Technical Note

Combined ACL and Segond Repair in Combined Acute Proximal ACL Tears and Segond Fracture

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Abstract: A renewed interest in anterior cruciate ligament preservation has been noted using arthroscopic primary repair in patients with proximal tears, but the main concern remained the control of the rotational instability. Segond fracture occurs in less than 10% of cases of acute anterolateral instability, but it can result in continued rotation instability. The aim of this study is to describe the surgical technique to acutely repair both the anterior cruciate ligament and Segond fracture in the acute setting.

Introduction

Anterior cruciate ligaments (ACL) tears are frequent sports-related injuries, and over the past few decades, ACL reconstruction has represented the gold standard technique to address the injured structure.[1,2,3] With the benefit of modern arthroscopic surgical techniques and devices, there has been a renewed curiosity in primary repair of ACL.[4,5] This procedure may be a surgical alternative for those patients presenting with functional impairment after acute proximal ACL injuries with potentially less morbidity, although clinical outcomes for ACL repair using modern techniques is still limited. The ACL is the most important restraint to anterior tibial translation, and recent surgical and biomechanical studies have shown that anterolateral rotational instability (ALRI) is the effect of only a combined lesion of the ACL and secondary restraints, such as anterolateral ligament (ALL) and capsule, Segond fracture, and lateral meniscus posterior root (LMPRT).[6,7] The incidence of ALL injuries associated with ACL tears is about 90% of cases, and the Segond fracture (SF) occurs in less than 10% of cases of acute anterolateral instability.[8] A SF is defined as an avulsion-type fracture of a bony fragment by the pull of a ligament from its insertion point. Today, after the anatomical description of the ALL, the SF is considered to be a tibial avulsion of the distal insertion of the ALL.[9] The goal of ACL surgery is to control rotational instability of the knee and pivot shift phenomenon[10] because residual rotational instability is correlated with less satisfactory outcomes and a return to sports activity.[11,12,13] For this reason, the treatment of associated lesions, especially lesions of the ALL, is recommended at the time of ACL surgery.

The aim of this technical note is to describe the surgical technique used in this particular type of combined ACL and ALL injury (Video 1).

Preoperative Evaluation

Clinical evaluation is performed to identify acute ACL tears using Lachman test and pivot shift test.

Radiographs are used to better detect an SF and to define its dimension. We suggest using a direct suture or anchor fixation (surgeon discretion) when the bone fragment is 2 cm^2 or smaller. We recommend using three parallel square knot stiches using no. 2 Vicryl suture or a 5-mm suture anchor with mattress suture

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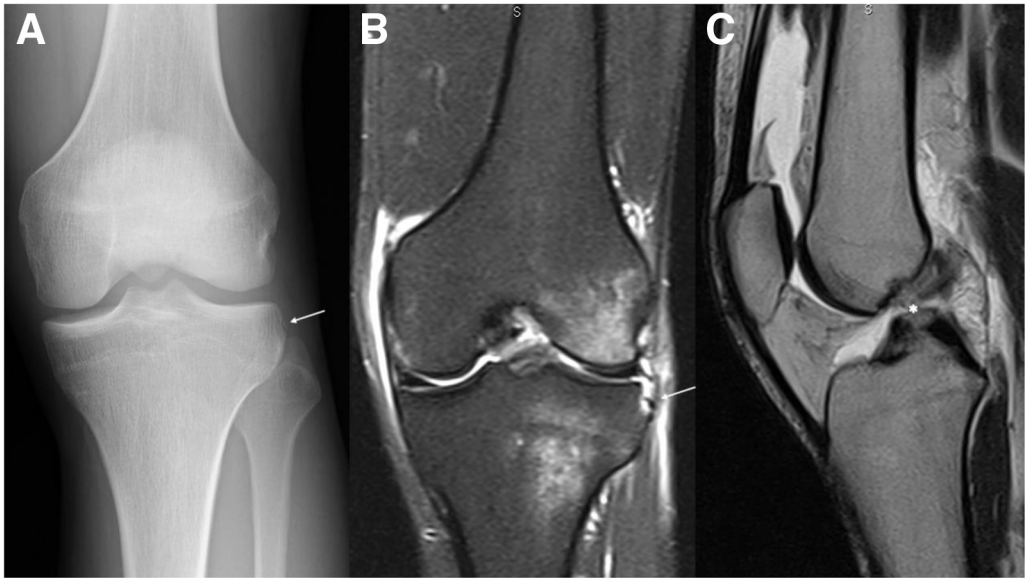

Fig 1. Preoperative evaluation. (A) Arrow indicates the bony fragment in the lateral tibial plateau of the left knee. (B) Arrow indicates Segond fracture in magnetic resonance imaging (MRI) (T2-TSE weighted coronal view) in the same patient. (C) Asterisk (*) indicates the anterior cruciate ligaments (ACL) tears in MRI (T2-TSE weighted sagittal view). The remnant is classified as type II (according to van der List et al.[14]) with good quality.

fixation, while the patient's knee was in 90° of flexion and neutral rotation. Fragments larger than 2 cm^2 could be secured by cannulated screws.

Magnetic resonance imaging (MRI) is used to confirm the diagnosis and to find concomitant lesions. On the basis of their MRI appearance, ACL tears were graded according to the classification of Van der List et al. into four types.[14]

- Type I included more proximal tears that occur close to the femural origin of the ligament, with at least 75% of the length of the ligament remaining attached to the tibia.
- Type II included proximal tears with at least 50% of the ligament.
- Type III included distal tears with less than 50% of the ligament remaining attached to the tibia.
- Type IV included very distal tears occurring close to the tibial insertion of the ACL, with about 90% of the ligament remaining attached to the femur.

Moreover, the tissue quality of the ACL on the preoperative MRI was evaluated to predict eligibility for ACL repair and classified as good, fair, and poor, according to van der List and Di Felice.[15] Patients with type I–III tears with at least 50% of tibial ACL remnant intact along with good tissue quality could be selected for the ACL repair (Fig 1).

Surgical Technique

General Preparation

The patient's consent is obtained to undergo either ACL repair or ACL reconstruction based on the inclusion and exclusion criteria (Table 1). The patient receives standard preoperative antibiotics, is transferred to the operative suite, and undergoes anesthesia. The patient is then placed in a supine position, and the operative leg is prepped and draped for a standard knee procedure (Table 2).

Table 1. Indications, Pearls and Pitfalls

Indications	Pearls	Pitfalls
• Acute tears (within 14 days) • type I, type II and type III tears with at least 50% of tibial ACL remnant	• Start with diagnostic arthroscopy • Preserve the femoral stump	• Inappropriate tensioning • Iatrogenic injury to the remnant
	• Respect antomy and tension of reapprox. • Stumps on femoral side out-in femoral tunnel drilling • Segond fixation according to bony Fragment dimension	• Inappropriate femoral tunnel placement

ACL, anterior cruciate ligament.

Table 2. Step-by-Step Surgical Procedure

Patient in a supine position
Preoperative clinical evaluation
Use three arthroscopic portal: AM (working), central (scope), AL (cannula)
Start with a diagnostic arthroscopy and decision
Remnant on the tibial side was prepared using no. 2 FiberWire and TigerWire using a lasso-loop knot-tying configuration
Test suture fixation by pulling traction on the ends of the stitches
Create a femoral tunnel in anatomical position using a 3.5-mm drill with the out-in technique
Use a stitch shuttle to pass the repair stitches up through the femoral tunnel
Pass the stitches through a dog bone button
Tension with the knee in full extension and tie off
Hockey stick incision in the lateral compartment
Inspect the fascia lata and longitudinally divided along its fibers to expose lateral compartment
The posterolateral corner to Gerdy's tubercle anteriorly was exposed and examined
Direct visualization of Segond fracture
Repair the lesion according its dimension
Postoperative clinical evaluation

AM, anteromedial; AL, anterolateral.

ACL Repair

Surgery is started and a transtendinous portal is used for diagnostic arthroscopy, and the anteromedial portal is used as a working portal. The torn ACL is carefully evaluated and probed to identify the tear type and determine tissue quality. An accessory anterolateral portal is created and a 6-mm passport cannula (Arthrex, Naples, FL) is inserted to facilitate suture passage and management. The ACL remnant on the tibial side is prepared by suture passage into the ligament with a scorpion suture passer using no. 2 FiberWire and TigerWire stiches (Arthrex, Naples, FL) that are looped through the ligament using a lasso-loop knot-tying configuration (Fig 2). The stitches are passed through the anteromedial and posterolateral bundle of the ACL. The strength of suture fixation is tested by pulling traction on the ends of the stitches. A femoral outside-in ACL guide is subsequently used to create a femoral tunnel. The guide is placed at the origin of the femoral stump for anatomic guidance. The femoral stump is not debrided at all to ensure anatomic positioning and biologic preservation. The femoral tunnel is drilled using an outside-in technique using a 3.5-mm drill. A FiberStick no. 2 (Arthrex, Naples, FL) is then passed from outside-in through the guide trocar and retrieved with a grasper from the anteromedial portal. The FiberStick is then used to pass the repair stitches up through the femoral tunnel in order to reapproximate the tibial ACL remnant to the femoral ACL stump. The repair stitches are then passed through a cortical button (Arthrex, Naples, FL). After cycling the knee, the repair stitches are tensioned with the knee in full extension and tied off with alternating half hitches. Finally, the repaired ACL is probed and evaluated at different degrees of flexion to confirm the integrity of the repair (Fig 3).

Segond Fracture Fixation

The lateral compartment is exposed by using a 5-cm lateral hockey-stick incision, which is carried down to the iliotibial band (ITB). The ITB is first inspected and then longitudinally divided along its fibers to expose lateral compartment. The lateral compartment is exposed form posterolateral corner to Gerdy's tubercle anteriorly (Fig 4). The anterolateral capsule is carefully explored and the Segond fracture is directly repaired to the tibial bone using a metallic anchor (4.5 Corkscrew, suture anchor, Arthrex, Naples, FL) (Fig 5). The anterolateral ligament and capsule are also reinforced by using Vycril no. 2 stitches in tension (Fig 6).

Postoperative Rehabilitation Protocol

A short range of motion (ROM) knee brace is applied postoperatively for the first 4 weeks. The brace is locked in extension for the first week, and then unlocked for the remaining 3 weeks. Weight bearing with brace and crutches is allowed, as tolerated on postoperative day 1. The first week is focused on pain and swelling control, with ice and anti-inflammatory drugs. Range of motion exercises are started 1 week after surgery with the goal to achieve and maintain full extension and progressively recover flexion. Full ROM is obtained by a maximum of 6 weeks after surgery. The brace is removed at 6 weeks after surgery, and the patient starts a supervised strengthening program. Sports activities are allowed 6 months postoperatively.

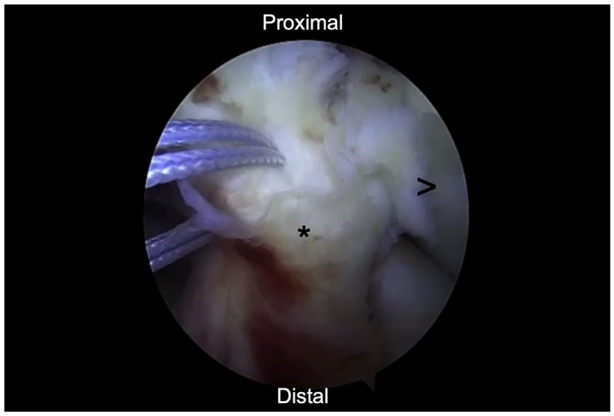

Fig 2. Asterisk (*) indicates the remnant anterior cruciate ligaments (ACL) on the tibial side. Arrow (>) indicates the medial side of the lateral femoral condyle of the left knee. The ACL remnant on the tibial side is prepared with a scorpion suture passer using no. 2 FiberWire and TigerWire stitches using a lasso-loop knot-tying configuration. The stitches are passed through the anteromedial and posterolateral bundle of the ACL.

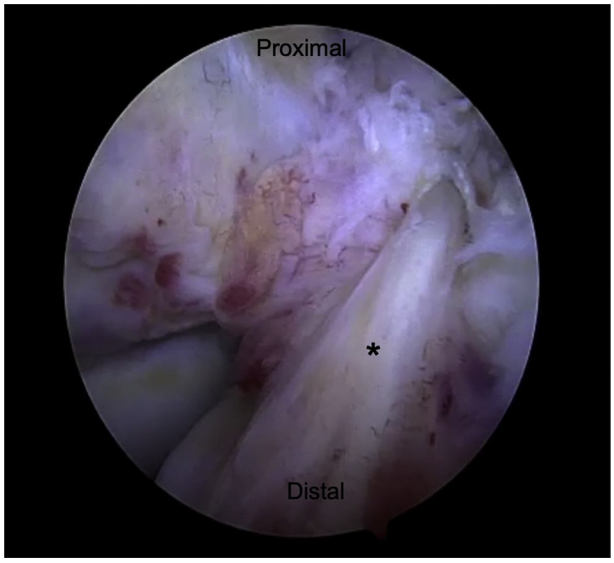

Fig 3. Asterisk (*) indicates the repaired anterior cruciate ligaments (ACL). The repair stitches are tensioned with the knee in full extension and tied off with alternating half stitches. The repaired ACL is probed and evaluated at different degrees of flexion to confirm the integrity of the repair.

Discussion

The description of a surgical technique based on a coupled repair of the ACL and of the SF was performed in this study. The rationale behind this study is the repair of the damaged structure should improve the healing potential toward complete recovery of normal knee function from a biological, anatomical, and biomechanical perspective. From a biological perspective, there are apparent advantages of ACL repair over reconstruction (Table 3). The blood supply is rich in vessels and anastomosis and it provides an adequate supply in all kind and site of tearing (proximal, distal and mid-substance); the early platelet clot seems to deliver growth factors that attract mesenchymal cells, which also governs their differentiation toward fibroblasts and myofibroblasts. The technique presented is a direct repair of the ACL performed in an acute phase, in which the ACL remnant is reapproximate to its femoral stump, which is not debrided, thus enhancing the healing potential of the ACL. Furthermore, the native ACL has proprioceptive receptors, and for all these reasons, ACL repair has several advantages over ACL reconstruction. ACL repair advantages include the absence of a graft harvesting, which can produce discomfort and disability. Moreover, there is evidence that proprioception correlates better with postoperative function and satisfaction than mechanical stability.

Recent studies reported satisfactory results with ACL repair using a different technique. DiFelice et al.[16] reported only 1 failure (9%) at a mean 3.5-year follow-up after primary ACL repair. Achtnich et al.[17] showed

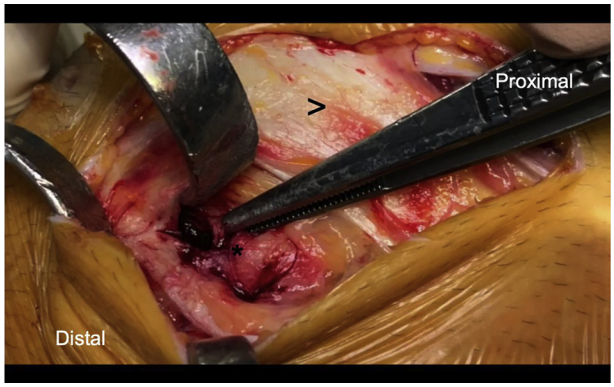

Fig 4. Asterisk (*) indicates the bony fragment of the Segond fracture. Arrow (>) indicates the fascia lata. The lateral compartment is exposed by using a 5-cm lateral hockey-stick incision, which is carried down to the iliotibial band (ITB). The ITB is first inspected and then longitudinally divided along its fibers to expose lateral compartment. The lateral compartment is exposed from the posterolateral corner to Gerdy's tubercle anteriorly.

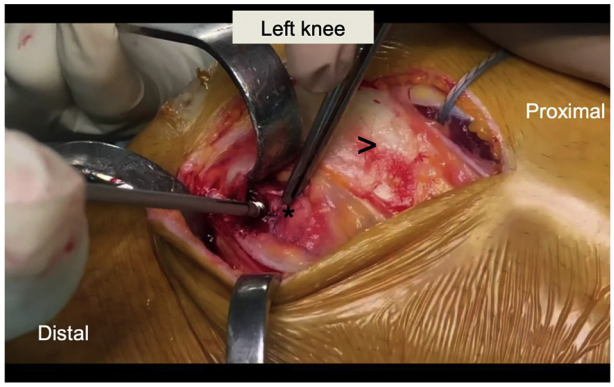

Fig 5. Asterisk (*) indicates the bony fragment of the Segond fracture. Arrow (>) indicates the fascia lata. The anterolateral capsule is carefully explored, and the Segond fracture is directly repaired to the tibial bone using a 4.5 suture anchor.

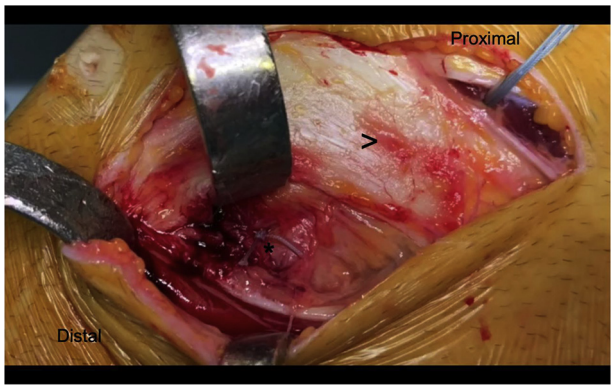

Fig 6. Asterisk (*) indicates the repaired Segond fracture. Arrow (>) indicates the fascia lata. The anterolateral ligament and capsule are also reinforced by using Vycril no. 2 stitches in tension.

Table 3. Advantages/Disadvantages of this Technique

Advantages	Disadvantages
• Anatomical repair of ACL	• Surgical skills are required
• Anatomical repair of Segond fracture	• Lateral incision
• Absence of a graft harvesting	• Higher cost of equipment
• Combined treatment of anteroposterior and rotational laxity	

ACL, anterior cruciate ligament.

a not significant trend toward more revision after primary repair, compared with ACL reconstruction.

Ferretti et al.[5] demonstrated that appearance of an acutely repaired ACL seems normal or close to normal in all but one case (90%) by 3 months and normal in all cases by 6 months.

Van der list et al.[18] in a recent meta-analysis evaluated 1,101 patients treated with different techniques of primary repair demonstrating a failure rate between 7% and 11% with good functional outcome scores.

As mentioned above, the primary goal of an ACL surgery is to stabilize the knee, particularly to control the rotational stability. It is well accepted that rotational instability is produced by a combined lesion of the ACL and secondary restraints such as ALL and capsule.[10] Moreover lesion of the anterolateral capsule, including ALL tears and Segond fracture, are associated to ACL tears in about 90% of cases. So, it is clear that the ACL is seldom injured in isolation. The Segond fracture is associated with ACL tear in ~10% of cases.

Paul Segond first described this fracture in 1879 as a resistant fibrous band in the lateral compartment of the knee, whose traction injury determines a cortical avulsion of the lateral proximal tibia.

Recently Claes et al.[9] confirmed the hypothesis that the anterolateral ligament inserts in the region on the proximal tibia from where SF consistently avulses, suggesting that the Segond fracture is a bony avulsion of the ALL.

The anterolateral ligament is very important in controlling rotational stability of the knee and the pivot-shift phenomenon, supporting early speculation that unrecognized injury to an extra-articular structure, such as the Segond fracture may account for some cases of rotational instability after ACL reconstruction. For this reason, SF fixation has been advocated to better restore rotational instability of the knee.[19] Ferretti et al.[20] demonstrated good clinical outcomes, restoration of rotational stability, and maintenance of knee range of motion at 2 years postoperatively, with direct repair of the Segond fracture in patients with an ACL reconstruction and a high-grade pivot shift, with no major complications.

The acute phase of repair allows the two repaired structures (ACL and SF) to heal by the spontaneous healing process of ligaments and also allows a completely anatomical treatment of the injured knee. Moreover, this does not require any tendon harvesting or lateral extra-articular reconstruction, thus, avoiding tendons or ITB harvesting. The aim of this technique is to perform a complete repair of the injured knee, obtaining a stable knee and control of the pivot-shift phenomenon.

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