area was reduced significantly ($p<0.05$) and the area measurements six week after running showed that the cartilage tissue returned to its pre-marathon stage. The degree of dGEMRIC change varied between subjects and regions within the knees.

Conclusions

The 3D rendering techniques provide an analytical tool that can be exploited to quantitatively measure the change in the dGEMRIC Index over the full area of the joint cartilage, which may supplement the currently utilized 2D approaches to evaluate dGEMRIC changes in the knee.

References

1. Tamez-Pena J *et.al.* "Knee Cartilage Extraction and Bone-Cartilage Interface Analysis from 3D MRI Data Sets", SPIE, 2004.
2. Williams A. *et.al.* "Effects Of Running A Marathon on dGEMRIC Of The Knee", OARSI 2005.

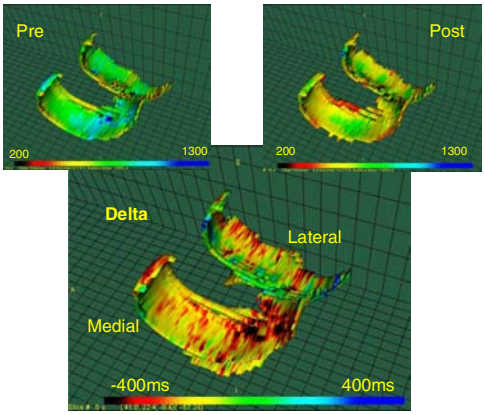

Figure 1. Pre, Post and Delta dGEMRIC map renderings of the femur cartilage.

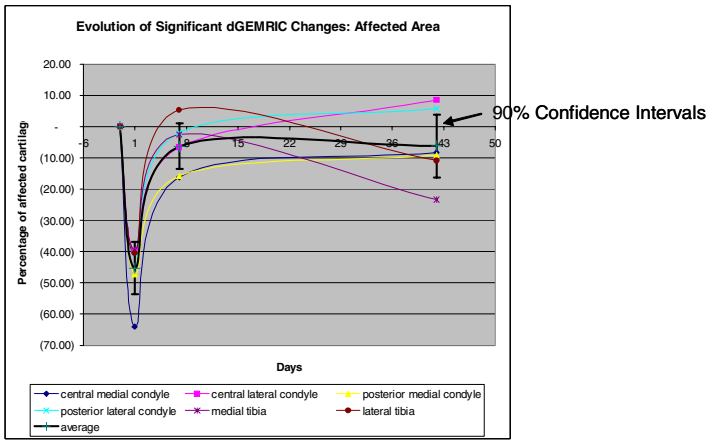

Figure 2. Evolution of the area affected by significant dGEMRIC change as measured by the 3D delta map.