Technical Note

ACL Reconstruction With Quadrupled ST Graft and Mini-Invasive Anterolateral Ligament Reconstruction

Jérôme Murgier, M.D., and Xavier Bayle-Iniguez, M.D.

Abstract: Anterior cruciate ligament (ACL) reconstruction with hamstring graft is the most common procedure around the world. More recently, the use of the semitendinosus (ST), in a quadrupled arrangement, has been described with great results. Having a thicker tendon instead of double gracilis, ST offers a graft with a diameter superior to 8 mm, thus more closely resembling the native ACL and decreasing the risk of graft failure. It has also been published that preservation of the ACL stump was paramount to obtain better graft vascularization and proprioception. In addition, reconstructing the anterolateral ligament is associated with better results. The aim of this technical note is to present an ACL reconstruction technique using a quadrupled ST graft with a double suspensory fixation associated with ACL stump preservation and a mini-invasive anterolateral ligament reconstruction.

Introduction

Anterior cruciate ligament (ACL) reconstruction is widely performed around the world. A myriad of techniques exists, with pros and cons for each of them. The two most popular grafts are bone—patellar tendon—bone (BPTB) and hamstring tendon (HT).1,2 Potential drawbacks of a BPTB autograft include the risk of anterior knee pain, patellar fracture, patellar tendon (PT) rupture, quadriceps weakness, and donor site morbidity, while the disadvantages of a HT autograft include hamstring pain, decreased hamstring strength, increased joint laxity, and delayed graft-tunnel healing with more tunnel enlargement.3 Nevertheless, there are very few differences that have been clearly demonstrated between these two reconstruction techniques, and the graft choice comes down to the surgeon’s discretion. However, the discovery of the anterolateral ligament (ALL) and its reconstruction have greatly changed this binary choice.4,5 The advantages of BPTB grafts over HT grafts became challenged by this additional procedure. We describe an anatomic single-bundle anterior cruciate ligament reconstruction using a 4-strand semitendinosus graft fixed with adjustable suspensory fixation systems (Graft Link, Arthrex, Naples, FL) that is associated with a percutaneous reconstruction of the anterolateral ligament with the gracilis.

Surgical Technique

To view the surgical technique, see Video 1 and Table 1.

Preparation

The semitendinosus and gracilis tendons are harvested by the standard technique and cleared of any residual muscular tissue. They are then separated and prepared. The semitendinosus is used for ACL reconstruction and the gracilis for ALL reconstruction. The full length of the semitendinosus needs to be between 24 to 27 cm. It is passed through a loop of the tightrope Attachable Button System (ABS) (Arthrex) and folded over. A whipstitch suture is performed at the extremity of the graft (free end) with FiberLoop thread (Arthrex). The graft is then passed through the loop of the ACL tightrope RT implant (Arthrex) and folded over again to produce a quadrupled ST graft (Fig 1). The four strands are tied together three times with FiberWire thread (Fig 2). The graft diameter is then measured.
Table 1. Pearls and Pitfalls

| Surgical Steps            | Pitfalls                                                                                                                                                                                                 | Tips and Tricks                                                                                                                                                                                                 |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ACL femoral tunnel drilling | - The free-hand guide can lead to the femoral tunnel being positioned too posterior and too proximal. This can cause a posterior wall fracture or a vertical graft.  
- Abundant residual tissue can hinder the surgeon’s ability to see the notch, which makes drilling the femoral tunnel difficult. In addition, when drilling the femoral tunnel under a great deal of flexion, the drill bit can damage the remnant. | - The first step is to find the right femoral tunnel position at 90° of knee flexion; this spot can vary from one patient to another. Following the "IDEAL position" recommendations makes it easier and safer. The subsequent drilling has to be made at maximum flexion.  
- To avoid remnant damages, the drill should be used directly at the size of the graft and at a lower speed. |
| ALL femoral tunnel drilling | - There is a risk of tunnel convergence between the ALL femoral tunnel and the ACL femoral tunnel.                                                                                                                                                                   | - The ALL femoral tunnel drilling is performed under direct scope visualization. The scope is placed in the ACL femoral tunnel via the anteromedial portal to allow direct visualization. When drilling the ALL femoral tunnel, if there are any signs of convergence between the two tunnels, then the direction of the ALL tunnel needs to be changed (generally more vertical). |
| Graft introduction        | - If a mark is not drawn on the tightrope loop, it can be hard to know when the button has entirely passed the lateral cortex.                                                                                                                                     | - A mark of the femoral tunnel length on the tightrope loop helps the surgeon control the position of the endobutton on the lateral cortex. Without controlling this length, the button can remain in the spongious bone, thus weakening the fixation or conflicting with the facia lata and causing lateral pain. |

ACL, anterior cruciate ligament; ALL, anterolateral ligament.

Fig 1. View of graft preparation (semitendinosus), after being passed through both tightrope implants (arrow denotes TightRope RT; star denotes Attachable Button System implant).

Fig 2. Superior view of the graft (star), fully prepared and tensioned.
The gracilis preparation follows, using two FiberLoop threads to whipstitch each graft at its extremity. The minimum length is 10 cm (Fig 3).

**Arthroscopic Surgery**

The second phase is the arthroscopic procedure. The meniscus is carefully assessed, and a meniscus suture is performed, if necessary. A ramp lesion is systematically sought via a trans-notch view. The ACL remnant is visualized and preserved as much as possible on the tibial aspect, but also the femoral one.

A free-hand guide is used to choose the entry point of the femoral tunnel at 90° of flexion (medial aspect of the lateral femoral condyle) (Fig 4). The positioning

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**Fig 3.** View of the gracilis, whipstitched on both extremities (arrows). It should measure more than 10 cm in length.

**Fig 4.** Arthroscopic view of the left knee. A free-hand guide (arrow) is used to choose the entry point of the femoral tunnel at 90° of flexion (medial aspect of the lateral femoral condyle: square).

**Fig 5.** Arthroscopic view of the inner part of the femoral tunnel (arrow) via the anteromedial portal (left knee).
is based on patient anatomy following the IDEAL position criteria. The knee is then flexed at maximum flexion, and a 4.5 guide pin is drilled from the entry point to the lateral cortex (the length of the femoral tunnel is assessed at this time). The femoral tunnel is then drilled at the same size as the graft, and its length depends on the graft length (generally between 15 to 20 mm). A suture loop is then passed through the femoral tunnel. The scope is then introduced via the anteromedial portal to visualize the inner part of the formal tunnel and later control the absence of communication between femoral tunnels (ALL and ACL) (Fig 5).

A longitudinal cutaneous incision of 3 cm is made on the lateral aspect of the lateral epicondyle (LE), the fascia lata is then sectioned longitudinally, and the lateral epicondyle is palpated (Fig 6). The ALL femoral entry point is located proximally and posteriorly to the LE, and a guide pin is inserted at this optimal location. During the drilling of the pin, a direct visualization on the screen allows the surgeon to verify whether there is any communication between the two tunnels (Fig 7), and if this is the case, the guide pin is removed, and another direction is chosen (generally more vertical). A 5-mm tunnel of 20 mm long is drilled guided by the pin.

The tibial tunnel guide is positioned on the ACL remnant at the tibial footprint. The guide pin is drilled to the joint, and successive reamers of increasing diameters are used until the size of the graft is achieved, to preserve the remnant. The tibial tunnel entry point is cleared using scalpel and shaver. The femoral loop is grabbed with a grasper through the tibial tunnel and the graft is then pulled into the joint under visual control (Fig 8). The adjustable feature of the button allows the surgeon to control the progression of the graft in the femoral tunnel (Fig 9). Tightrope shortening strands are pulled successively. At the tibial side, an ABS button is inserted onto the ACL tightrope (Fig 10). The graft is tensioned in full extension.

Fig 6. Lateral view of the left knee flexed at 90°. A longitudinal cutaneous incision of approximately 3 cm is made (arrow) on the lateral aspect of the lateral epicondyle.

Fig 7. Lateral view of the left knee during the drilling of the proximal anterolateral ligament (ALL pin; square). Direct visualization on the screen (star) allows the surgeon to verify whether there is any communication between the anterior cruciate ligament and ALL femoral tunnels.
A longitudinal 3-cm incision is made at the level of Gerdy’s tubercle (Fig 11). The ALL tibial tunnel is drilled at the level of Gerdy’s tubercle with a 7-mm diameter drill. In order to avoid any intra-articular effraction, the direction of the drill will be horizontal and anteroposterior. The gracilis is inserted in the femoral tunnel and fixed with a fully threaded knotless SwiveLock anchor (Arthrex) (Fig 12). The knee is then positioned at 30° of flexion (neutral rotation), and the graft is fixed at the tibial level with another knotless SwiveLock anchor (Arthrex) (Fig 13).

Discussion

This technique is inspired by the SAMBBA technique, as its objective is to preserve the ACL remnant. An additional extra-articular procedure
helps minimize anterolateral instability. The benefit of this step is still debated in primary ACL reconstruction; however, numerous recently published articles have demonstrated its utility in decreasing graft failure rates and protecting the meniscus suture.7-9 Consequently, it seems relevant to perform an ALL reconstruction in selected patients (major rotatory instability, constitutional hyperlaxity, high-demand athletes, or patients under 18 years old) (Table 2).
Fig 12. Lateral view of the left knee. The gracilis is inserted in the femoral tunnel and fixed with a fully threaded knotless SwiveLock anchor (Arthrex, Naples, FL), (arrow).

Fig 13. Lateral view of the left knee. The gracilis is fixed at the tibial level with a knotless SwiveLock anchor (Arthrex), (arrow), and the knee is flexed at 30°.

Table 2. Advantages and Disadvantages of Combined ACL ST Remnant Sparing Reconstruction and ALL Reconstruction Versus Standard ACL Reconstruction

| Advantages                                | Disadvantages                                               |
|-------------------------------------------|-------------------------------------------------------------|
| Easy technique, reproducible              | Longer procedure                                            |
| Lower ACL failure rate                    | Risk of posterior wall fracture and tunnel communication    |
| Remnant sparing technique (preservation of ACL’s biological properties - proprioception and vascularization) | Additional surgical step                                   |
| Mini-invasive surgery                     | Gracilis autograft harvesting required in addition to semitendinosus autograft |
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