Technical Note

An Alternative Femoral Fixation in All-Inside Anterior Cruciate Ligament Reconstruction: A Solution for Preventing Possible Graft Loosening

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Abstract: The aim of this surgical Technical Note is to search for a way to prevent possible graft loosening in all-inside anterior cruciate ligament (ACL) reconstruction. We used a fixed-loop cortical suspensory device on the femoral end and a suspensory cortical fixation technique and sutures on the tibial end. Then we flexed the knee for 150 cycles, reexamined the tightness of the ACL graft, and compared it with the initial tightness. Loosening of the ACL graft, which is suggested to be related to suspensory cortical fixation, could be prevented using the button system on the femoral end and tightening the suspensory cortical fixation on the tibial end.

The anterior cruciate ligament (ACL) is an important stabilizer of the knee joint. It is the primary passive restraint to anterior tibial translation and has a critical role in rotational stability of the knee.[1,2] ACL injury mostly occurs due to noncontact injuries in athletes.[3-7]

The number of ACL reconstruction surgeries has steadily been increasing over the last 2 decades, and it is estimated that 250,000 surgeries are performed each year in the United States.[6] The all-inside ACL reconstruction technique was first described in 1995[8] and has been gaining in popularity ever since. Lubowitz et al.[9] developed the original technique and described a second-generation all-inside ACL reconstruction technique. This differed from the original technique in terms of graft construct in that the quadrupled graft was tensioned and linked to adjustable-loop cortical suspensory devices on both the femoral and tibial ends.

Adjustable-loop cortical suspensory fixation devices are reported to loosen, particularly when they are not tied off after retightening.[10,11] We present a technique in which we perform all-inside ACL reconstruction with a fixed loop on the femoral side, and after fixing the graft on both sides, we flex and extend the knee 150 times, then retighten and tie off the tibial adjustable cortical suspensory fixation device tensioning sutures.

Surgical Technique

The patient is placed supine, prepared, and draped. The anterolateral and anteromedial portals are opened (Fig 1; Video 1). Diagnostic arthroscopy is performed, including the ACL and all other intra-articular structures using an examination probe (Fig 2). After ensuring that the ACL is ruptured, the scope and examination probe are removed from the knee joint and we proceed with graft harvesting.

The tibial tubercle is palpated and a 2 to 3 cm oblique incision is made medial to the tibial tubercle. The fascia of the sartorius muscle is exposed, and semitendinosus and gracilis tendons are palpated (Fig 3). The gracilis tendon insertion is superior to the semitendinosus tendon insertion. However, their insertions converge at the pes anserine. The sartorius fascia is then elevated, and the semitendinosus tendon is identified. It is then harvested using a semitendinosus tendon stripper and prepared as quadrupled with adjustable-loop cortical suspensory (ACL TightRope, Arthrex, Naples, FL) on

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Fig 1. Arthroscopy portals for the right knee in a supine patient. (AL, anterolateral FAL, far anterolateral; AM, anteromedial.)

the tibial end and with a fixed-looped button system (RetroButton, Arthrex) on the femoral side (Fig 4). The length of the quadrupled graft is adjusted, with a minimum of 6 cm long.

Portals are reopened. The femoral and tibial tunnels are reamed as Blackman and Stuart[12] described in their all-inside ACL reconstruction technique. The ACL femoral footprint is identified, and remnant fibers are removed using a shaver and radiofrequency ablation. The resident's ridge and the center of the femoral socket are identified. The far anteromedial portal is

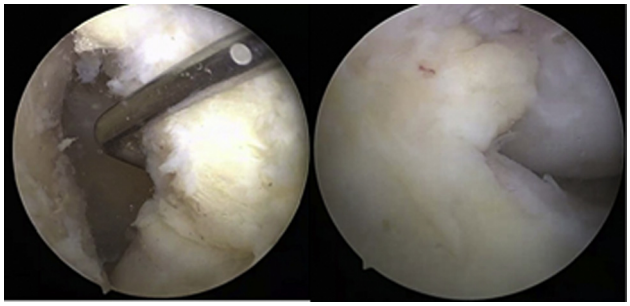

Fig 2. (Left) Femoral footprint of ruptured ACL through anterolateral portal. (Right) Remnants of ACL through the anterolateral portal.

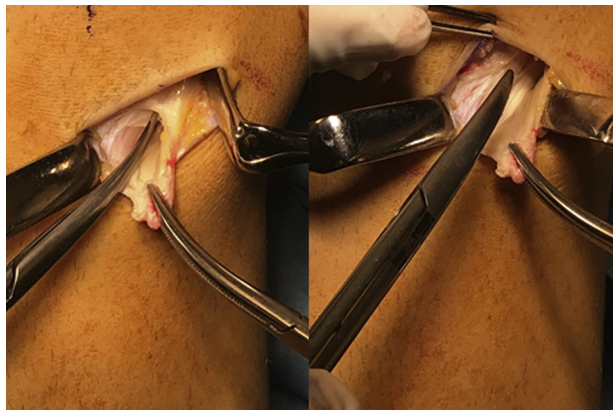

Fig 3. The elevation of the sartorius fascia.

opened, and the 2.4-mm guide pin is inserted. Then the knee is flexed to 120°. The guide pin is advanced through the center of the intended femoral tunnel and lateral cortex. A 20-mm femoral socket, the same diameter as the quadrupled graft, is created using FlipCutter (Arthrex). A looped suture is loaded to the end of the guide pin and passed intra-articularly from the tunnel (Fig 5).

Next, the tibial footprint of the ACL is identified and removed. The tibial guide is inserted and positioned either over the center of the tibial footprint of ACL, just anterior to the medial eminence, or along a line extended from the posterior border of the anterior horn of the lateral meniscus and fixed. The extra-articular end of the tibial guide is placed over the point between the tibial tubercle and the medial cortex of tibia.[13] The total length of tibial tunnel is measured off the guide. A minimum of 40 mm is required for a standard 270-mm graft to allow for tensioning. The FlipCutter device with the same diameter as the quadrupled graft is advanced, and a 30-mm tibial tunnel is reamed (Fig 6). A looped TigerStick (Arthrex) is inserted into the joint through the tibia to be used as a graft-passing suture.

The total length of tibial and femoral tunnels and intra-articular distance should be 10 mm longer than the quadrupled graft to avoid "bottoming out" of the graft. The length of the femoral and tibial tunnels should be 20 and 30 mm, respectively, and the intra-

Fig 4. (Left) Graft harvesting. (Right) The quadrupled semitendinosus graft for all-inside ACL reconstruction.

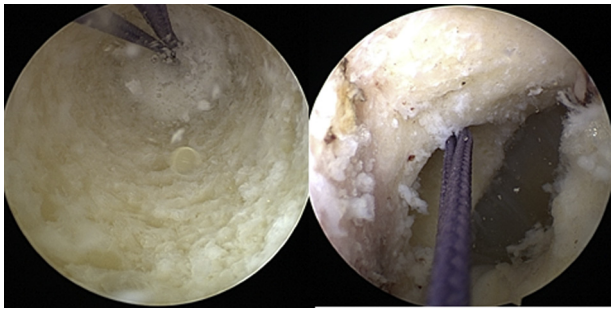

Fig 5. (Left) Femoral tunnel view through the far anterolateral portal. (Right) Femoral tunnel through the anterolateral portal.

articular portion of the graft is considered to be 30 mm. Both ends of the graft are identified with a marking pen at 20 mm, which will guide us as the graft passes through its the femoral and tibial sockets.

The femoral end of the graft is passed, and the fixed-looped button system is fixed on the lateral femoral cortex. Next the tibial end is passed using the adjustable-loop cortical device and tightened over the cortex using the white tensioning sutures attached to it. After tensioning, we examine the graft with probe for tightness. The flexion-extension cycle is repeated 150 times, and the graft is examined for tightness again (Fig 7).

Discussion

The advantages of all-inside ACL reconstruction are that it enables a much smaller incision on the tibia[9,13,14] and smaller tunnels are used that help maintain bone stock in the postoperative period and for multiligament reconstructions. Preserving the periosteum also causes less pain in the postoperative period.[12,15] In addition, a single semitendinosus graft is sufficient in most cases.[12,16] Preserving the gracilis tendon helps maintain knee flexion strength.[12,17] This is important in knee stability in terms of return to sports and achieving the same level before injury.[11,16]

In a recent meta-analysis study comparing suspensory and aperture fixation techniques, suspensory fixation was found to be superior in terms of side-to-side difference and graft ruptures postoperatively. Our technique aims to have a greater tightness than the classical suspensory technique in that we replaced the cortical suspensory device with a fixed-looped button system. Our result indicates that this is possible to achieve with a fixed loop that does not allow loosening.

Tensioning the graft during ACL reconstruction is paramount. Some studies have suggested that the type of preferred surgical technique affected the tension of the graft.[10,18] The aim of this Technical Note was to search for a solution for the graft tensioning problem. The surgical steps of the all-inside ACL reconstruction are performed as Blackman and Stuart described.[12]

Adjustable-loop cortical suspensory fixation devices enable surgeons to place the desired graft length into the tunnels. However, due to the adjustable-loop property of these devices, after tightening of the graft and cyclic loading of the graft, the possibility of loop lengthening becomes an issue. Several studies on lengthening of the adjustable-loop systems were reported.[10,11,18]

The length and size of the graft should be meticulously adjusted intraoperatively. Any mistake during sizing of the graft would change the tightness, especially if the graft is longer than the sum of the femoral and cortical tunnels and the intra-articular portion. The limitation of our technique is that the tightness of the graft can only be adjusted on the tibial side since we use RetroButton on the femoral side (Table 1).

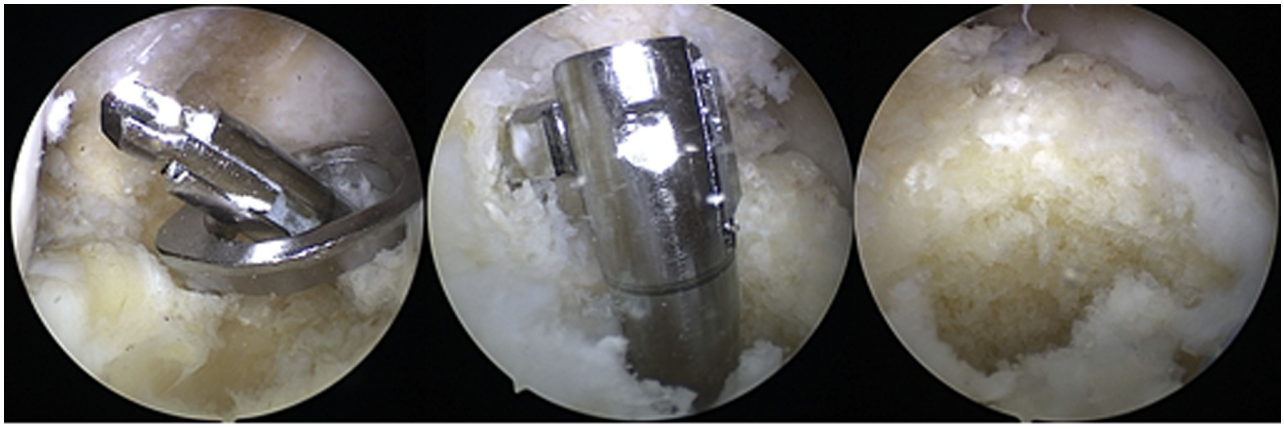

Fig 6. (Left) The introduction of Flip-Cutter into the joint through the tibial insertion of the ACL. (Middle) Opening of the Flip-Cutter and retrograde drilling of tibial tunnel. (Right) The view of the tibial tunnel through the anterolateral portal.

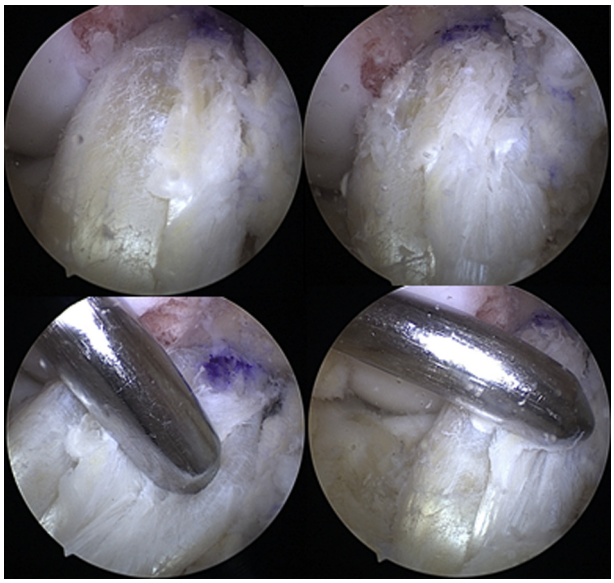

Fig 7. (Upper left) ACL graft after initial tightening. (Upper right) ACL graft after 150 cycles of flexion and extension. (Bottom left) Examination after after initial tightening. (Bottom right) Examination after 150 cycles of flexion and extension.

The all-inside technique offers the ability to obtain a large-size graft using only semitendinosus tendon compared with using semitendinosus and gracilis tendons in other techniques. In one study, the mean diameter of the semitendinosus-only grafts was found to be 8.6 mm.[16] It also allows smaller incision, better cosmesis, and preservation of bone stock for any revision or multiligament rupture surgery. To prevent graft loosening in the adjustable-loop cortical suspensory system, both the femoral and tibial side could be sutured over the cortex or the femoral side could be replaced with a fixed loop.

One limitation of this technique note is the possibility of error in adjusting the tunnel and graft length during graft tensioning due to only 1 suspensory fixation device usage. Future studies with larger series are necessary to find a solution for the graft loosening problem in the suspensory fixation technique (Table 2).

Table 1. Pearls and Pitfalls

Pearls	Pitfalls
History, mechanism of injury, age, preoperative physical examination findings, and imaging of the knee joint are important.	The measurement of the total tunnel length, which comprised femoral tunnel, intraarticular distance, and tibial tunnel should be meticulously performed during the surgery. Since femoral side is fixed and could not be adjusted once it is placed over the lateral femoral cortex, the graft could only be tightened on the tibial side. This may not be able to avoid buttoming-out of the graft in cases of miscalculation of the total tunnel length.
Extreme care should be taken when harvesting and preparing grafts.	
A single tendon is generally sufficient; therefore, a second tendon should be secured during harvesting.	
Footprints are important landmarks on each side.	
Tunnel positions should be checked using C-arm intraoperatively.	

Table 2. Advantages and Disadvantages

Advantages	Disadvantages
Reduces graft loosening problem.	Difficulty during initial femoral tunnel advancement of the RetroButton.
Low rates of rerupture are expected.	

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