dGEMRIC following PCL injury: A Case Report

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Background

Recently the dGEMRIC technique has been shown to visualize pre-radiographic changes in articular cartilage at the biochemical level [1] by examining the relative distribution of glycosaminoglycan (GAG) *in vivo*. GAG is known to be lost in response to joint trauma [2] an occurrence that diminishes the compressive resilience of articular cartilage making it softer and more susceptible to further injury. GAG loss from cartilage is also known to be an early and consistent event in the pathogenesis of osteoarthritis.

The degree and time course of cartilage GAG degradation and/or recovery from traumatic joint injury has not been widely studied in humans due to a lack of non-destructive assessment methods and the difficulty in determining pre-injury 'normal' GAG levels of injured joints. The purpose of this case report is to demonstrate the potential for molecular changes in articular cartilage following joint injury.

Methods

A 30-yr-old man sustained an isolated right knee posterior cruciate ligament rupture after being involved in a motor vehicle accident. The patient reported minimal knee swelling and moderate discomfort following the injury, however continued full weight bearing. Conventional MRI was performed at 4 weeks post injury, revealing an isolated PCL rupture, specifically there was no bone bruising. Non-operative management was advised and a knee rehabilitation program instituted. Knee swelling subsided by 3 months post-injury at which time the knee was reportedly completely asymptomatic.

Coincidentally, the patient had undergone dGEMRIC scanning one week prior to the accident. Repeat dGEMRIC scans were performed at 1, 3 and 6 months post-injury. dGEMRIC was performed at 3T on a Siemens whole-body MRI scanner (Magnetom Trio) 90min after a double dose IV injection of Magnevist (Berlex, NJ) and a 10-15min walk. 2D single slice dGEMRIC images in the coronal and medial sagittal views were obtained through the center of the condyle at each imaging session using an FSE IR sequence with 5 inversion delays ranging from 50-2080ms, TR/TE = 2200/14ms. Slices were 3mm thick with an in-plane resolution of 275μm. The scan time was 15 min per single slice 2D acquisition. T1(Gd) maps were generated with a pixel-by-pixel 3-parameter fit routine using Matlab (The MathWorks, MA) and dGEMRIC indices calculated as average T1(Gd) values in a selected region of interest (ROI). Full-thickness ROIs in the weight-bearing cartilage were drawn in each of 4 compartments in coronal views (lateral and medial femoral condyles and tibial plateaus) and each of 2 compartments in a medial sagittal view.

Results

dGEMRIC images acquired 1 and 3 months after PCL rupture showed progressive declines in dGEMRIC indices examined compared to pre-injury images (Figure 1). As a control, an additional scan of the contralateral knee, acquired at the 3-month imaging session, demonstrated dGEMRIC indices consistent with pre-injury values. Averaging the T1(Gd) values of each of the 6 ROIs produced a global dGEMRIC index whose value over time decreased 14% and 19 % at 1 and 3 months, respectively, and returned to within 3% of pre-injury values at 6 months post-injury (Figure 2). Repeated measures ANOVA analysis revealed that dGEMRIC averaged across all 6 ROIs varied significantly over all the time points examined ($p < 0.00002$). Two-sample T-Tests assuming equal variance revealed significant changes between successive time-points ($p < 0.003$, $p < 0.05$, $p < 0.0002$ for baseline–1, 1-3, 3-6 month time periods, respectively).
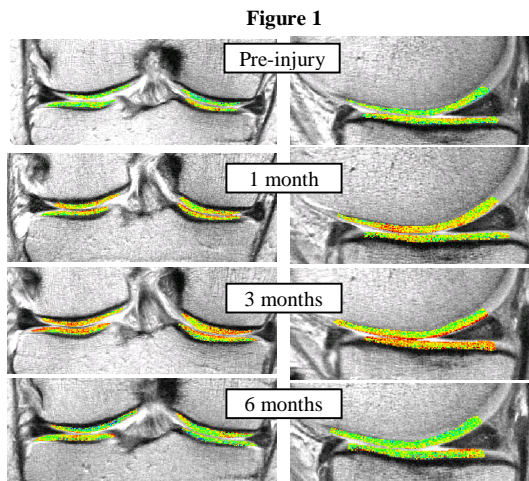
Figure 1

Figure 1 – dGEMRIC knee images showing T1(Gd) before (top) and up to 6 months (bottom) following PCL rupture in coronal (left) and medial sagittal (right) sections. Images acquired 1 and 3 months following injury show decreases in T1(Gd) as the dGEMRIC maps appear more yellow and red, respectively, than the pre-injury map. Images acquired 6 months following injury show an increase in T1(Gd) appearing more green and blue.

Figure 2 – dGEMRIC index pre and post PCL rupture shows significant decreases of 14% and 19% at 1 ($p < 0.003$) and 3 months ($p < 0.0004$), respectively. At 6 months post-injury, the dGEMRIC index returned to within 3% of pre-injury levels. ANOVA analysis found significant dGEMRIC changes across all time points examined, $p < 0.00002$.

Figure 2
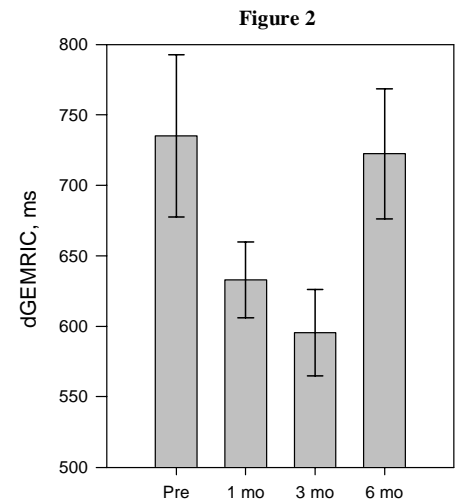
Discussion/Conclusions

This unique case provides the opportunity to retrospectively observe molecular level cartilage changes following joint injury. This case demonstrates it is possible to observe statistically significant changes in cartilage biochemical status in as little as a 1-month time-frame and that PCL ruptures may be an interesting area for further study using the dGEMRIC technique. In addition, this case provides evidence that traumatic joint injuries may result in sufficiently global GAG loss (and recovery) that the biochemical status of cartilage can be tracked with 2D dGEMRIC sections.

References

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[2] Lohmander *et al*. Changes in joint cartilage aggrecan after knee injury and in osteoarthritis. Arthritis Rheum. 1999; 42(3)534-544.