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Original article

Serial magnetic resonance imaging study of posterior cruciate ligament reconstruction or augmentation using hamstring tendons



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ABSTRACT

Purpose: The purpose of this study was to analyze serial changes in the magnetic resonance imaging (MRI) signals of autograft hamstrings single bundle posterior cruciate ligament (PCL) reconstruction and the effects of remnant preservation (augmentation).

Material and methods: Twenty-two isolated PCL injuries were arthroscopically reconstructed or augmented with hamstring tendons. MRI scans were obtained at 3, 6, and 12 months, and prior to the second-look arthroscopy (average 20.7 months). The patients were divided into 2 groups by remnant preservation: five PCL reconstructions after PCL remnant resection (Group Rec) (23%), and 17 reconstructions preserving the remnant (Group Aug) (77%). The 22 patients were also divided in two groups depending on the location of the PCL tear. There were 9 knees with proximal tear (Type P) (41%) and 13 knees with distal tear (Type D) (59%). The signal intensity and fiber continuity of 4 zones (proximal, middle, distal intra-articular and tibial tunnel zones) were evaluated by the Mariani score.

Results: The average MRI evaluation score gradually increased from 6 months through the final MRI. The intra-articular part of the graft exhibited slower maturation (12 months – final scan) as compared with the tibial tunnel (6–12 months). The distal zone underwent better maturation than the proximal or middle zones at all points. In the proximal zone, the score for Group Aug was significantly higher than Group Rec. In the proximal zone, the Type D score with a proximally-preserved remnant was significantly higher than Type P without a proximal remnant.

Conclusions: The hamstring tendons require more than 1 year to achieve low-signal intensity. PCL remnant has a beneficial effect on the maturation of the hamstring graft.

Level of evidence: IV: therapeutic case series.

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1. Introduction

Magnetic resonance imaging (MRI) has been widely-used in the past to evaluate graft integrity following hamstring anterior cruciate ligament (ACL) reconstruction, and has provided much information regarding the healing process [1–5]. With respect to the posterior cruciate ligament (PCL), the value of MRI in diagnosing native PCL tears [6–8] and the natural healing process without surgery has also been well-established [9–14]. There have been few studies to date reporting graft integrity following PCL reconstruction, and little is known about the fate of the PCL graft. There is only

one serial MRI evaluation of graft integrity up to 12 months after PCL reconstruction [15]. They studied the graft integrity using MRI, and reported that their intensity increased at 6 months and then decreased gradually. They concluded that graft maturation requires more than 12 months after PCL reconstruction.

Over the last decade, there has been increased interest in new and improved techniques for PCL surgery with better results. Recently, several augmentation techniques for PCL injury have been reported [16–23]. Six clinical reports have concluded good results for PCL reconstruction with preservation of the remnant [17,18,20–23]. It is still unclear whether the preserved PCL remnant could support graft maturation after PCL reconstruction.

The purpose of this study was:

- to analyze the serial changes in the MR signals of the hamstring autograft used for PCL reconstruction and augmentation;

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- to determine the remnant preservation effect by evaluating the MRI graft appearance. Our hypothesis was that MRI evaluations will detect some effects of remnant preservation,

2. Materials and methods

2.1. Patients

From 2002 through 2011, 22 arthroscopic single bundle PCL reconstruction for isolated PCL injury were performed by a single surgeon.

There were 19 men and 3 women (mean age 31.5 years 18–53 years, $SD \pm 10.2$). The average time between injury and surgery was 32 months (1 month–20 years, $SD \pm 60.3$ months).

The indication for surgery was a side to side 5 mm difference and continuity of the PCL on MRI. In the first 5 cases (2002–2003) (23%) PCL remnant was resected (Group Rec); in the next 17 cases (77%) it was preserved (Group Aug). Combined anterior cruciate ligament or posterolateral tears were excluded.

2.2. Surgical technique

The graft tendons (semitendinosus and gracilis) were harvested, and then used as a seven or eight strand graft. The average graft diameter of the femoral side was 8.1 mm (6–10 mm) and the tibial side was 9.1 mm (7.5–11 mm). For proper preparation of the tibial tunnel, a posteromedial portal was carried out [24]. The surgeon introduced the PCL tibial guide system to the back side of the PCL, positioning more than 1.5 cm below the articular surface and just distal to the tibial PCL insertion, to avoid damage to the remnant PCL attachment.

To prepare the femoral tunnel without removing PCL remnant, the surgeon placed the tip of a pin and drilled about 7 mm proximal to the margin of the articular cartilage of the medial femoral condyle at the 1 o'clock position for a right knee (11 for a left knee), from the high antero-lateral arthroscopic portal, mimicking the antero-lateral bundle. The graft tendon was fixed to the femoral tunnel using EndoButtons CL (Smith & Nephew Endoscopy, Andover, MA). It was fixed with 2 staples (Meira, Nagoya, Japan) to the tibia with maximum manual anterior drawer stress and the knee joint flexed at 90°.

2.3. Postoperative rehabilitation

For the first 10 days, a knee brace was used to immobilize the knee in a slightly flexed position. Early ranges of motion exercises were allowed with a soft brace that had a 90°-initial range of motion restriction. Weight-bearing was allowed as tolerated at 3 weeks after the operation. At 6 months, the patients were allowed to take off the brace. By 10 months, sports activities could be resumed.

2.4. Patient Assessment

Serial postoperative evaluations and MRI scans (1.5-Tesla Signa HDxt; GE Healthcare, Copenhagen, Denmark) were performed at 3, 6 and 12 months and at final evaluation (just before the second arthroscopy and extraction of the staples from the tibia) (18–27 months; average 20.7 months, $SD \pm 2.6$ months). To evaluate the stability of the knee, bilateral radiographs were obtained by maximum manual posterior stress. The posterior stability was graded according to the 4 groups of the IKDC evaluation form.

2.5. MRI classification

The preoperative MRI scans were classified with regard to the PCL injury location and the remnant (Fig. 1). Type P was a proximal tear, and the remnant was detected mainly distally (9 knees) (41%). In Type D, the PCL tear was distal, and the remnant was detected mainly proximally (13 knees) (59%), including 3 cases of PCL avulsion fracture.

All MRI interpretations were performed by an orthopaedic surgeon, who was not aware of the results of the clinical evaluation. All examinations used a 320×256 matrix, 16 FOV, and 4 mm continuous slice thickness. The standard knee imaging protocol included SE T2-weighted (TR: 3100, TE: 85, Ex: 2) sequences with fat suppression (axial, coronal, and sagittal planes) and SE proton density (TR: 2000, TE: 20, Ex: 2) sequences (coronal and sagittal planes).

The MRI evaluation was performed using the Mariani analysis (Table 1) [15]. This evaluation method consists of two steps. One is the 4-level grading system to analyze the signal intensity at each zone [25] and the other is the morphologic continuity parameters of the graft [26]. The 4-level grading system is as follows [25]. Grade I: homogeneous, low-intensity signal within the entire graft segment. Grade II: at least 50% of a “normal” ligament signal. Grade III: less than 50% of the normally apparent ligament signal. Grade IV: diffuse increase in signal intensity with abnormal appearing

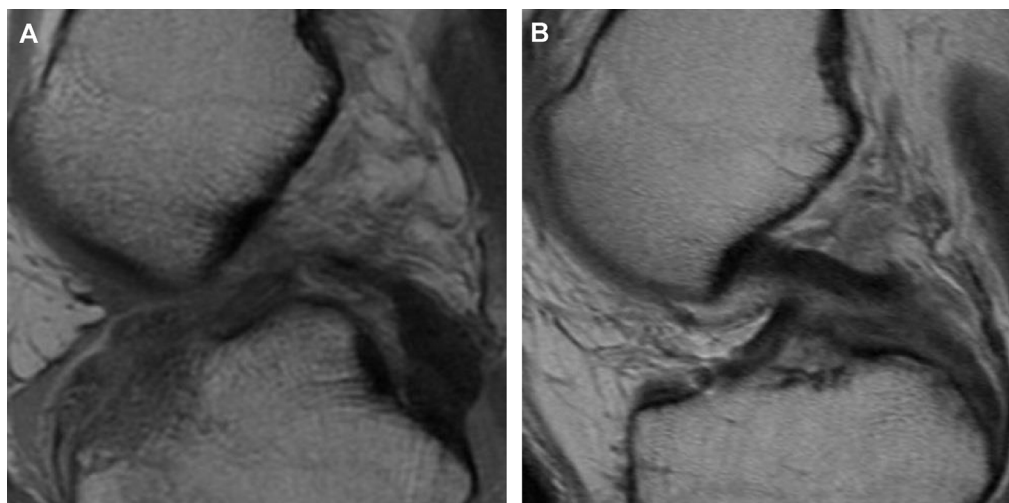


Fig. 1. Preoperative MRI classification of the PCL injury. (A) Proximal injury and the remnant is detected mainly distally (Type P): 9 knees. (B) Distal injury and the remnant is detected mainly proximally (Type D): 13 knees.

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