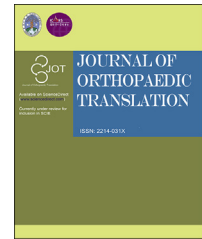


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ORIGINAL ARTICLE

Quantitative analysis of T2 relaxation times of the patellofemoral joint cartilage 3 years after anterior cruciate ligament reconstruction

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KEYWORDS

ACL;
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T2 mapping

Summary Objective: To evaluate patient-specific patellofemoral joint (PFJ) cartilage 3 years postoperatively using T2 mapping magnetic resonance imaging and the uninjured contralateral side as control.

Hypothesis: The cartilage of the PFJ in the anterior cruciate ligament (ACL) reconstructed knees would show increased T2 values compared to the uninjured contralateral knees at 3-year follow-up, and the femoral (trochlear) cartilage would be more susceptible than the patella in degeneration in ACL-reconstructed knees.

Methods: Ten patients with clinically successful ACL-reconstructed knees were prospectively enrolled 3 years postoperatively. Sagittal images of both knees were obtained using T2

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mapping. Cartilage over the medial, central, and lateral regions of the trochlea and patella was divided into superficial and deep regions. Average T2 values of the cartilage at each region of interest of the ACL-reconstructed and uninjured contralateral knees were compared for each individual patient.

Results: Overall, the T2 values at the superficial layers of the medial and central trochlear cartilage of the ACL-reconstructed knees were significantly higher than those of the uninjured contralateral knees by 4.23 ± 9.09 milliseconds (8.9%; $p = 0.043$) and 5.94 ± 8.12 milliseconds (10.9%; $p = 0.019$), respectively. No significant difference was found in other cartilage areas of the trochlea and patella. In individual patient analysis, increased T2 values of ACL-reconstructed knees were found in all 10 patients in at least one superficial region and eight patients in at least one deep region of the trochlear cartilage, five patients in at least one superficial region, and eight patients in at least one deep region of the patellar cartilage.

Conclusion: Despite a clinically satisfactory ACL reconstruction (with negative anteroposterior drawer and pivot shift tests), all patients showed at least one region with increased T2 value of the PFJ cartilage 3 years after ACL reconstruction, especially at the medial compartment of the trochlear cartilage.

The Translational Potential of this Article: Little data has been reported on PFJ cartilage condition after ACL reconstruction. This study could help develop noninvasive diagnostic methods for detection of early PFJ cartilage degeneration after ACL reconstruction.

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Introduction

While satisfactory clinical outcomes regarding the functional stability of the knee after anterior cruciate ligament (ACL) reconstruction have been widely reported, recent mid- to long-term follow-up studies have revealed prevalent development of radiographic osteoarthritis (OA) in ACL-reconstructed knees [1–6]. Although numerous studies have reported on the development of OA in the tibiofemoral joint (TFJ) after ACL reconstruction, postoperative radiographic OA in the patellofemoral joint (PFJ) has been reported in 11–90% (median 36%) of patients 2–15 years after the surgery [1,4,6]. Radiographic PFJ OA may be more common than TFJ OA and associated with worse knee-related symptoms, including anterior knee pain and decreased functional performance [7,8].

Any interventions targeted at preventing OA development after ACL reconstruction—at its earliest and responsive (i.e., reversible) stage—would therefore be of the greatest value to the young patient population with ACL injuries. Considerable progress has been made in recent years by detecting changes in the biochemical compositions of cartilage using magnetic resonance imaging (MRI) techniques such as T1 ρ , T2, dGEMRIC, and sodium MRI [9–18]. Changes in collagen integrity, proteoglycan, and water contents are some of the most broadly discussed histological measurements of cartilage degradation and early indicators of cartilage degeneration [9,10,13,14,18]. Recent studies have focused on correlations between T1 ρ values and proteoglycan content, and between T2 values and water/collagen content [10,13–15]. Significant differences in the average of T1 ρ and T2 values between asymptomatic and osteoarthritis symptomatic patients were reported [11,16,19–21]. However, most of these advanced MRI investigations of early knee OA have been focused on the TFJ.

Using these advanced MRI techniques to detect early onset OA of the PFJ of the knee after ACL reconstruction is yet to be investigated.

Therefore, the objective of this study was to quantitatively evaluate the biochemical composition changes of the articular cartilage of the PFJ after ACL reconstruction using T2 relaxation times (T2 mapping) at 3-year follow-up. The uninjured, contralateral knee was used as a control for comparison. This technique has been used previously to investigate early OA of the TFJ cartilage after ACL reconstruction [19]. In this study, we hypothesized that: (1) the cartilage of the PFJ in the ACL-reconstructed knees would show increased T2 values compared to the uninjured contralateral knees at 3-year follow-up; and (2) the femoral (trochlear) cartilage would be more susceptible than the patella in degeneration in ACL-reconstructed knees.

Methods

Patients

Ten patients (20 knees) who underwent ACL reconstruction due to unilateral ACL rupture were recruited at 3 years after surgery. The inclusion criteria were an acute unilateral ACL rupture without other ligament injury, no evidence of cartilage damage at the time of ACL injury confirmed by MRI and arthroscopy, less than 4 months from injury to surgical operation, and no history of injury or pain on the contralateral knee. No patients had additional injury to either knee after ACL reconstruction.

This study complied with the Declaration of Helsinki after obtaining approval from the Institutional Review Board of the local institution. A written informed consent was obtained from each patient before any test.

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