Technical Note

Pedicular Hamstring With 2 Adjustable Loops for Anterior Cruciate Ligament Reconstruction: The Double-Loop Technique

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Abstract: Pedicular hamstring grafts have become increasingly popular for anterior cruciate ligament reconstruction, preserving sufficient blood supply to enhance bone-to-tendon healing while providing additional mechanical fixation on the tibial side. This Technical Note introduces an original approach utilizing a dual adjustable loop fixation for hamstring grafts, maintaining the tibial insertion, in anterior cruciate ligament reconstruction.

Anterior cruciate ligament (ACL) reconstruction is a well-established procedure, having garnered extensive recognition for its efficacy in restoring knee stability. Among all the existing techniques, hamstring grafts has emerged as a preferred choice in contemporary practice, and preserving the tibial insertion of the hamstrings could improve the vascularization of the graft.[1,2]

Although several surgical techniques using hamstring grafts with preserved tibial insertion have been reported, they involve the use of an interference screw on the tibial side.[3] The reliance on interference screws introduces an element of compression that may impact the graft's biological environment and vascularity, potentially impeding optimal healing and negating the mechanical benefit of a double fixation. We describe an adjustable loop in conjunction with the tibial pedicle for tibial fixation. This approach aims to provide circumferential fixation within the tunnel without subjecting the graft to compression.

Surgical Technique

This Technical Note outlines the fixation procedure for a semitendinosus autograft with preserved tibial insertion, employing 2 adjustable suspensory fixation system loops (Procinch RT; Stryker) (Fig 1). Please refer to Video 1 for a detailed visual demonstration.

The technique could be combined with any usual procedure, especially with anterolateral ligament reconstruction.

The surgical procedure is conducted under general anesthesia. The patient is positioned supine on the operating table, and a leg holder is secured laterally to the thigh at the level of the tourniquet. This setup allows for optimal access to the knee joint. A surgical ladder facilitates controlled and precise mobilization of the knee throughout the entire range of motion, from 0° extension to full flexion.

Harvesting and Preparation

The semitendinosus graft is harvested using a conventional closed stripper technique, with meticulous attention paid to preserving its tibial insertion. Any remaining muscle fibers are carefully removed to ensure a clean graft. Step-by-step technique is described in Table 1.

Arthroscopic Procedure

Classic anteromedial and anterolateral portals are made and a diagnostic arthroscopy is performed to assess any meniscal or chondral lesion. The tibial remnant of the ACL is deliberately preserved for enhanced proprioception.[4]

Tibial Tunnel

An ACL tibial guide, set at 55°, is utilized and placed on the tibial footprint. The guide pin is drilled to the joint,

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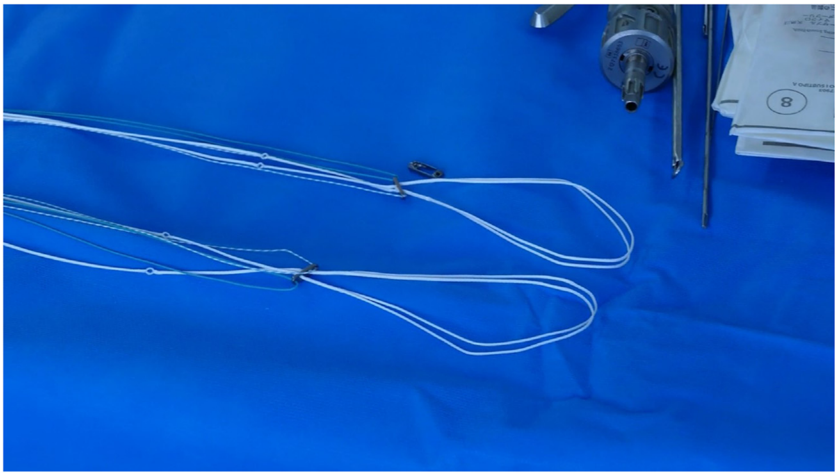

Fig 1. Adjustable suspensory fixation system loops (Procinch RT; Stryker) and XL plate.

followed by the use of incrementally sized reamers until the desired graft size is achieved. This approach aims to preserve the remnant of the native ACL.

Femoral Tunnel

A blind 25-mm-long femoral tunnel is drilled using an inside-out technique. With the knee at 90°, the entry point is selected using a freehand guide. After flexing the knee to 120°, an eyed guide pin is passed, and the blind tunnel is drilled to a usual diameter of 8 or 9 mm, depending on the graft width. A 4.5-mm cannulated reamer is then inserted to drill the path for the femoral button, with the reamer serving as a gauge for the femoral tunnel length (length C). Posterior debris is removed using a shaver.

Table 1. Step-by-Step Graft Preparation

1. Button F (femoral) is sutured to the free end of the semitendinosus, after being folded for approximately 2 cm using a whipstitch suture (FiberLoop × Braid; Stryker). Care is taken not to jam the button. (Fig 2)
2. The graft is tightened by pulling on button F, and then it is passed through the loop of button T (tibial). (Fig 3)
3. The right hand grasps the tibial button through the loop of the femoral button, while the left hand grasps button F. (Fig 4)
4. To fold the graft in 2 strands, the right hand pulls the graft through the loop of button F. (Fig 5)
5. The graft is folded once more into 3 strands, with button F positioned at the top for the femoral tunnel and button T at the bottom for the tibial tunnel. (Figs 6 and 7)
   Note: Step 3 may be repeated if the graft is of sufficient length to create a fourth strand.
6. To maintain a tubulated graft, a loose loop can be made on the femoral side of the graft, with a 2-0 absorbable thread, facilitating the passage of the graft during ascent through the femoral tunnel. The graft must be able to slide.
7. The graft is sized.
8. The graft is soaked with vancomycin and placed in the muscle compartment.
9. The final adjustment of the graft length will be made later according to the length of the tunnels. This can be achieved by pulling more or less on the 2 endobuttons.

Shuttle Passing and Graft Passage

To prevent femoral button incarceration in the iliotibial band, an additional 5 mm is added to length C and marked on the femoral button wire. A suture loop is passed through the femoral tunnel using the eye pin and then captured with a grasper from the tibial tunnel.

The graft is shuttled from the tibial to the femoral tunnel under arthroscopic control. Once the femoral button has passed the femoral cortex, it is flipped by pulling the 2 wires and drawn back from the tibial side to press against the femoral cortex.

Under arthroscopic guidance, the surgeon monitors the progression of the graft in the femoral tunnel. The femoral strands of the femoral Procith ST are pulled until the graft is fully seated in the femoral tunnel. The XL button (G-Lok XL; Stryker) is fixed to the tibial button, and the graft is pulled through the tibial socket after tensioning the tibial Procith XL. The 3 strands of the graft then balance, sliding and forming a pulley around the 2 loops.

Care is taken to prevent soft tissue interposition between the tibial cortex and the tibial button (Fig 8). The graft is tensioned in full extension after cycling movements and then retensioned for optimal fixation. Pearls and pitfalls are described in Table 2.

Rehabilitation

The postoperative rehabilitation protocol for this procedure aligns with standard practices, emphasizing full weightbearing and progressive range-of-motion exercises.

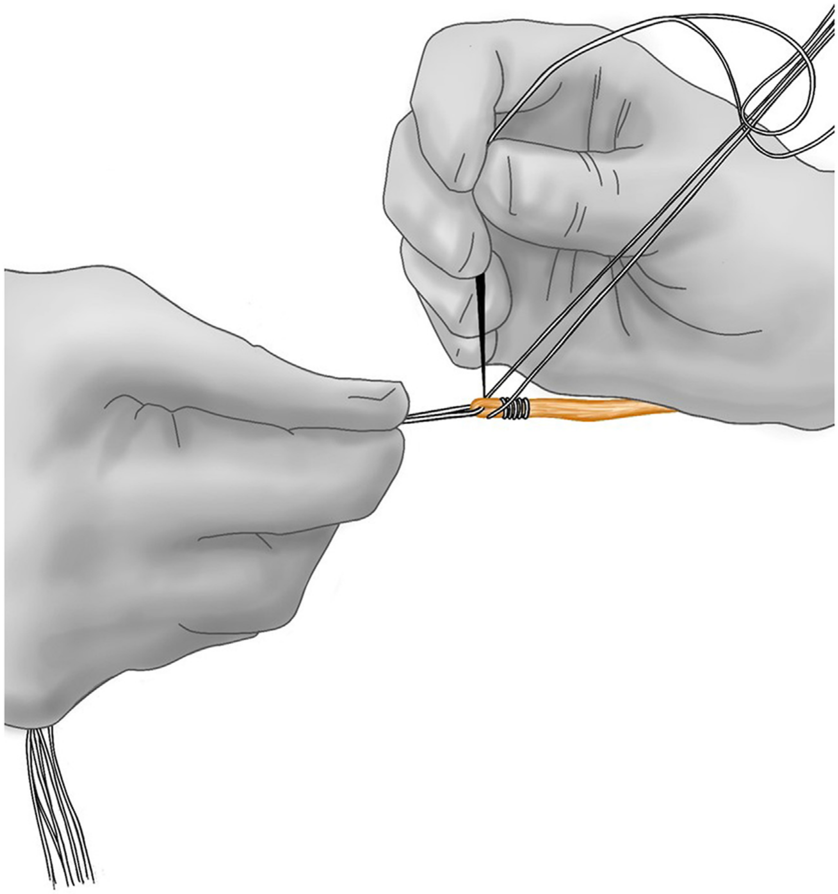

Fig 2. Femoral button is sutured to the free end of the semitendinosus, after being folded for approximately 2 cm using a whipstitch suture.

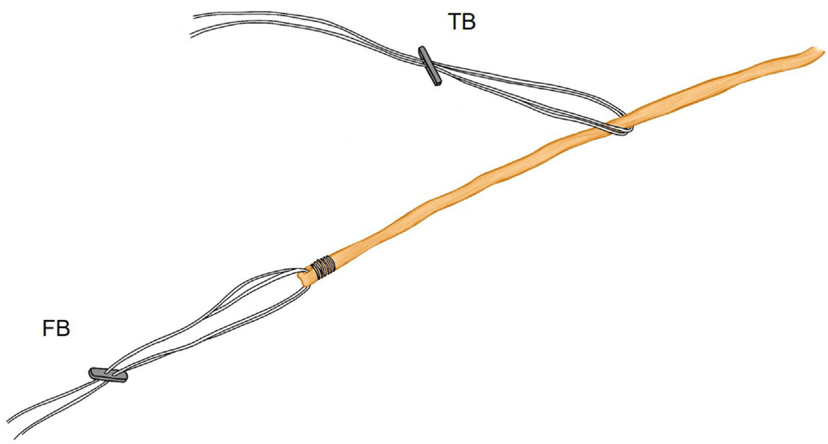

Fig 3. Femoral button attached to the semitendinosus is passed inside the loop of the tibial button. (FB, femoral button; TB, tibial button.)

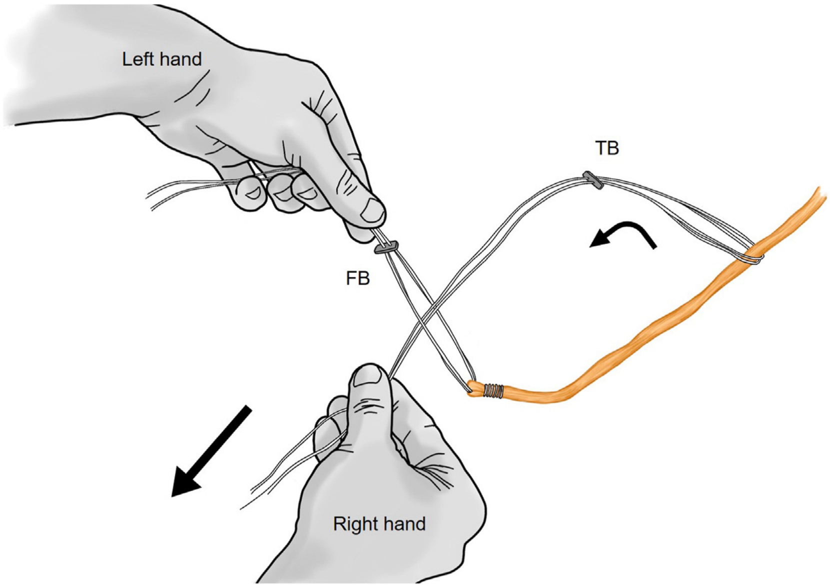

Fig 4. The right hand is threaded through the loop of femoral button to reach tibial button, while the left hand grasps the femoral button. (FB, femoral button; TB, tibial button.)

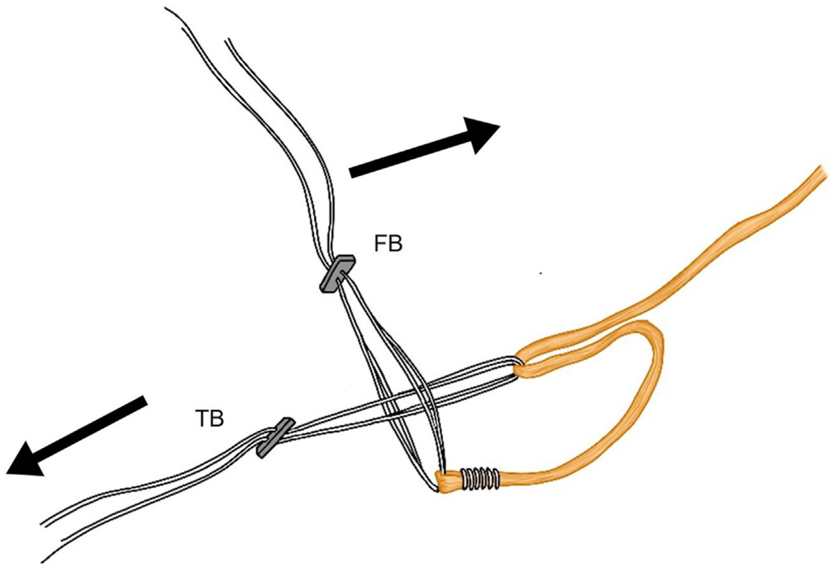

Fig 5. By pulling the 2 buttons in opposite direction, the graft is folded into 2 strands. (FB, femoral button; TB, tibial button.)

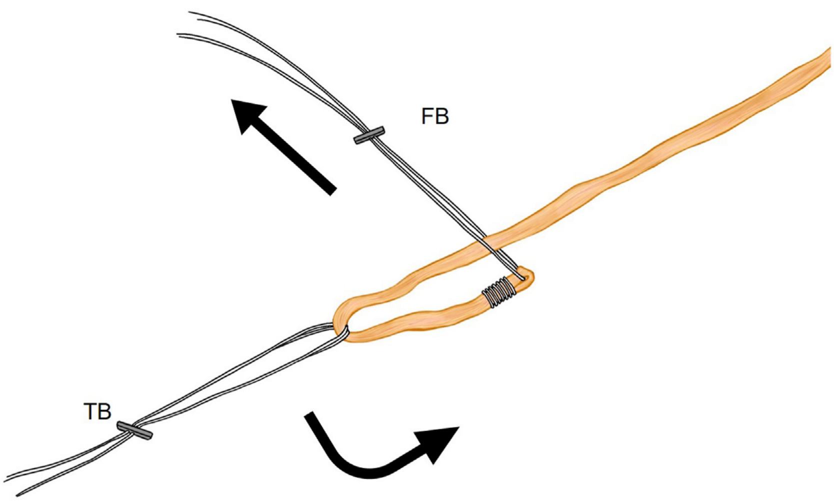

Fig 6. The graft is now folded into 3 strands by pulling the femoral button up and the tibial button down. (FB, femoral button; TB, tibial button.)

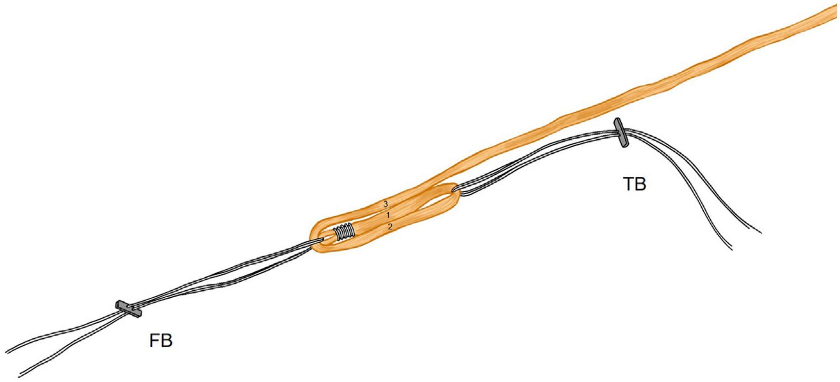

Fig 7. Final result of graft preparation: the graft is folded into 3 strands. On the femoral side, there is the femoral button, and on the tibial side, there is the tibial button and the pedicle. (FB, femoral button; TB, tibial button.)

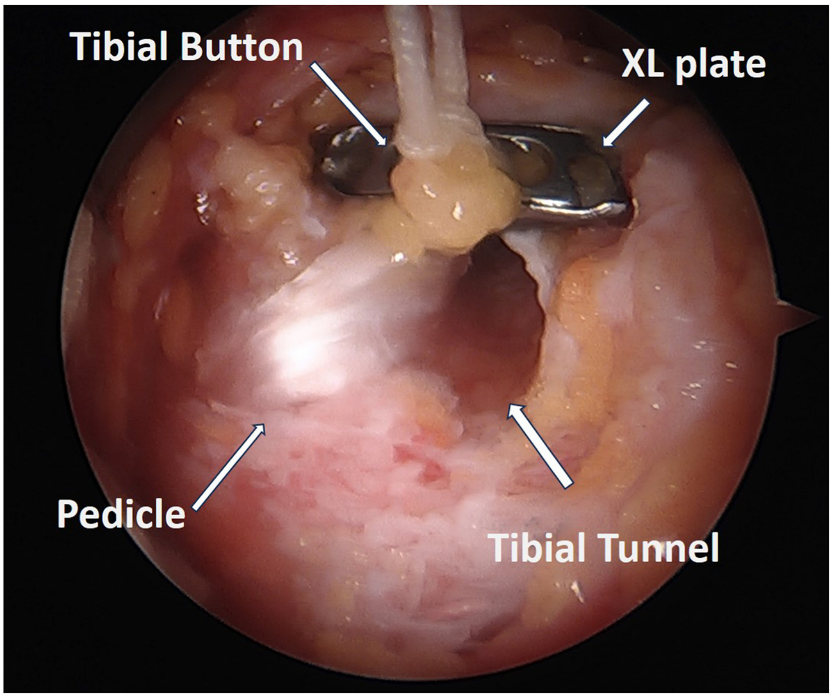

Fig 8. Extra-articular tibial tunnel view, left knee, supine position: the button does not compress the semitendinosus.

Table 2. Pearls and Pitfalls

Pearls	Pitfalls
Use a 2-0 absorbable thread to maintain a tubulated graft on the femoral side of the graft.	Don't forget to fix the XL button before the graft passage.
Mark the femoral tunnel length on the tightrope loop wires to control the position of the endobutton on the lateral cortex.	Femoral endobutton is not applied to the femoral cortex.
Once the femoral button is against the cortex, pull the tibial button downward to tighten the graft when it is raised so that the femoral button remains against the cortex.	

Table 3. Advantages and Limitations

Advantages	Limitations and Risks
Small ancillary: no preparation table needed	Graft can be thin in 3 strands but acceptable with lateral tenodesis
Preservation of tibial insertion hamstrings with biological and mechanical advantages	Graft lying around during preparation (graft soaked with vancomycin and placed in the muscle compartment)
Better distribution of traction loads on the tibial side	
Only 1 type of fixation, no hesitation on the size or diameter of the screws	
No measurement and mathematical calculation of the length of the tunnels to suture the graft to itself	
No complications due to the interference screw: balonization, advancement of the graft within the bone tunnel, graft laceration, intra-articular screw issues	

Discussion

The technique presented in this study represents an evolution of the single-anteromedial bundle biological augmentation technique.[4] The core idea is to create a biological environment that promotes graft healing and enhance graft incorporation. Advantages and limitations are described in Table 3.

Recent literature advocates for the preservation of the hamstring tibial attachment to enhance the ligamentization process. Preserving the tibial insertion of the hamstring in isolated ACL reconstruction has been shown to facilitate better graft incorporation through improved vascularization.[5]

Combining this technique with anterolateral ligament reconstruction could further improve graft incorporation.[6]

However, all these techniques describe a tibial fixation with an interference screw that compresses the graft within the tunnel. In contrast to traditional techniques, our approach could prevent complications related to the crushing of the tendon, thereby promoting a biological environment conducive to graft healing with a 360° fixation within the tibial tunnel.

The anatomic and mechanical factors that contribute to the susceptibility of tibial fixation are well known. The lower density of cancellous bone at the proximal tibial epiphysis, coupled with the direct application of tensile loads along the axis of the tibial tunnel, may compromise the pullout strength of an interference screw, specifically, the sliding of the tendon graft along the screw.

The concept of preserving bony graft insertion during ligament reconstruction has been discussed for years, with evidence suggesting that maintaining the tibial insertion of hamstring tendons increases the maximum load to failure at the tibial tunnel.[7]

Unlike the interference screw, which alone supports all the pullout strength, the adjustable loop allows for an equitable distribution of the tensile forces among the strands, thereby increasing the maximal load to failure at the tibial tunnel (Fig 7).

This technique has the potential to simplify ACL reconstruction and improve graft healing. It may be applicable across various surgical techniques as lateral extra-articular procedures. However, the medium- and long-term clinical results need thorough evaluation to validate the technique's efficacy and safety.

Disclosures

All authors (K.I., M.C., G.R., E.R.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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