Technical Note

All-Inside Arthroscopic Anterior Cruciate Ligament Reconstruction and Internal Brace With Recycling Suture

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Abstract: Anterior cruciate ligament (ACL) rupture is a common injury of the knee. Arthroscopic ACL reconstruction is a standard treatment for this condition. All-inside ACL reconstruction has many advantages compared with conventional techniques. However, there are still concerns regarding graft elongation and stability with all-inside ACL reconstruction. Here, we propose an arthroscopic technique using the shortening strands of a flexible suspensory button as an internal brace. This method provides the advantages of increased stability and ACL graft protection while using the same implant as the all-inside ACL reconstruction technique.

Anterior cruciate ligament (ACL) rupture is one of the most common sports injuries. The standard treatment is ACL reconstruction, which can prevent further damage to the cartilage and meniscus. In addition, this may help the patient return to their previous sports activities.

Anterior cruciate reconstruction is an effective treatment for patients who sustain an ACL injury. There are 2 surgical techniques that are widely used: conventional ACL reconstruction (open socket) and all-inside ACL reconstruction (AI ACLR, closed socket).[1-4]

AI ACLR has the advantages of bone preservation, retensioning the ACL graft, use in skeletally immature patients, use of only a single hamstring tendon in the graft, and no complications associated with screws. However, there are some concerns about AI ACLR, including graft elongation from suspensory cortex fixation and the stability of fixation.[5-7] There are techniques that use high-strength sutures to increase the strength of ACL grafts and protect them during the ligamentization period of the graft, such as fiber tape augmentation and internal suture augmentation techniques.[8-10] Here, we propose an AI ACLR technique that uses the shortening limbs from an ACL TightRope (Arthrex, Naples, FL) adjustable button as the internal brace to prevent graft elongation and protect the graft without using additional sutures.

Surgical Technique (With Video Illustration)

Patient Setup

After regional anesthesia with spinal nerve block, the patient is placed in the supine position. A lateral post is placed proximal to the knee at the level of the tourniquet, and a foot roll is placed to keep the knee flexed to approximately 90°. A tourniquet is applied on the operative thigh. The knee is then checked for full range of motion and confirmed to be stable on the foot roll at 90° of flexion.

Graft Harvest

A 3-cm longitudinal skin incision is made 2 fingerbreadths below the anteromedial joint line. The superior border of the pes anserinus is identified and separated from the medial collateral ligament with blunt dissection. The semitendinosus tendon is identified and

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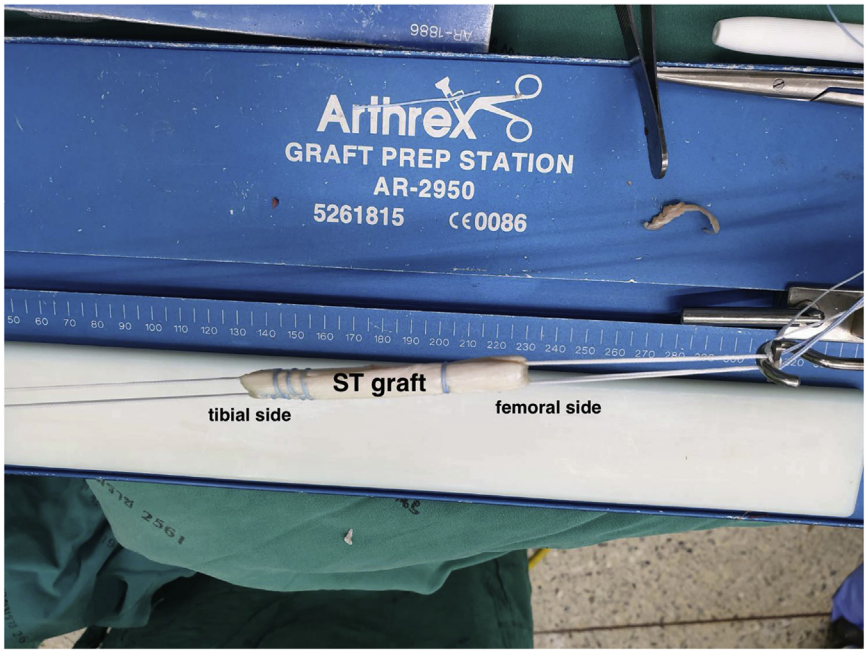

Fig 1. Graft preparation for all-inside ACL reconstruction and internal bracing with semitendinosus graft. The graft is prepared to approximately 6.5 cm in length with the femoral side attached to a TightRope RT (Arthrex), which has a cortical button, and the tibial side is attached to a TightRope ABS (Arthrex), which does not include a cortical button. (ACL, anterior cruciate ligament; ST, semitendinosus.)

stripped from the tibia by pulling with a right-angle clamp. The graft is then harvested with a closed-ended tendon stripper, and a double-looped ACL graft of approximately 6.5 cm in length is prepared. The ACL TightRope RT (Arthrex), which contains a cortical button, is attached to the femoral end of the graft, and an ACL TightRope ABS (Arthrex), without a cortical button, is attached to the tibial end of the graft (Fig 1).

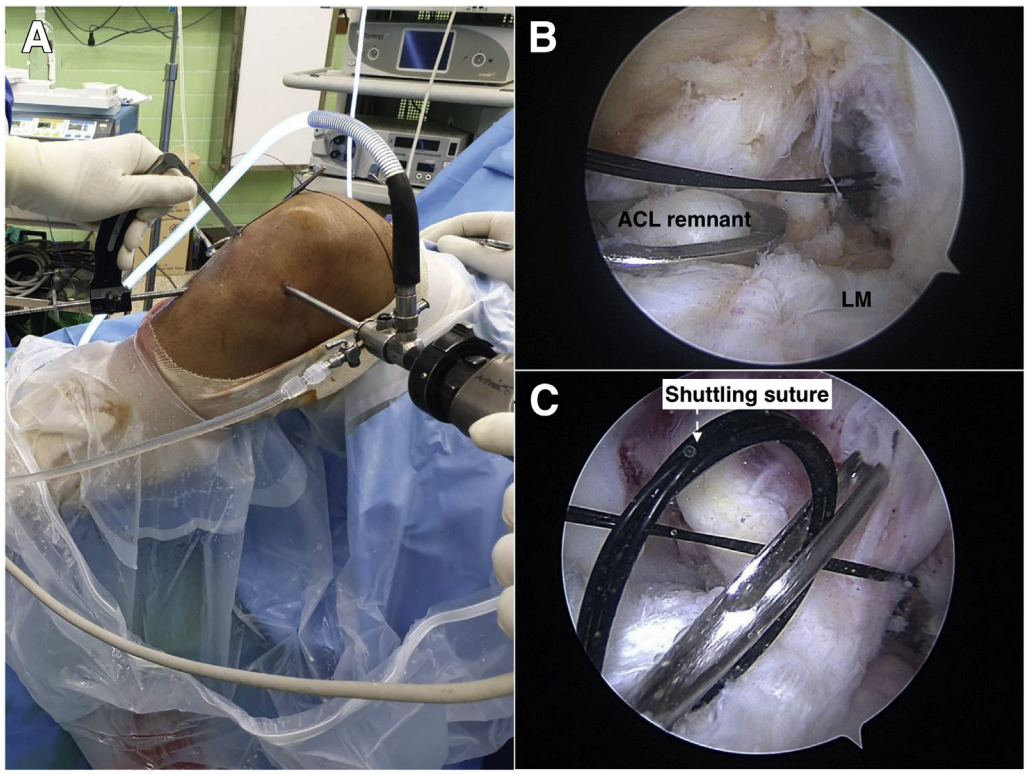

Fig 2. The method of tibial tunnel preparation for all-inside ACL reconstruction and internal bracing of the left knee. (A) Retrograde reaming with a FlipCutter (Arthrex). The reaming length should be less than the overall tibial tunnel length measured. (B) Arthroscopic viewing from anterolateral portal of the left knee. The tibial aiming device is placed anterior to the posterior border of the anterior horn of the lateral meniscus. (C) Two shuttle sutures are passed through the tibial tunnel with the lower end of the Beath pin and retrieve together with femoral shuttle sutures through the anteromedial portal. (ACL, anterior cruciate ligament; LM, lateral meniscus.)

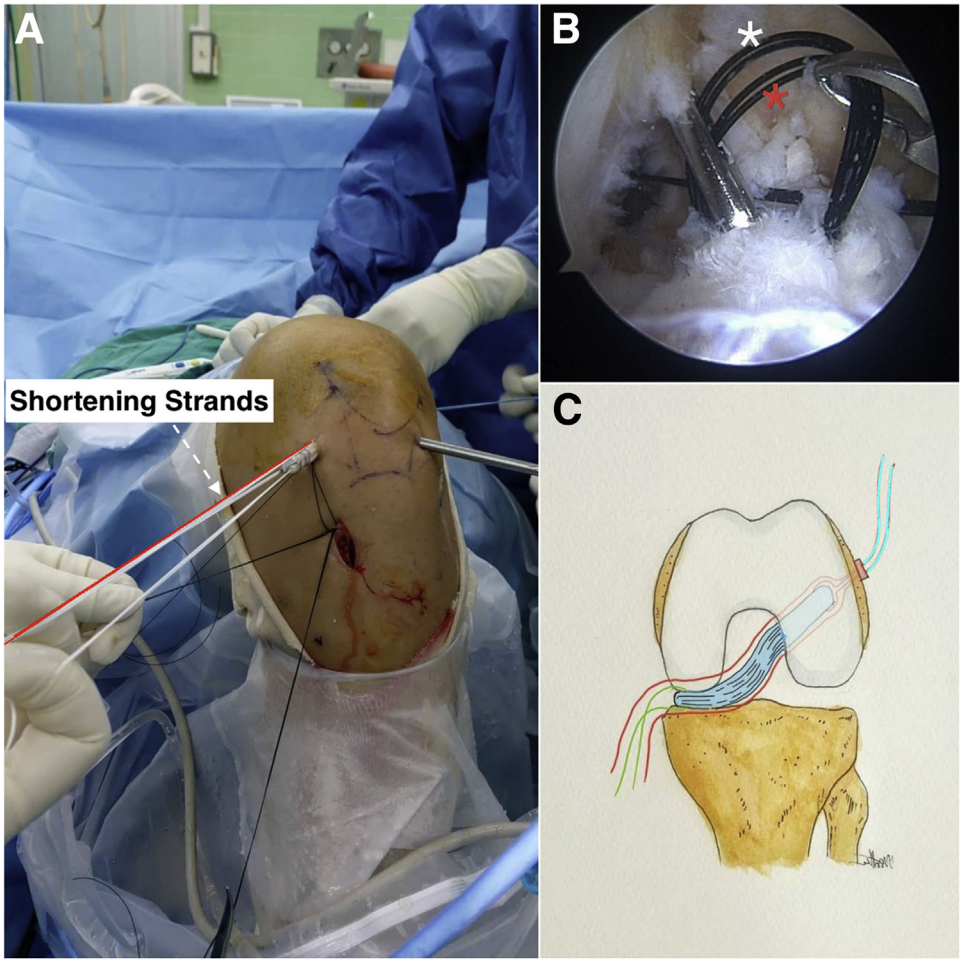

Fig 3. Graft passage for all-inside ACL reconstruction and internal bracing of the left knee. (A) The ACL graft is passed through the femoral socket first, and then the shortening strands (red line) of the TightRope (Arthrex) are alternately pulled to seat the graft in the femoral socket. (B) The loop marked by the white star shuttles the ACL graft through the tibial socket, and the loop markes by the red star shuttled the shortening strands from the femoral TightRope (Arthrex) through the tibial socket. (C) Illustrated drawing showing graft passage step. The red line represents the shortening strand sutures of the TightRope. (ACL, anterior cruciate ligament.)

Portal Creation

Standard anterolateral and anteromedial portals are created. Arthroscopic examination is performed through the anterolateral portal.

Tunnel Creation

Any associated meniscal lesions are treated as indicated. An arthroscopic shaver is then used to remove the ACL remnant from its femoral attachment, but it is preserved at the tibial attachment. The starting point of the femoral tunnel is marked with a 60° microfracture awl. The starting point is checked by switching the arthroscope to the anteromedial portal for better visualization of the femoral tunnel location.

The 8-mm transportal offset guide (Arthrex) is placed at the femoral footprint via the anteromedial portal while the knee is held in full flexion. The femoral tunnel is then created by antegrade drilling a guidewire and then reaming a tunnel over the guidewire of at least 20 mm in length. The reamer size used is equal to the diameter of the graft. A shuttle suture is passed through the femoral tunnel. A Tibial ACL Marking Hook (Arthrex) is then positioned at the ACL footprint adjacent to the anterior horn of the lateral meniscus within the ACL tibial remnant, and the length of the tibial tunnel is measured. The tibial socket is then created by drilling a guide wire antegrade through the tibia. Retrograde reaming is then performed using a FlipCutter (Arthrex) with an osseous socket at least 25 mm in depth. Meticulous reaming is suggested during this step to avoid fracture of the anterior tibial cortex. The soft tissue around the tibial socket is removed with an arthroscopic shaver to ease ACL graft passage (Fig 2).

Graft Passage

A Beath pin loaded with 2 shuttle sutures is passed into the tibial tunnel. One shuttle suture from the femoral tunnel and one shuttle suture from the tibial tunnel are then retrieved through the anteromedial portal simultaneously to prevent tissue interposition. The graft is passed into the joint via the anteromedial portal with the femoral shuttle suture, the femoral ACL TightRope RT (Arthrex) is drawn into the femoral tunnel, and the button is then flipped on the femoral cortex. The shortening strands of the TightRope are alternately

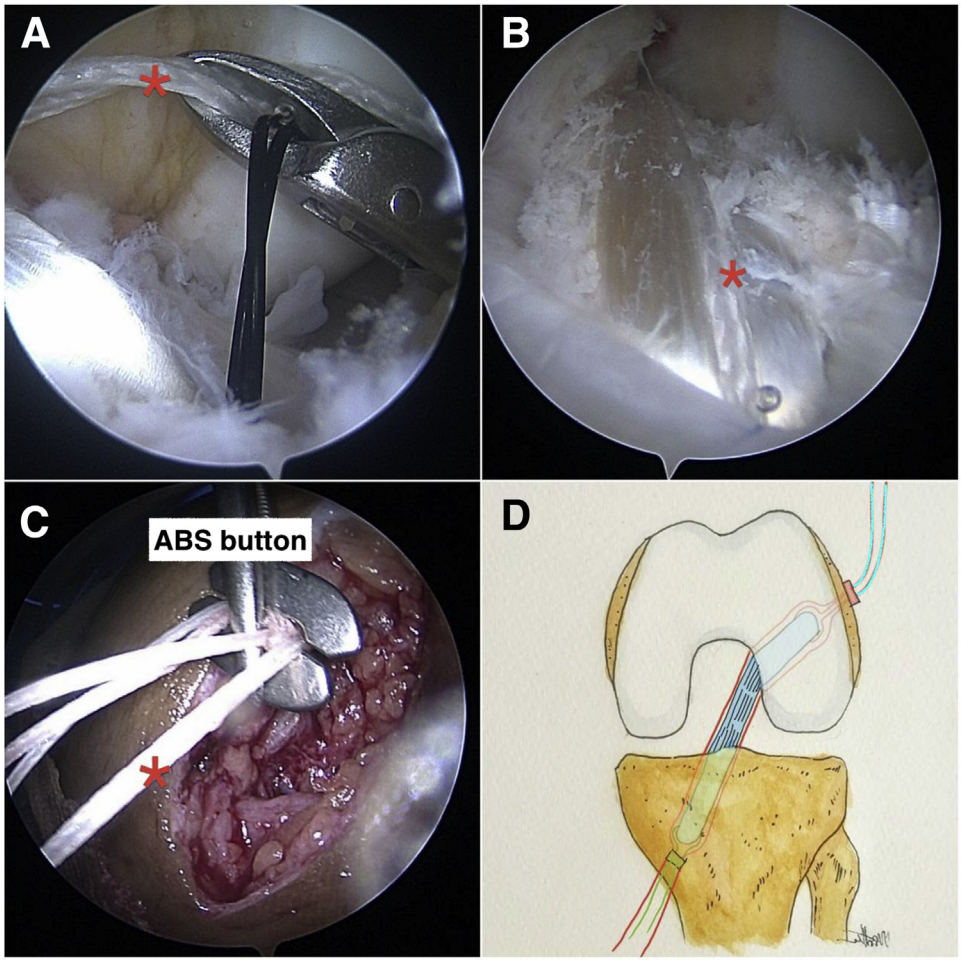

Fig 4. The arthroscopic views and illustrated drawing from a patient who underwent all-inside ACL reconstruction and internal bracing of the left knee. (A) Retrieving the shortening strand (red star) sutures attached to the femoral TightRope (Arthrex) with the shuttle suture through the anteromedial portal. (B) The shortening strands (FiberWire) act as an internal brace-to protect the ACL graft. (C) An ABS button (Arthrex) is placed at the tibial cortex. The ACL graft is tensioned first, and then a knot is tied with the shortening strand sutures (red star) with optimal tension. (D) Illustrate drawing shown the finished construct. The red line represents the shortening strand sutures. (ACL, anterior cruciate ligament.)

pulled until the ACL graft is fully seated in the femoral socket (Fig 3). The tibial TightRope limbs are then loaded into one of the tibial shuttle sutures, which is pulled to draw them through the tibial tunnel. An ABS button (Arthrex) is then attached to the tibial TightRope. The shortening strands of the tibial TightRope are then alternately pulled to seat the graft in the socket. The other shuttle suture from the tibia is then used to retrieve the shortening strands of the femoral TightRope through the tibial tunnel. These shortening strands are then attached to the ABS button. Cyclic loading by repeated flexion and extension of the knee is performed for pretensioning of the ACL graft. Final tensioning is performed at approximately 30° of knee flexion. Tensioning of the tibial TightRope is performed first, and then a knot is tied with the shortening strands of the femoral TightRope on the ABS button to complete the internal brace (Fig 4 and Video 1). A postoperative radiograph is performed after the operation (Fig 5).

Postoperative Protocol

Patients without cartilage or meniscus pathology are allowed to weight bear as tolerated on the first postoperative day without a knee brace. Range of motion exercises and isometric strengthening exercises are started when postoperative pain is controlled. The goal at the second postoperative week is to obtain passive range of motion from 0 to 90°. At 2 months postoperatively, patients are allowed to run and cycle. Patients start sports-specific training at 4 to 6 months postoperatively and can return to previous sports activity at 8 months postoperatively.

Advantages/disadvantages, pearls/pitfalls, and indications for the procedure are further described in Table 1.

Discussion

Arthroscopic ACL reconstruction is a standard treatment for ACL injury. The results of all-inside ACLR have not been reported as being different from those using a conventional technique in terms of stability, rate of return to sports, or failure rate. The advantages of AI ACLR are bone preservation, ease of revision surgery, ability to retension the graft, its ability to be used in small diameter or attenuated graft,[11] and the ability to perform the

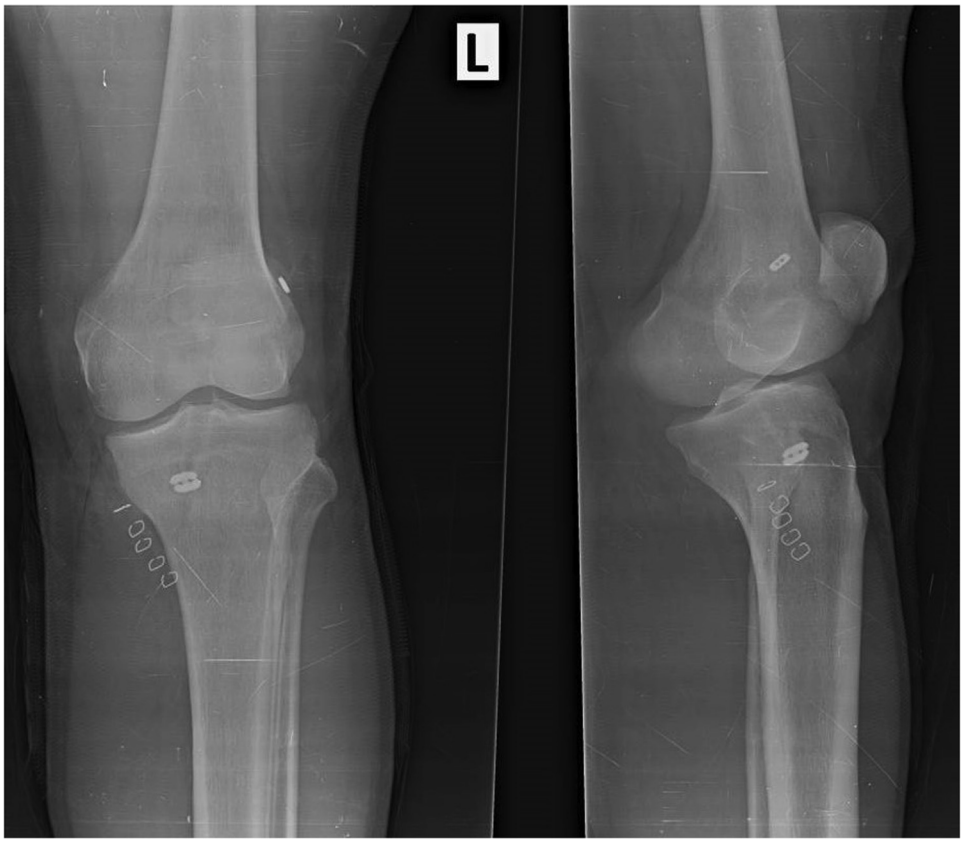

Fig 5. Postoperative radiograph of the left knee following ACL reconstruction and internal bracing with shortening strands from the TightRope (Arthrex). (ACL, anterior cruciate ligament.)

Table 1. Advantages/Disadvantages, Pearls/Pitfalls, and Indications for the Procedure

Advantages
Bone preservation technique
Ability to retension the graft
Protects ACL graft during healing process
Prevent graft elongation
Better cosmetic appearance with small incisions
Cost saving
Disadvantages
Special equipment is required
Arthroscopic skill is needed
Pearls
Prepare a short ACL graft of not more than 6.5 cm in length and trim both ends to a smooth cylinder to make the graft passage into the tibial tunnel easier
Slightly over-ream the femoral and tibial tunnel to allow space to retension the graft
Remove soft tissue at the tibial socket before graft passage
Retrieve the shuttle sutures together through the anteromedial portal before passing the ACL graft through the AM portal to prevent soft-tissue interposition
Pitfalls
If the graft is too long, it will bottom out in the tibial socket
Do not overtighten the internal brace
Do not entangle the shuttle sutures and TightRope limbs
Indications
Acute ACL injury with open physes
ACL injury with small and short graft

ACL, anterior cruciate ligament; AM, anteromedial.

surgery in skeletally immature patients. There are still some concerns in AI ACLR, such as graft elongation and fixation stability.[3-7]

In the previous literature, internal brace augmentation was performed by using FiberTape (Arthrex) to protect the ACL graft and could augment the graft with biologic tissue such as amnion, or bone marrow concentrate.[8-10,12,13] However, in a cadaveric study, Lai et al.[14] showed that suture augmentation also improved the ultimate load to failure and cyclic displacement in ACL grafts. There was also a surgical technique using multiple suture strands to augment ACL which was reported by Kuptniratsaikul et al.[15] The suture acts as a structural tie before fully ligamentization of the ACL.

The advantages of this procedure allow for early range of motion and weight-bearing to regain normal activity. Our proposed surgical technique uses the shortening strands of the ACL TightRope that are normally removed for use as an internal brace augmentation to protect the ACL graft and prevent graft elongation during the remodeling process.

To our current knowledge, there are no studies about the long-term outcomes of internal bracing in terms of the rerupture rate, graft ligamentization, tunnel widening, or revision rate. We believe that our technique with suture augmentation can stabilize the ACL

graft to prevent elongation. This technique also may help in patients with a short graft that need extra stability without the addition of other materials.

Acknowledgments

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