

Original Article

Remnant preserving anterior cruciate ligament reconstruction: evaluation of early graft remodeling by magnetic resonance imaging

Stergios G. Papastergiou, Nikolaos Manidakis, Nikolaos Koukoulis, Eleni Melikidou, Ioannis Christou, Georgios Nitis, Themistoklis Vampertzis

Agios Pavlos General Hospital, Thessaloniki, Greece

Abstract

Objectives: To evaluate the graft remodeling phase following anterior cruciate ligament reconstruction augmentation with remnant preservation. **Methods:** Between March and December 2018 19 patients underwent anatomic single bundle anterior cruciate ligament reconstruction using hamstrings with preservation of the intact ligament fibres and the peri-ligamentous synovium when possible. All patients were subjected to magnetic resonance imaging at 2 and 4 months post-operatively. Patient demographics, percentage of intra-operative remnant preservation and graft magnetic signal intensity using the signal/noise quotient method were recorded. **Results:** 12 patients were male and 7 were female with a mean age of 26.5 years. A low signal intensity in the mid portion of the graft was observed in those patients where a larger percentage of the ligament and synovium was preserved at 2 months post-operatively. The signal intensity was even lower at the 4 month scan. **Conclusions:** Remnant preserving anterior cruciate ligament reconstruction seems to lead to quicker graft remodeling as reflected in the post-operative magnetic resonance signal intensity. Graft revascularization and remodeling seem to correlate with the percentage of remnant preservation. These results support the use of fast-track rehabilitation protocols in this set of patients.

Keywords: Anterior cruciate ligament, Reconstruction, Augmentation, Remnant preservation, Remodeling

Introduction

Remnant preservation during anterior cruciate ligament (ACL) reconstruction has been found to be beneficial in terms of increased early post-operative antero-posterior and rotational stability¹, increased early proprioceptive function², as well as possible enhancement of graft revascularization and subsequent ligamentization^{3,4}. The theoretical disadvantage is the creation of too bulky a graft and a cyclops lesion. Although there does not seem to be a long-term difference between standard and minimal graft debridement techniques⁵, the current literature offers conflicting evidence regarding the early clinical benefits of remnant preserving ACL reconstruction^{6,7}. The aim of our study is to evaluate early graft remodeling using radiological parameters.

Materials and methods

We prospectively studied 19 anatomic single bundle ACL reconstructions using a four-strand double-looped

semitendinosus and gracilis autograft with remnant preservation. All patients included in this study had partial ruptures of the ACL with varying degree of intact ligament fibres bridging the femoral and tibial ACL attachments (Figure 1). Minimal debridement to all structures of the intercondylar notch and fat pad was undertaken. Particular care was taken to preserve all bridging fibres, peri-ligamentous synovium and the ACL stump. The tibial guide was placed through a split in the tibial footprint so that the graft could pass

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Corresponding author: Nikolaos Manidakis, Agios Pavlos General Hospital of Thessaloniki, 161 Ethnikis Antistasis Av, Kalamaria, 551 34, Greece

E-mail: nimanidakis@hotmail.com

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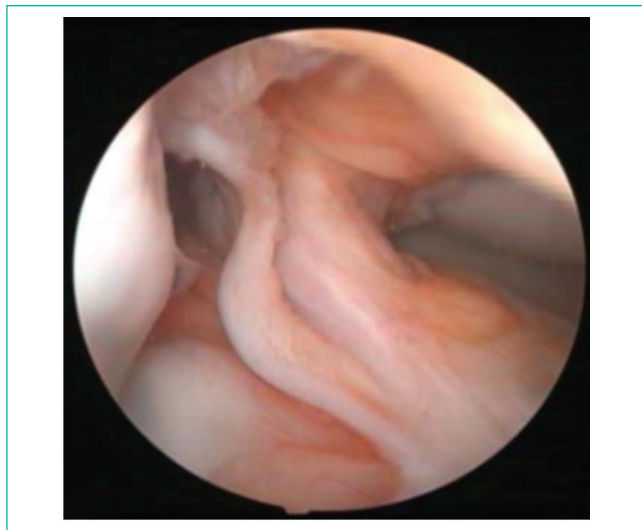


Figure 1. Intraoperative image demonstrating attenuated ACL fibres. The fibres have maintained their femoral and tibial attachments.



Figure 2. Intraoperative image demonstrating graft placement through the remnant tissue.

through the remnant tissue (Figure 2). In the cases where a larger percentage of intact fibres was present, the guide suture was fed into the tibial tunnel with the aid of a curved suture passer/retriever.

The percentage of intact ligament fibres was assessed on review of the arthroscopy videos by the senior author (SGP).

As part of the study protocol all patients had a magnetic resonance imaging (MRI) scan at two and four months following their remnant preserving reconstruction. All scans were performed in our institution's 1.5 T MRI scanner using T2 sagittal and ACL oblique paracoronal sequences in a dedicated knee coil. The mid-graft signal intensity was quantified using the signal/noise quotient formula (SNQ)⁸: $SNQ = \text{ACL signal} - \text{Quadriceps or patellar tendon signal} / \text{signal of background}$

Results

The patient cohort consisted of 12 male and 7 females with a mean age of 26.5 years (18-42). On combined review of the procedure videos and the post-operative MRI scans, it was noted that patients with a larger percentage of intact ligament fibres and synovium exhibited a lower signal intensity at the mid-portion of the graft on the 2 month scan. The average mid-graft signal intensity was measured even lower at 4 months post-operatively. Thus the higher amount of remnant preservation correlated with progressively lower mid-graft signal intensity in this group of patients (Figures 3, 4).

Discussion

The biomechanical advantage of remnant preservation during arthroscopic ACL reconstruction is directly related to

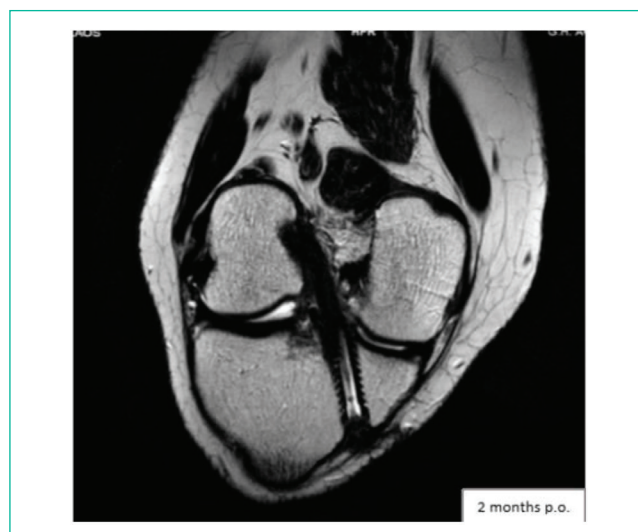


Figure 3. T2 ACL oblique paracoronal MR image at 2 months post-op demonstrating low graft signal intensity.

the type of remnant tissue. Crain et al⁹ reported on different ACL scar attachment sites. They noted that bridging fibres from the femoral anatomic footprint to the tibia offer superior biomechanical properties compared to those fibres attached on the posterior cruciate ligament (PCL), despite being elongated. In our study all patients had varying degrees of intact fibres that bridged the femoral and tibial ACL attachments. Cases with remnants scarred on the PCL were not included in this study.

ACL graft revascularization has been shown to commence



Figure 4. T2 ACL oblique paracoronal MR image at 4 months post-op demonstrating even lower graft signal intensity.

at its intra-articular portion with gradual spread to the intraosseous sites throughout the first post-operative year³. Therefore graft revascularization of the intra-articular part is an important link in the ligamentization process that is probably enhanced by remnant preservation^{3,4}. Due to this fact, we measured the MR signal intensity at the mid-portion of the graft for our study's purposes.

The SNQ ratio used for quantification of the signal intensity is the standard method to assess the ligamentization process. A higher signal intensity indicates increased early healing with revascularization¹⁰, whereas a lower signal intensity corresponds to the remodeling phase of healing¹¹.

Our results suggest that by preserving favourable ACL remnants there is an acceleration of the graft remodeling process as indicated by the reduced MR signal intensity. The further reduction of signal intensity on the second post-operative scan, especially on patients where a larger percentage of fibres was preserved, seems to consolidate this concept. Future research in the form of randomized controlled trials is needed in order to provide solid evidence regarding the role of remnant preservation in the ACL graft ligamentization process.

Despite the relatively small number of patients included in this study, we believe that ACL augmentation using

appropriate remnant tissues is a reasonable treatment option that can lead to faster rehabilitation following arthroscopic ACL reconstruction.

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