INTRODUCTION:
Anterior cruciate ligament (ACL) injuries place the knee at risk for early osteoarthritis (OA). Early detection of articular cartilage damage could provide insight into the mechanisms of disease, and allow the development of new treatment strategies. dGEMRIC is a molecular imaging technique that can be used to study the loss of glycosaminoglycan (GAG) content of articular cartilage following ACL injury [1]. GAG loss is associated with cartilage degeneration. With the dGEMRIC technique, T1-maps of hyaline cartilage are created following an IV administration of an anionic gadolinium [Gd(DTPA)2] contrast agent. Since cartilage matrix is largely composed of GAG molecules with negatively-charged carboxyl and sulfate groups, it repels the negatively charged contrast ions. As a result, the Gd(DTPA)2 concentration is higher in cartilage regions with low GAG concentration and the cartilage T1-relaxation time is reduced [1]. The resulting dGEMRIC index is related to both the GAG concentration and the time between Gd(DTPA)2 administration and image acquisition. In healthy subjects it is optimal to acquire MR images 90 to 120 minutes after intravenous contrast injection [2]. For studies of ACL-injured patients, the contralateral uninjured knee is frequently used as a control. Serial imaging of both knees would result in differences in the time between contrast administration and image acquisition.

METHODS:
Subjects consisted of 5 men and 7 women (mean age 33 years; range 20–49) who satisfied the following inclusion criteria: unilateral ACL injury, no prior history of knee injury or disease. The median time between injury and MR imaging was 67.5 days (range 18–406 days). dGEMRIC was performed on a 1.5T Siemens Symphony magnet. Each subject received 0.2 mmol/kg of Gd(DTPA)2 (Magnevist®, Bayer Healthcare) contrast agent, followed by a saline flush. Immediately after contrast administration, each subject walked for 10 minutes to promote diffusion of the contrast into synovial fluid and cartilage. After 90 minutes, a series of 5 fast spin echo inversion recovery sequences (inversion times of 160ms, 650ms, 350ms, 150ms, and 28ms) were acquired in the mid-sagittal plane of the medial femoral condyle for T1 mapping. The sequences were performed in the ACL-injured and contralateral uninjured knees sequentially, however, the order was alternated such that the injured knee was scanned first and the uninjured knee was scanned second in the odd-numbered subjects while the opposite order was used in the even-numbered subjects. This was done to account for the potential bias in the T1-relaxation time because of differences in the time between contrast administration and image acquisition (90 versus 100 minutes). The MRmapper software package (2006a R2; Beth Israel Deaconess Medical Center, Boston, MA) was used to create T1 maps of each knee and to calculate the dGEMRIC index for the articular cartilage of the femur and tibia. Statistical comparisons were made between the dGEMRIC indices using a random coefficients mixed linear model to account for the potential bias in the T1-relaxation time because of cartilage degeneration [2].

RESULTS:
When evaluating main effects, the pooled dGEMRIC index (± standard deviation) if the ACL-injured knees was significantly less than that of the uninjured knees (460.4±72 vs 419±53; p=0.01). There was no significant difference due to scan order (p=0.30). However, the evaluation of the effects of knee status as a function of imaging order revealed an important finding (Fig. 1). When the ACL-injured knee was imaged 90 minutes after contrast administration, there was no significant difference in the dGEMRIC indices between the ACL-injured and uninjured knees for either the femoral (p=0.19) or the tibia (p=0.39) articular cartilage (Fig. 1). However, when the injured knee was imaged 100 minutes after contrast administration, there were significant differences in the dGEMRIC indices for both the femur (p=0.04) and the tibia (p=0.008; Fig. 1). The dGEMRIC indices for the uninjured knees were not affected by imaging order (femur: 460.8±58 vs 460.0±58; tibia: 429.5±58 vs 430.8±58; Fig. 1).

DISCUSSION:
Future work is necessary to determine the optimal delay for the ACL-injured knee since it may continue to decrease beyond the time 100 minute delay evaluated in the current study.

REFERENCES: