Technical Note

Quadrupled Semitendinosus ACL Reconstruction Combining Cortical Button in Femur and Interference Screw in Tibia

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Abstract: Anterior cruciate ligament (ACL) reconstruction with hamstring tendons has gained popularity in the past and is the most used type of graft in several national registries. It usually involves the harvest of both gracilis and semitendinosus tendons from the ipsilateral knee. More recently, the use of only 1 of the tendons (semitendinosus) in a tripled or quadrupled arrangement has been described, especially in an all-inside type of reconstruction. Having a thicker tendon with a quadrupled semitendinosus (ST), instead of double gracilis and ST enables to a have a graft with enough diameter to resemble more closely the native ACL and decreases the risk of graft rerupture. This Technical Note aims to present a way of reconstructing the ACL using a quadrupled ST graft, with suspensory cortical button in femur and interference screw in tibia, as an alternative to the all-inside technique.

National registries show that hamstring autograft is the leading type of graft used in anterior cruciate ligament (ACL) reconstruction surgery worldwide. When combining the 101,125 patients from Denmark, Luxembourg, Norway, Sweden, UK, and US registries, hamstrings represent the graft of choice in 67.9%. It leads in all registries except for Luxembourg (n = 300) were comes second after patellar tendon and in the United States (n = 28,055) were comes second after allografts.[1]

Hamstrings is usually a synonym of using both gracilis and semitendinosus (ST) tendons in a double arrangement. However, different type of tendon combinations and arrangements have been used and described.[2] Quadrupled ST has been described, especially for an all-inside technique with cortical button fixation in femur and tibia.[3] Sparing the use of gracilis tendon could theoretically have the advantage of compromising less the deep flexion strength of the knee. As a consequence, this could represent faster recovery and better chances of returning to play sport at the same level.

In the other hand, the ST tendon has a larger diameter than the gracilis. Having a quadrupled ST creates a higher diameter graft than a doubled ST-gracilis construct. Nuelle et al.[4] found in their study that a diameter of at least 8 mm in more than 95% of quadrupled ST grafts on 60 patients. This is particularly important because hamstrings graft size has been identified as a risk for rerupture when diameter is less than 8 mm.[5,6] As a result, aiming for quadrupled ST can also decrease the risk of failure.

In a biomechanical cadaveric study, 15 pairs of knees were tested for tensile failure. The quadrupled ST showed a significantly higher maximum load at failure, compared with patellar tendon, quadrupled gracilis, and both hamstring tendons.[7]

The purpose of this study is to present a Technical Note for the ACL reconstruction with a quadrupled ST fixed in femur with a loop cortical device and in tibia with an interference screw.

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The authors report that they have no conflicts of interest in the authorship and publication of this article. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

Received June 25, 2019; accepted August 18, 2019.

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2212-6287/19809

https://doi.org/10.1016/j.eats.2019.08.011

This study was conducted in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans. The institutional review board of the institution approved this study.

Technique

Patient Positioning

The surgery is performed under general or regional anesthesia, without tourniquet, in the supine position. The patient is prepared and draped in the usual sterile fashion.

Surgical Approach and Harvest

For the knee scope, standard anterolateral and anteromedial portals are made. There are important anatomical landmarks for the ST autograft harvest. First, the tibial tubercle and the posteromedial cortex of the proximal tibia should be identified. In a midpoint between these 2 landmarks can usually be found and the pes anserinus palpated under the skin. The incision should be made from this midpoint directed downward, longitudinally, and between 3 and 5 cm (Fig 1). This is followed by hemostasis and dissection of soft tissues until the pes anserinus can be exposed and visualized.

Next, the distal pes anserinus is lifted with an "L"-shape incision (Fig 2), dissecting first the superficial sartorial fascia that covers the tendons (Fig 3). Try to avoid going deep into the superficial medial collateral ligament. As the ST tendon is detached from the bone, try to preserve the gracilis insertion as best as possible (Fig 4).

Find the division between the ST and gracilis. It is easier to identify their division from underneath (Fig 5). There is an overlap between them that can make it challenging. Once you split between them with scissors, pass Vicryl suture to the edge of the ST tendon (Fig 6). Then, find 1 or 2 attachments that the ST tendon might have to the medial gastrocnemius. Next, extract the tendon using a stripper. We use a closed stripper (Fig 7), but an open stripper would work fine as well.

It is very important to be patient in this last step of the harvest to avoid cutting the tendon too short. Advance slowly into the thigh while gently pulling the tendon until it is detached from the muscle. Sometimes this

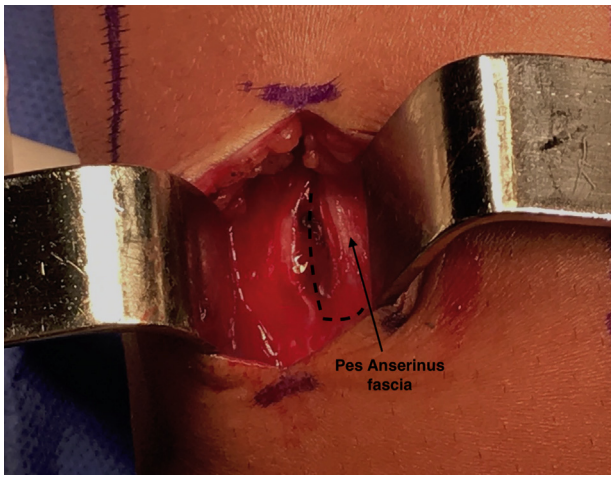

Fig 2. The dotted line shows the "L"-shaped incision over the sartorial superficial fascia. Supine position.

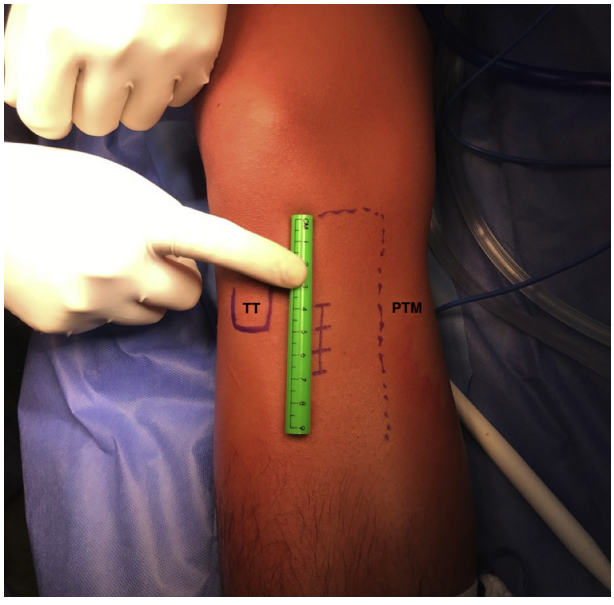

Fig 1. Surgical approach for harvesting the semitendinosus tendon between the tibial tuberosity and the posteromedial cortex of the tibia. Supine position. (PTM, posteromedial tibial cortex; TT, tibial tuberosity.)

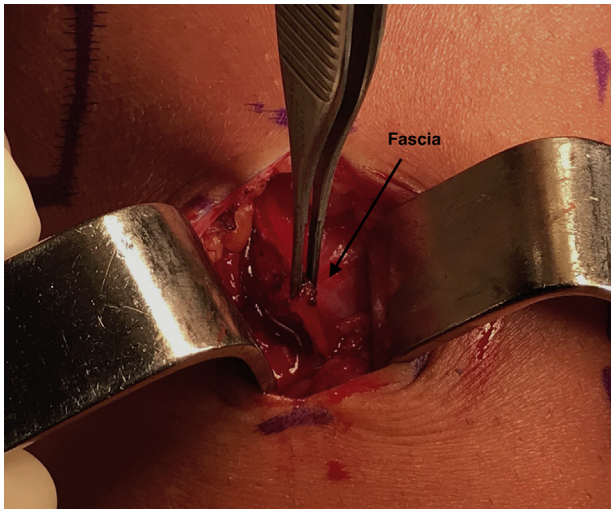

Fig 3. The fascia is lifted to expose the semitendinosus tendon. Supine position.

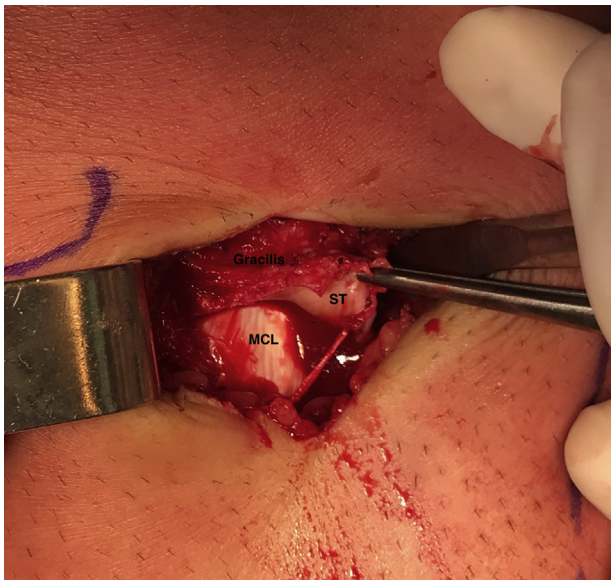

Fig 4. The semitendinosus tendon has been detached while keeping the insertion of the gracilis tendon. Under the pes anserinus, the medial collateral ligament is seen. Supine position. (MCL, superficial medial collateral ligament; ST, semitendinosus.)

may take 1 to 2 minutes, but it is essential to have a graft as long as possible.

Graft Preparation

The tendon is measured (Fig 8) and mixed with saline and vancomycin. Aim to have a tendon of at least 24 cm to quadruple it. Fold it twice (Fig 9) and hang it on the XO button fixed-length cortical device (ConMed, Utica, New York). You may use other brands. If you choose to use a fixed loop length button, the total length of the femoral tunnel has to be measured before deciding what loop length to use. Aim to have 15 mm of graft in the tunnel, then the length of your fixed length loop would be equal to the total femoral tunnel length minus 15 mm. Finally, add sutures to the end of the quadrupled tendon; it is then ready to be used as an ACL graft (Fig 10).

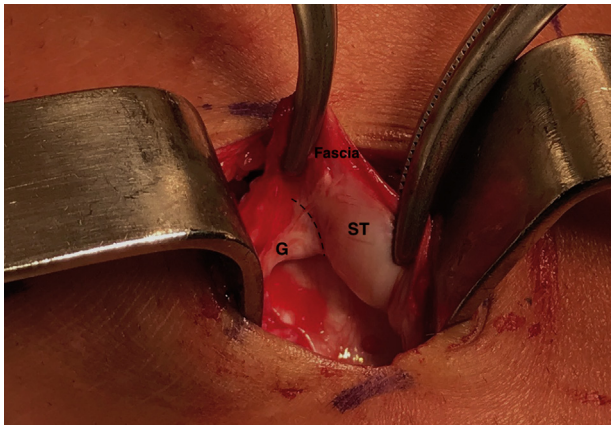

Fig 5. The dotted line shows the division between the gracilis and semitendinosus tendon, seen from underneath. Supine position. (G, gracilis; ST, semitendinosus.)

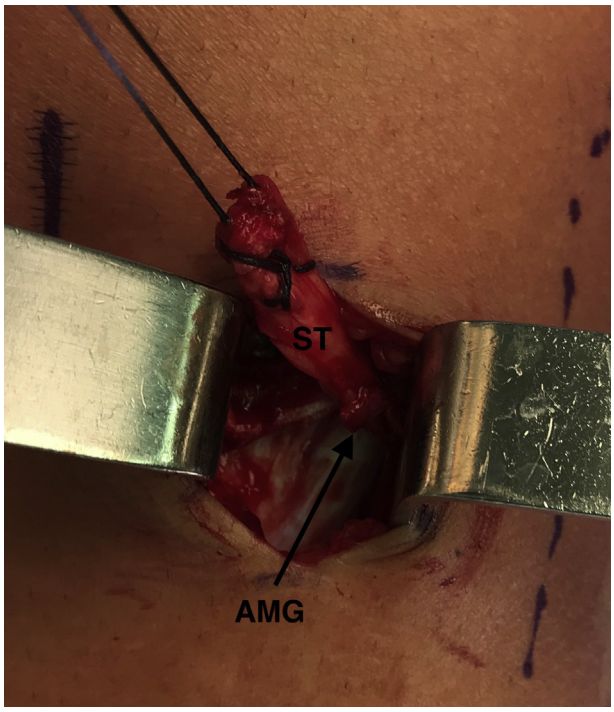

Fig 6. Traction sutures are placed in the edge of the semitendinosus tendon and attachments to the medial gastrocnemius are cut. Supine position. (AMG, attachments to the medial gastrocnemius; ST, semitendinosus.)

ACL Reconstruction

The femoral tunnel is drilled from the medial portal in a midpoint between the anteromedial and posterolateral bundle footprint. First, a 5-mm drill is used to pass across the lateral femoral cortex (Fig 11), then measure

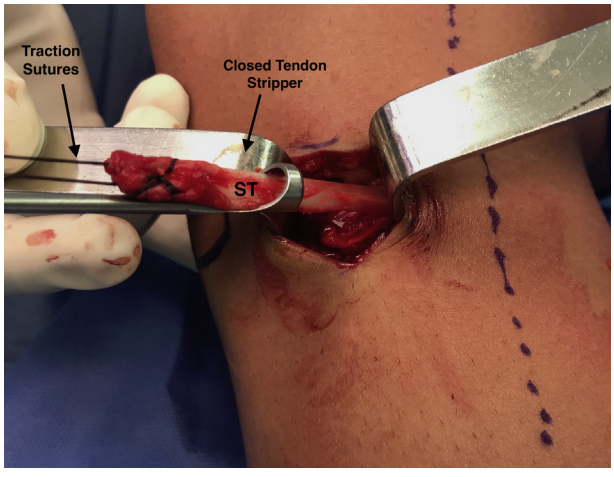

Fig 7. The closed tendon stripper is used to extract the ST from the muscle junction. Supine position. (ST, semitendinosus.)

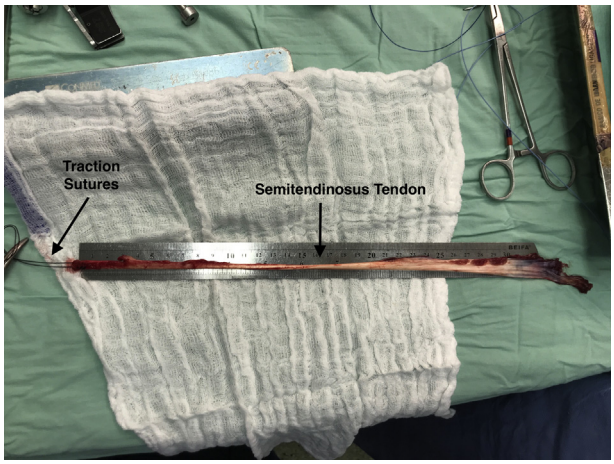

Fig 8. Semitendinosus graft of 30-cm-plus total length.

the length of the tunnel and decide the size of the fixed length loop button device (XO Button). An adjustable loop device can also be used. The second drill is only drilled 15 mm, which is the amount of graft to have inside the femoral tunnel (Fig 12).

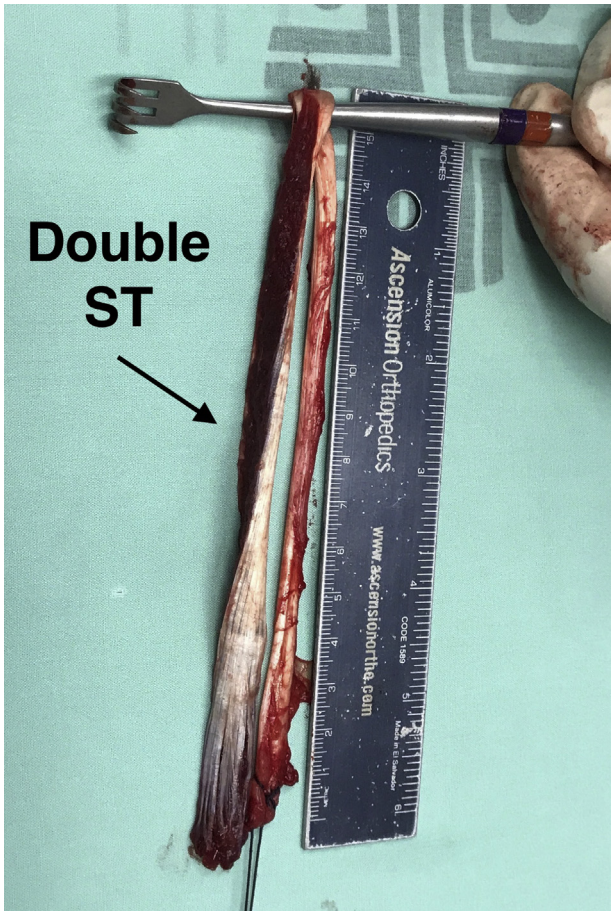

Fig 9. Showing the semitendinosus tendon folded once in a double configuration. It is then folded again to have a quadrupled graft. (ST, semitendinosus.)

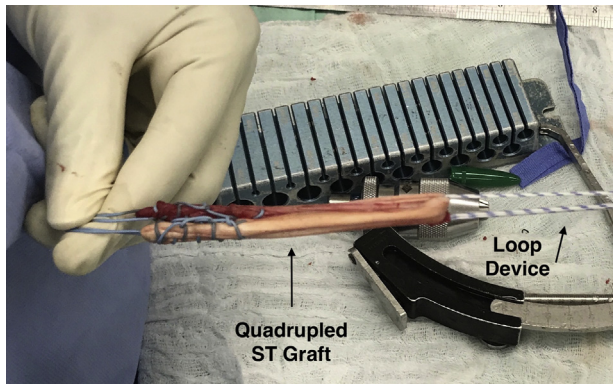

Fig 10. Semitendinosus tendon in a quadruple configuration in the loop device.

The tibial tunnel is drilled within the center of the native tibial ACL footprint using a drill of the same graft width (Fig 13). The guide of the tunnel is placed on a 45° angle to have a shorter tunnel. The graft will typically have 15 mm in the femoral tunnel, 20 mm intraarticular, and 25 mm or more in the tibial tunnel, depending on its final graft.

Most of the time, the graft will not protrude outside the tibial tunnel, but ensure it be seen inside the tunnel.

For the tibial fixation, a 35-mm BioScrew XtraLok (ConMed) 1 mm above the ACL graft diameter is used. The graft is fixed in 10° of knee flexion and neutral rotation. Figure 14 shows the notational guide next to the graft; Fig 15 shows the tibial fixation with this type of screw. Figure 16 shows the final configuration of the ACL reconstruction. Finally, use the tendon whipstitches to add a postfixation to the cortex or periosteum of the tibia. The complete technique can be seen in the Video.

Discussion

This technique has the main advantage of respecting the gracilis tendon anatomy and function, while using

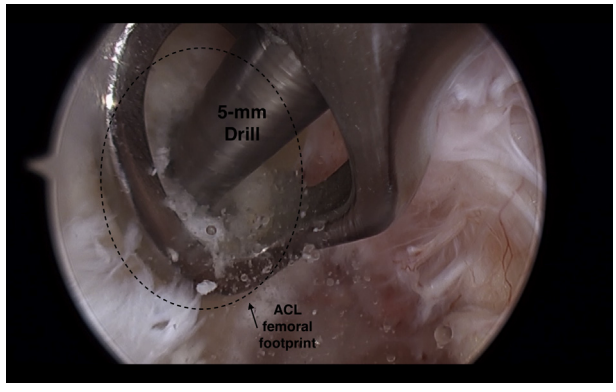

Fig 11. The femoral tunnel is drilled first with a 5-mm drill in the center of the anatomic femoral ACL footprint. Anterolateral portal view. (ACL, anterior cruciate ligament.)

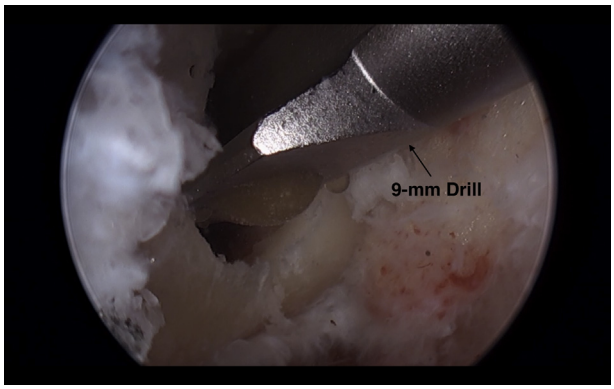

Fig 12. The second drill, of greater diameter, must match the graft diameter and should be drilled 15 mm of depth. Anterolateral portal view.

only the ST tendon. It also helps to obtain a thicker graft compared with a double gracilis-ST combination (Table 1). This thicker graft has less chance of tear and failure.[5,6]

Additionally, it is a less expensive technique than the all-inside technique. Cortical loop devices are more expensive than interference screws. Using 1 screw and 1 button reduces costs compared with 2 buttons.

Limitations of this technique include the amputation of the ST tendon or harvesting a ST shorter than 24 cm that would become a quadrupled graft shorter than 6 cm. This is probably too short to have enough fixation in the tibial tunnel with an interference screw. Also, when the graft is too short, the surgeon will not be able to see it in the tibial tunnel. To improve the tibial fixation in this case, add a post with the graft sutures in the edge of the tendon. These sutures can be fixed with a screw or passed through the tibial cortex as shown in the video.

Kouloumentas et al.[8] compared, in a randomized controlled trial, quadrupled ST graft in an all-inside technique against a traditional hamstrings technique with suspensory femoral fixation and tibial interference screw. The quadrupled ST had significantly better flexor isokinetic measurements. Further studies are needed to confirm if the theoretical advantages of leaving the gracilis tendon become in real advantages in muscle strength (knee flexion especially).

Additionally, it should be studied if this technique allows athletes to return to play faster or in a better level compared with when the 2 tendons are harvested. Finally, it would be important to correlate the diameter

Fig 13. The tibial guide is placed in the center of the tibial ACL footprint. Anterolateral portal view. (ACL, anterior cruciate ligament.)

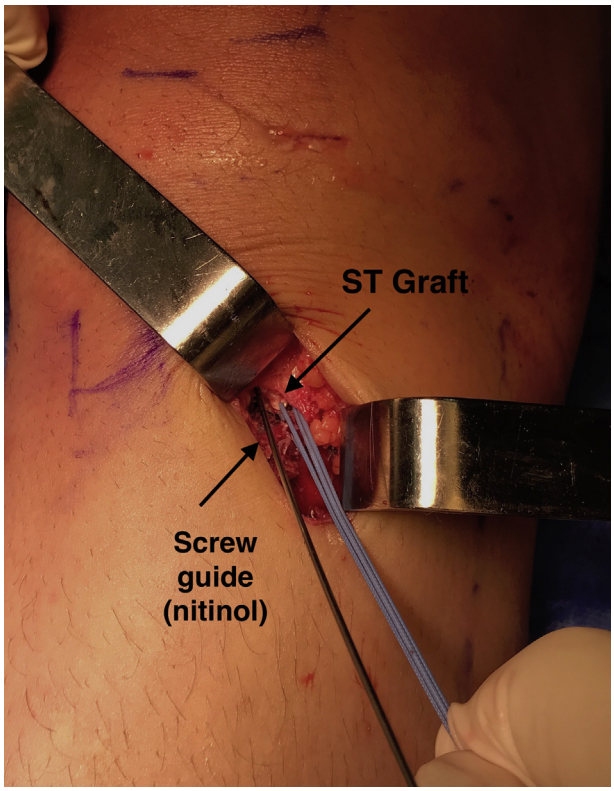

Fig 14. The nitinol guide is used to place the interference screw in the tibial tunnel. Supine position. (ST, semitendinosus.)

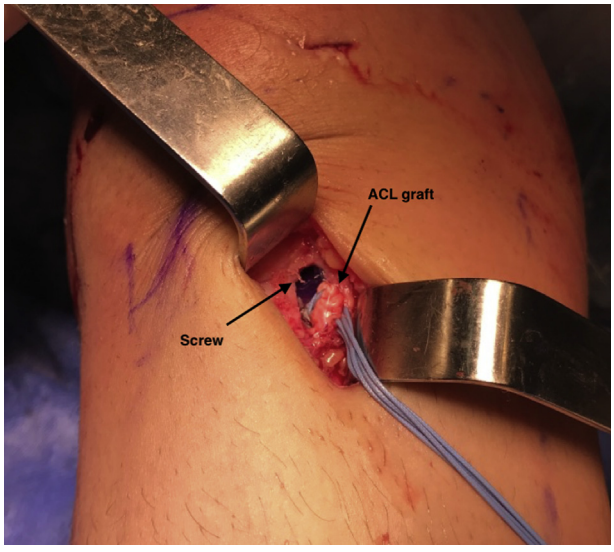

Fig 15. Depending on the final length of the graft, some of it might be visible outside the tibial tunnel. Supine position.

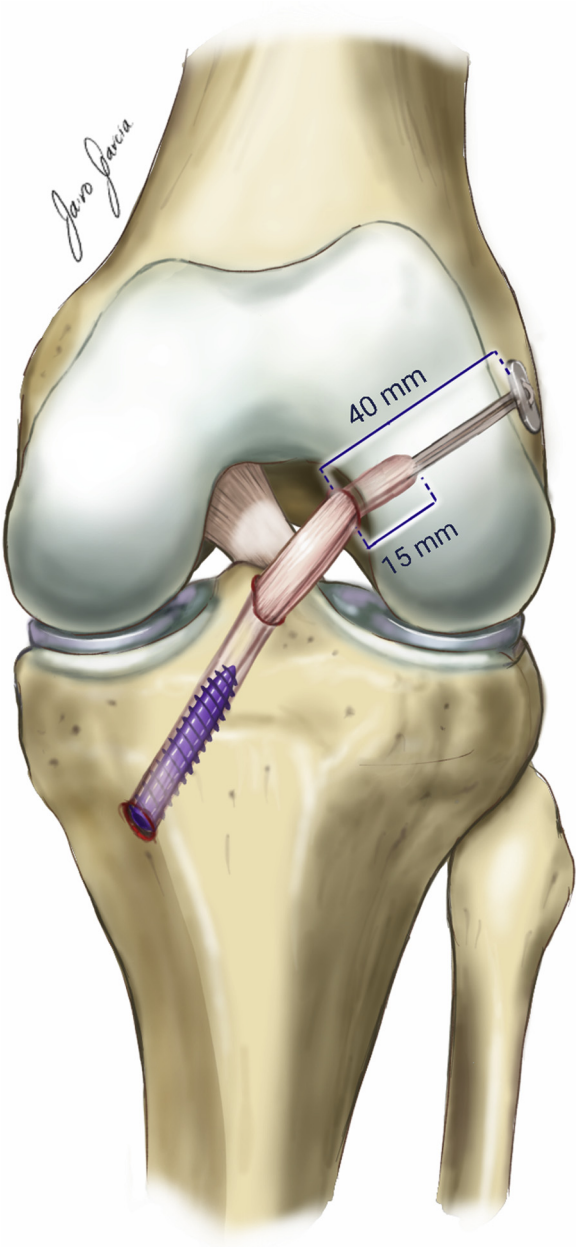

Fig 16. Final fixation of the graft with a cortical button in femur and interference screw in tibia. Anterior view of the knee.

of the graft and risk of rerupture compared with the traditional gracilis-ST technique.

Acknowledgment

The authors thank María Alejandra Muñoz, medical intern from Universidad Icesi, for helping with the narration of the video. Andres Parra, from the communications office at Fundación Valle del Lili for his help editing of the video.

Table 1. Advantages and Disadvantages of this Quadrupled ST ACL Reconstruction Technique

Advantages	Disadvantages
1. Only uses 1 tendon (ST) while leaving the gracilis almost intact.	1. ST tendons shorter than 24 cm may not be visible in the tibial tunnel.
2. Provides a greater diameter graft compared with double gracilis-ST graft.	2. The amount of tendon fixed in the tibial tunnel may be insufficient if the tendon is too short, in which case a post would have to be added.
3. Less expensive technique than an all-inside quadrupled ST reconstruction technique.	

ACL, anterior cruciate ligament; ST, semitendinosus.

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