

Technical Note

Combined Anterior Cruciate Ligament Primary Repair With an Autograft Reconstruction

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Abstract: Anterior cruciate ligament (ACL) reconstruction using an autograft gives good results that could provide improved failure rates. ACL augmentation saving the remnant has demonstrated advantages, such as saving vascular supply and nerve receptors, which could be useful for healing. Conversely, isolated repair techniques are gaining interest but do not give good results because structural augmentation is necessary to reinforce the repair and expect healing. We describe a technique combining the advantages of both techniques with an autograft using the semitendinosus and repair of the remnant. This combined technique allows protection and redirection of the remnant, improves graft incorporation, and covers more graft by suturing the remnant around an autologous graft.

One of the reasons for anterior cruciate ligament (ACL) reconstruction failure is a lack of graft incorporation.¹ ACL augmentation saving the remnant has demonstrated advantages, such as saving the vascular supply and nerve receptors.² However, with the inside-out femoral tunnel drilling technique, the drill can damage the remnant; furthermore, spontaneous healing of the proximal part of the rupture is outside the femoral ACL footprint. There is a trend to perform primary repair of proximal ACL tears with no additional structure bridging the rupture.³ But isolated ACL suture does not provide good results, and Murray⁴ has demonstrated the need to augment the ACL rupture and reinforce the repair to expect healing. The interest of this technique is to associate the strengths of the 2 techniques to protect and redirect the remnant, improve graft incorporation, and cover more graft suturing the remnant around an autologous graft.

Surgical Technique

This technique (Video 1) is based on the technique already published using the semitendinosus (ST) in four strands and suspensory fixation at femoral and tibial sides.⁵ Steps with pitfalls and tips are presented in Table 1. The first difference concerns the arthroscopic step. The remnant is assessed and classified depending on the aspect of its different parts: tibial insertion, mid-body, and femoral insertion of the native ACL. Depending on the visual aspect of the remnant and arthroscopic and vascular aspect, it was decided to save it and use it for associated repair.

First, the tibial tunnel is drilled in the middle of the ACL native tibial attachment. It is important to target the center of the tibial footprint. Then, the femoral extremity is detached either from the femur or from the posterior cruciate ligament using a Smillie meniscus knife (Fig 1). When the remnant is healed on the notch, little pieces of bone are harvested with the remnant to improve the mechanical property of the remnant's proximal extremity. Once the remnant is completely released from its proximal attachment, 2 sutures are passed through the anteromedial portal in the free proximal extremity using a knee Scorpion Suture passer (Arthrex) and 2 TigerLink sutures (Arthrex) (Fig 1). A suture relay is passed from the tibial tunnel to the anteromedial portal and the 2 TigerLink sutures are pulled into the tibial tunnel. The remnant free extremity is pulled into the proximal part of the tibial tunnel to open the notch space to perform the femoral tunnel and protect the remnant from the drill (Fig 2) because an in-out technique is used to perform the femoral tunnel.

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Table 1. Surgical Steps, Pearls, and Pitfalls

Surgical Steps	Pitfalls	Tips and Tricks
Remnant release	If the remnant is insufficiently detached, it is difficult to reorient the free part to correctly position it toward the entrance of the femoral tunnel.	Care must be taken to remove the remnant from the medial side of the lateral condyle and from its adhesions to the posterior cruciate ligament both on the side and behind. The curvature of Smillie chisel is particularly well suited for this operation.
Remnant suture	The remnant is sutured through the anteromedial instrumental portal. Soft tissue can remain between the TigerLink sutures and shuttle suture which can hinder their manipulation.	After making the anteromedial incision, the soft tissues along the entire path of the anteromedial instrumentation portal are cleaned with a shaver. This will allow the surgeon to insert the various instruments through the same passage. The use of untangling pliers inserted on the sutures coming out of this portal also helps avoid the synovial plicae.
Tibial tunnel drilling	If you drill the tibial tunnel after detaching the remnant, it may be difficult to drill the tibial tunnel in the center of the tibial ACL footprint. Moreover, while drilling, the graft can twist around the drill bit.	Once the decision to repair the ACL is made, the tibial tunnel must be immediately drilled before detaching the remnant. The residual ACL fibers are still taut, which makes drilling a lot easier. The drill bit can clearly be seen rotating inside the remnant without damaging it.
Notch vision	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 or the TigerLinks.	After passing 2 or 3 TigerLinks in the proximal end of the remnant, they are then introduced into the previously drilled tibial tunnel. A shuttle suture is used for this step. The remnant partially enters the tibial tunnel and the notch becomes visible.
Graft introduction	If the TigerLinks are not tight when the graft is introduced, they can get tangled with the graft and the Pullup, making the final tensioning step difficult.	After inserting the TigerLinks into the loops of the femoral Pullup, they must be slightly tensioned. A clamp is then placed 3 to 4 cm lower on the TigerLinks. The weight of the clamp exerts sufficient tension while allowing the graft and TigerLinks to ascend at the same time as the graft. This trick also allows the remnant to be attracted to the femoral tunnel by the graft during its ascent.

ACL, anterior cruciate ligament.

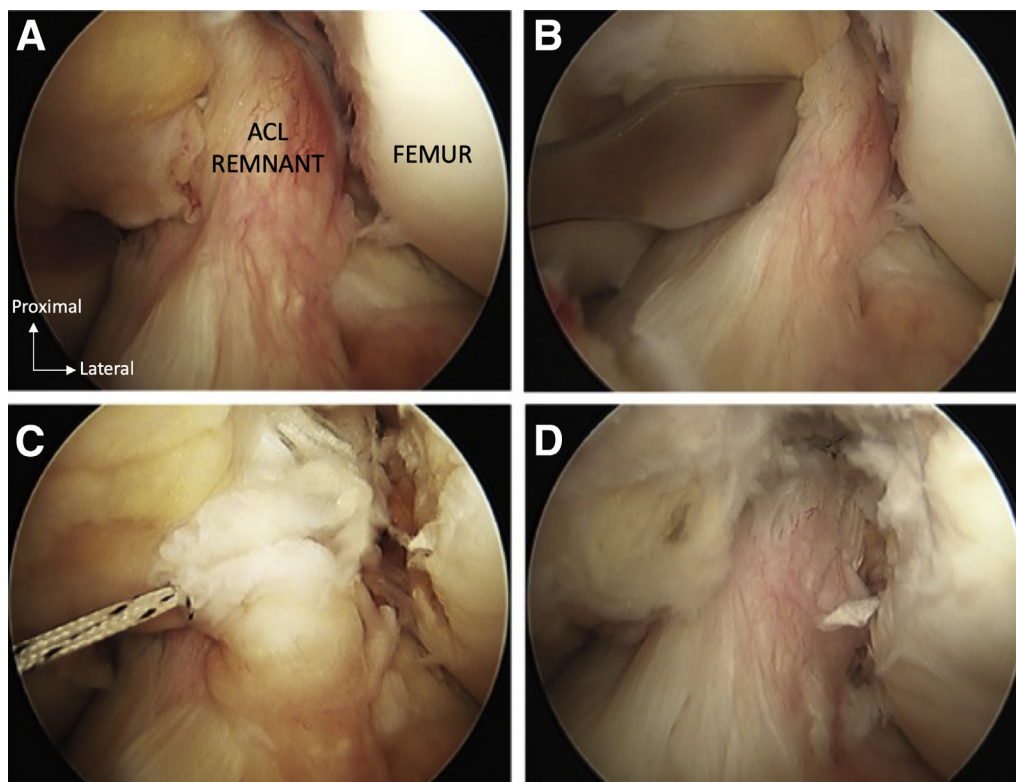


Fig 1. Arthroscopic views of the notch of a left knee reconstruction of the ACL with a view through an anterolateral portal with the 4-ST repair technique. (A) At the beginning of the surgery, rupture of the ACL is seen, with a remnant laying and healed on the posterior cruciate ligament. (B) The remnant is detached using a Smillie meniscus knife. (C) Two sutures are passed through the anteromedial portal in the free proximal extremity of the remnant. (D) Final view with the remnant raised along the graft to the femoral side. (ACL, anterior cruciate ligament; ST, semitendinosus.)

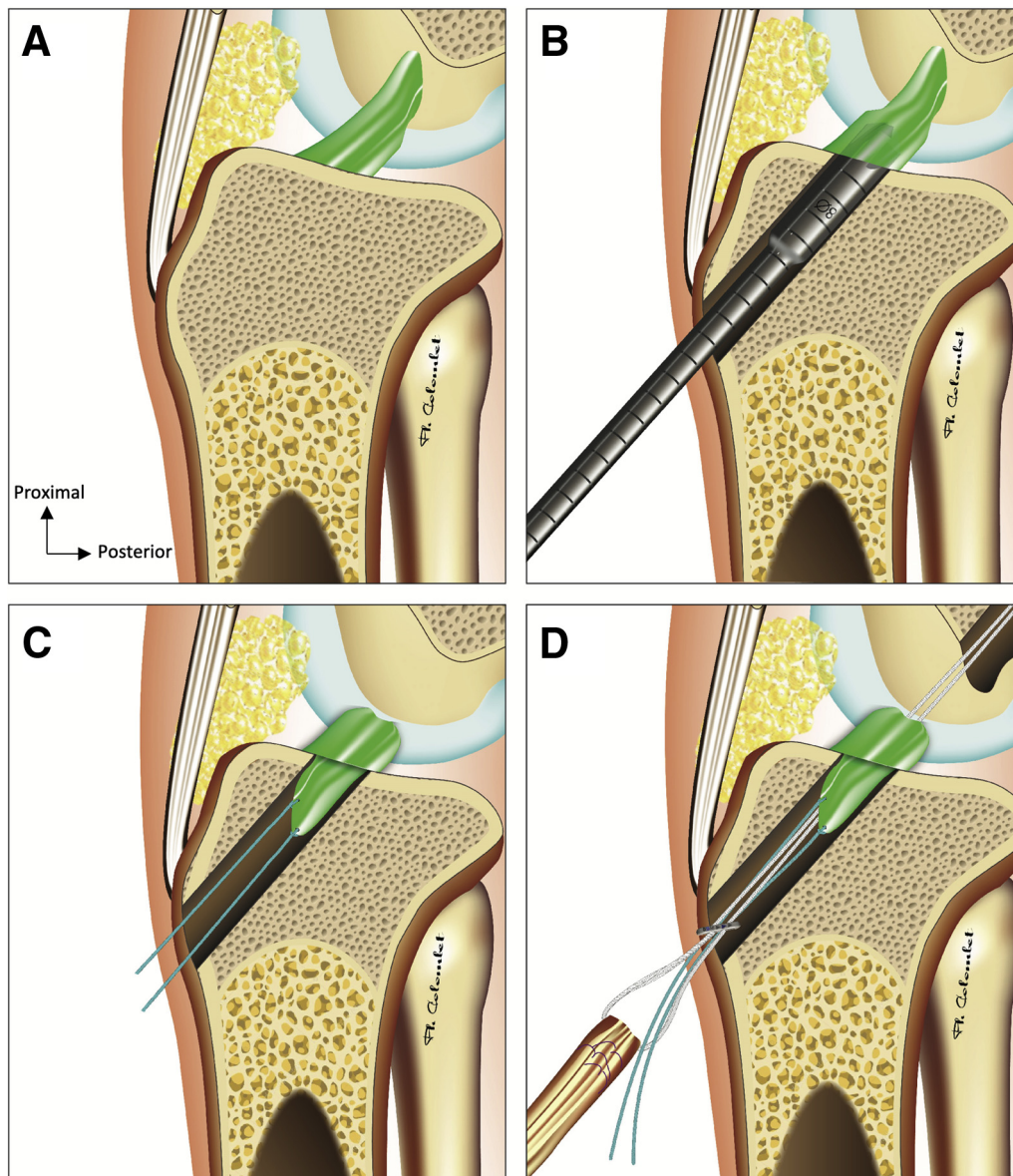


Fig 2. Surgical steps of the technique. (A) Rupture of the ACL. (B) A complete tibial tunnel is performed targeting the middle of the ACL native tibial footprint. (C) Sutures are passed in the remnant and pulled in the tibial tunnel to allow a good view of the femoral cortex and to achieve the femoral tunnel without any damage of the remnant. (D) Once the femoral tunnel is done, traction threads of the graft are passed; just before inserting the graft, the suture braids are passed in the loop of the femoral Pullup. (ACL, anterior cruciate ligament.)

A suture relay is placed to tract the graft as described in the original technique.⁵ The femoral Pullup (SBM) threads are pulled into the 2 tunnels; before inserting the graft in the tibial tunnel, the 2 TigerLink sutures are passed in the Pullup femoral loops in opposite directions. Then the 4 ST grafts are placed in the final position, and the femoral Pullup is flipped and tightened. A tibial traction is applied to lock the femoral Pullup on the femoral cortex. Once the four ST grafts are secured, tightening the tibial Pullup XL (SBM), manual traction is applied on each TigerLink suture separately. The arthroscopic view of the notch controls the remnant progression to the femur, as can be seen in

the Video. This step is done in extension and in flexion. When the surgery is complete, the graft usually cannot be seen, and flexion/extension is applied to the knee to regulate perfect behavior of the graft/remnant without any notch impingement. Then the 2 TigerLink sutures are placed on both sides of the Pullup XL button and knotted above it (Fig 3).

Discussion

Proposed in the 1980s, repair of ACL tears was abandoned because of unacceptable failure rates, but was initially an isolated repair technique. In 2009, Murray⁴ proposed adding a scaffold to bridge the ACL

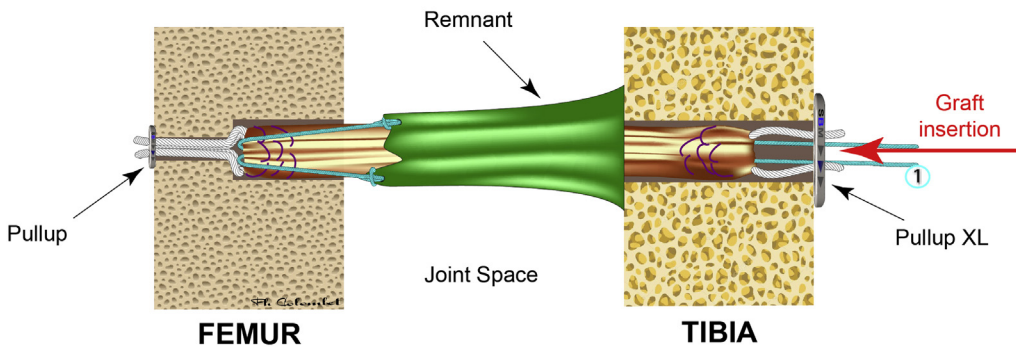
4ST-Repair

Fig. 3. The 4-ST repair technique. The graft goes through the remnant and is fixed with adjustable cortical fixations at femoral and tibial sides. 1. Traction sutures are passed in the remnant and then in the loop of the femoral cortical fixation. (ST, semitendinosus.)

rupture to increase ACL healing in ACL repair. To consider such an ACL repair, some criteria have to be checked, but the concept highlights the role of the remnant keeping the mechanoreceptors and saving the vascular supply² coming from the tibial insertion; this can lead to better graft integration and therefore better clinical results.⁶ At the same time, we reported in 2018 good functional and clinical results for ACL reconstruction using 4 strands of semitendinosus autologous graft with both femoral and tibial cortical adjustable fixation.⁷ Our technique allows redirection of the

proximal end of the remnant, which is not usually healed in femoral ACL native insertions after ACL tear. The technique described in this article allows association of the advantages of these 2 techniques: to perform an ACL reconstruction with adjustable fixations and to save the remnant (Fig 4). The remnant is pulled along the graft to the femoral tunnel, reducing the risk of cyclops' syndrome, which can happen when the free end of a remnant is floating in the notch in the ACL augmentation technique.² This technique also allows covering of the proximal part of the graft that may provide better healing of this graft part, which is the weakest link of ACL reconstruction. Noh et al.⁸ have proposed using a cortical fixation like a pulley but have described a technique using an Achilles tendon allograft with a screw on the tibial side. Our technique allows adaptation of the graft diameter instead of using hamstrings. One of the inconveniences of this technique is the risk of increasing the amount of soft tissue in the notch; the graft diameter has to be reduced compared with the standard 4-ST technique (Table 2).

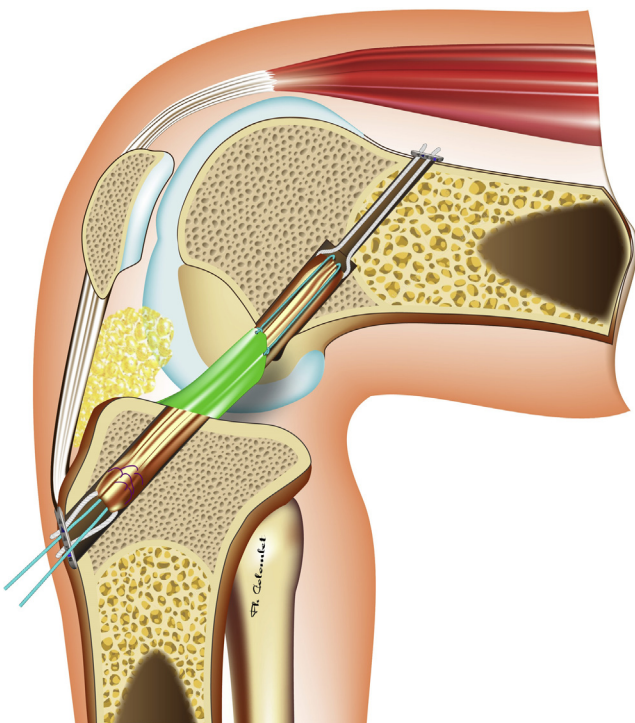


Fig 4. Sagittal cut of the knee at 90° of flexion with the graft in position. The traction braids of the remnant can be tied at the tibial side as they are passed in the holes of the tibial button. Use the femoral cortical fixation as a pulley, allowing the remnant to rise on the graft.

Table 2. Advantages and Disadvantages

Advantages

- Conservation of the entire remnant and its orientation to the native footprint.
- ST-4 autograft as a biological tissue bridge for the ACL reconstruction to protect the repair until it can be ligamented.
- Rise of the graft to the femur to allow to conserve the remnant.
- No synthetic device in the joint.
- No change of our usual technique with an in-out technique for the femoral tunnel and 2 adjustable cortical fixations.
- No additional device or technical gesture at the lateral femoral cortex to decrease the risk of complications from devices or braids knots.

Disadvantages

- Applicable only if ACL tear at the femoral insertion without any atrophy of the remnant.
- The tibial tunnel must be performed at the exact center of the tibial footprint.
- It is necessary to take enough ACL remnant with the grasp to avoid failure of the repair when pulling on the braids.

ACL, anterior cruciate ligament; ST, semitendinosus.

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