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Association of fibrosis in the infrapatellar fat pad and degenerative cartilage change of patellofemoral joint after anterior cruciate ligament reconstruction

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ABSTRACT

Background: The purpose of this study was to evaluate the prevalence and risk factor of cartilage degeneration of the patellofemoral joint (PFJ) that was diagnosed by second-look arthroscopy.
Methods: One-hundred and seven patients who underwent ACL reconstruction were evaluated by preoperative MRI, postoperative MRI and second-look arthroscopy. Severity of infrapatellar fat pad (IPFP) fibrosis was evaluated by MRI at an average of 26 months after ACL reconstruction. Cartilage degeneration was assessed by second-look arthroscopy at 29 months.
Results: Twenty-five patients (24.0%) showed cartilage degeneration of the PFJ in second-look arthroscopy. Patients were divided into three groups according to severity of IPFP fibrosis of postoperative MRI (i.e. Group A, focal and incomplete band fibrosis, n = 69; Group B, complete band fibrosis, n = 31; and Group C, diffuse and infiltrated fibrosis, n = 7). Cartilage degeneration of the PFJ was significantly worsened with more fibrosis formation of the IPFP ($P < 0.001$). Other factors for instabilities (BMI, age, concomitant meniscal procedure, time from injury to reconstruction, severity of IPFP fibrosis at preoperative MRI and clinical scores) were not correlated with cartilage degeneration of the PFJ. The multivariate logistic regression analysis of degeneration of the PFJ after ACL reconstruction identified more severe fibrosis tissue formation of the IPFP and initial cartilage defect as significant predictors.
Conclusions: More extensive fibrosis of the IPFP and initial cartilage defect may be related to further degenerative changes of the PFJ. Other factors did not affect cartilage degeneration of the PFJ, although the muscle strength, the individual activity level or the rehabilitation protocol was not evaluated in the short-term follow-up period.

1. Introduction

Reconstruction of the anterior cruciate ligament (ACL) is intended to restore knee joint stability, avoid long-term degenerative problems, and improve function after a rupture of the ACL [1–7]. However, there are serious concerns regarding the incidence of osteoarthritis (OA) after ACL injuries, even with surgical treatment [8–10]. Long-term follow-up studies have demonstrated that 43-93% of patients manifested radiological changes indicative of OA [11–13]. Although the association between ACL reconstruction and knee OA has focused on the tibiofemoral joint, only a few studies have evaluated radiographic patellofemoral joint (PFJ) OA after ACL reconstruction [14]. A recent literature review reported that PFJ OA has a prevalence ranging from 11% to 90% (median

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36%) at 2-15 years after surgery and is a potent source of knee symptoms after ACL reconstruction [15]. The apparent large variability in PFJ OA prevalence is possibly caused by different diagnostic tools and varying radiographic methods.

While risk factors for the development of tibiofemoral joint OA are well demonstrated with ACL injury and reconstruction, PFJ OA after ACL reconstruction has been mostly unrecognized [15,16]. Several reports have shown that meniscus involvement, chondral injury, older age at the time of the operation, and quadriceps strength deficits contribute to the development of PFJ OA after ACL reconstruction [12,17–19]. However, few studies have been able to explain the exact mechanism, hence the exact cause of degeneration in PFJ after ACL reconstruction remains unclear [15,20].

Several reports have proposed a correlation between synovial fibrosis in the infrapatellar fat pad (IPFP) and anterior knee pain after ACL reconstruction [21–23]. We aimed to determine whether extensive synovial fibrosis in the IPFP after ACL reconstruction affects PFJ OA and the clinical results. Therefore, the purpose of this study was to evaluate the prevalence and risk factor of cartilage degeneration of the PFJ that was diagnosed by second-look arthroscopy in the short-term follow-up period. It was hypothesized that (1) larger fibrosis tissue of IPFP demonstrated by magnetic resonance imaging (MRI) is correlated with more degenerative change of PFJ after ACL reconstruction; and (2) younger patient age and better joint stability are correlated with less cartilage degeneration after ACL reconstruction in the short-term follow-up period.

2. Methods

2.1. Patient Selection and Study Design

A total of 1117 knees underwent primary ACL reconstruction between 2000 and 2012 at our institution. All operations were performed with an all-arthroscopic method by two surgeons at the same institution. The inclusion criteria consisted of the following: (1) evaluation of the preoperative and postoperative MRI; (2) a well-maintained ACL graft on the postoperative MRI; and (3) the second-look postoperative arthroscopy for hardware removal. Among 1117 patients who underwent primary ACL reconstruction surgery, 616 patients (55%) had postoperative MRI following ACL reconstruction, and 167 patients (15%) underwent the second-look postoperative arthroscopy for hardware removal. Although we routinely recommended the MRI study and the second-look arthroscopy to all patients, many refused the study for economic reasons or lack of time. Consequently, our results include this selection bias. The exclusion criteria were as follows: previous surgery of the affected knee, multiple ligament injury (except for medial collateral ligament) and revision surgery. However, patients who underwent meniscal surgery (meniscectomy or meniscal repair) or were treated for a cartilage lesion were included.

Accordingly, 107 patients were evaluated retrospectively. The mean age of the patients was 27.3 ± 9.5 years (range 15-54 years). Postoperative MRI was performed at a mean of 26.2 ± 23.1 months (range 5.0-135.6 months) and duration between ACL reconstruction and second-look arthroscopy was 28.7 ± 15.8 months (range 7.0-111.0 months). All patients were evaluated at clinical follow-up including instabilities and clinical scores at a minimum of 24 months (range, 24.0-152.3 months). Thirty-four subjects (32%) had isolated ACL reconstruction and 73 subjects (68%) had combined meniscal procedure (repair or meniscectomy) at the time of ACL reconstruction. Meniscus injuries were identified in 82 (76.6%) patients. There were 25 (23.4%) isolated medial tears, 41 (38.3%) isolated lateral tears, and 16 (15.0%) bilateral tears. Out of a total of 41 patients, medial meniscal tear was treated with repair (n = 26, 63.4%), partial (n = 5, 12.2%), subtotal (n = 5, 12.2%), and total (n = 5, 12.2%) meniscectomy. Out of a total of 57 patients, lateral tear was treated with repair (n = 21, 36.8%), partial (n = 10, 17.5%), subtotal (n = 1, 1.8%), and total (n = 3, 5.4%) meniscectomy. Twenty-two (38.6%) lateral tears were not treated because they showed incomplete and stable patterns. Median time from injury to surgery was 8.2 ± 16.8 months (range 0.5-120.0). Median BMI (body mass index) calculated based on height (cm) and weight (kg), was 25.3 ± 4.2 kg/m^2 (range 18.4-40.1). Ethical approval for the study was obtained from our Institutional Review Board.

In all cases the arthroscopic single-bundle reconstruction was performed using autologous hamstring tendon with a remnant-preserving technique. The tibial tunnel was placed at the center of the ACL footprint, and the femoral tunnel was located in the direction of half-past-10 for the right knee (and in the direction of half-past-one for the left knee). For all operations, a transtibial technique was applied with the same fixative materials for tibial and femoral tunnels [24].

2.2. Radiologic Evaluation

The simple radiographs including bilateral standing anteroposterior, lateral and Merchant views were taken at preoperative and follow-up periods. Modified Insall–Salvati ratio was measured by lateral radiograph of the fully extended position [25]. MRI was performed in non-weight bearing and supine position. All MRI examinations were performed with 3 Tesla MRI (Philips Intera Achieva 3.0 T; Philips, Eindhoven, The Netherlands) or 1.5 T MRI (GE Optima 1.5 T; GE Medical Systems, Milwaukee, WI). Insall–Salvati ratio was also determined by MRI preoperatively and at follow-up [26]. IPFP fibrosis tissue was classified into three groups based on fibrosis pattern of the sagittal image of MRI preoperatively and at follow-up (Figure 1). Group A was assigned when the fibrosis band was focal and incomplete. Group B was assigned if the fibrosis band had completely continued from the inferior pole of the patella to the tibial plateau. Group C was assigned when the fibrosis band was diffuse and infiltrated. Two independent investigators, blinded to the arthroscopic findings, clinical history, and initial MRI interpretations, reviewed the simple radiographs and MRI studies. Two of the authors performed all the measurements twice with an interval of 1 week.