Technical Note

Anterior Cruciate Ligament Reconstruction Using a Tibial-Pedicled Quadrupled Semitendinosus Autograft With Dual Adjustable-Loop Cortical Suspension

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Abstract: Anterior cruciate ligament reconstruction is one of the most commonly performed procedures in knee surgery. Despite its frequency, numerous technical variations exist, and several aspects remain controversial. Hamstring tendons are among the most frequently used autografts, and there is growing interest in techniques that preserve the gracilis tendon. Additionally, preservation of the tibial insertion of the hamstrings has recognized biological and mechanical advantages. In this technical note, we describe a technique that aims to combine the advantages of both approaches: the benefits of using a short single semitendinosus graft, preserving the gracilis tendon, which is associated with lower donor-site morbidity and improved flexion strength compared with traditional 2-tendon harvests, and the advantages of maintaining the tibial attachment of the semitendinosus, which include improved graft vascularization and a secondary point of tibial fixation. This method uses a tibial-pedicled, quadrupled semitendinosus graft combined with a dual adjustable-loop cortical suspension device. The technique is reproducible, is cost-effective, and may offer both biological and mechanical benefits over conventional approaches.

Anterior cruciate ligament (ACL) reconstruction is a common procedure,[1] with hamstring tendons—typically the semitendinosus and gracilis—being the most frequently used autografts.[2,3] Preservation of the tibial insertion of the hamstrings has gained popularity because of its biological advantages, including maintenance of graft vascularization and provision of a secondary tibial fixation point.[4-6] Single semitendinosus graft techniques have also become increasingly adopted given that they preserve the gracilis tendon and are associated with reduced donor-site morbidity, decreased postoperative pain, and improved flexion strength compared with 2-tendon harvests.[7-11] Various techniques combining semitendinosus tibial insertion preservation with different graft configurations and fixation methods have been described.[5,12-18]

In this technical note, we present a reproducible ACL reconstruction technique using a quadrupled, tibial-pedicled semitendinosus autograft combined with dual adjustable-loop cortical suspension (Video 1). This approach aims to optimize both the biological integration and mechanical strength of the graft by combining the advantages of graft preservation and modern fixation methods.

Surgical Technique

The procedure is performed under general or spinal anesthesia with a tourniquet applied to the proximal thigh. The patient is placed in the supine position with the operative leg supported on a leg holder, allowing full extension and at least 120° of flexion (Fig 1).

Graft Harvest

The semitendinosus graft is harvested through an oblique incision on the anteromedial surface of the tibia; a Blunt Tip Tendon Stripper (Stryker, Kalamazoo,

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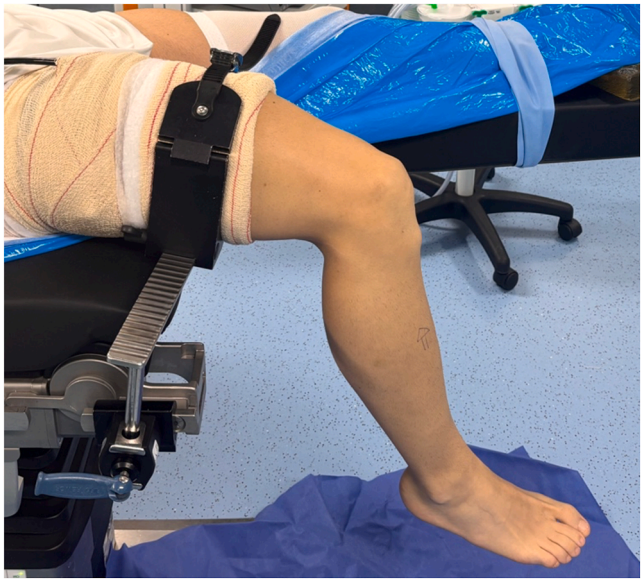

Fig 1. Patient positioning using leg holder: lateral view of right knee. The patient is placed in the supine position with the operative leg supported on a leg holder, allowing full extension and at least 120° of flexion.

Arthroscopy

Diagnostic arthroscopy is performed through anterolateral and anteromedial portals, and any meniscal or chondral lesions are addressed. The ACL footprint is debrided, preserving some native fibers without compromising visualization.

Femoral Tunnel Drilling

An accessory medial portal is created under direct visualization, inferomedial to the anteromedial portal and just above the medial meniscus. The femoral tunnel is drilled inside-out using the VersiTomic A/M guide with Straight Curve (Stryker) via the accessory portal. A flexible guide pin is introduced while the knee is gradually flexed to 120°, targeting the center of the femoral footprint (Fig 4). A 25-mm socket is drilled with a flexible reamer to match the graft diameter; the remainder is drilled with a 4.5-mm drill (VersiTomic Flexible Reamer; Stryker).

Tibial Tunnel Drilling

The tibial tunnel is drilled outside-in using the Tibial Drill Guide with Single Point Forked Arm (Stryker), a rigid drill, and a guide pin. The guide is positioned through the anteromedial portal at 55°, targeting the center of the native footprint (Fig 5). A full-length tunnel matching the graft diameter is created.

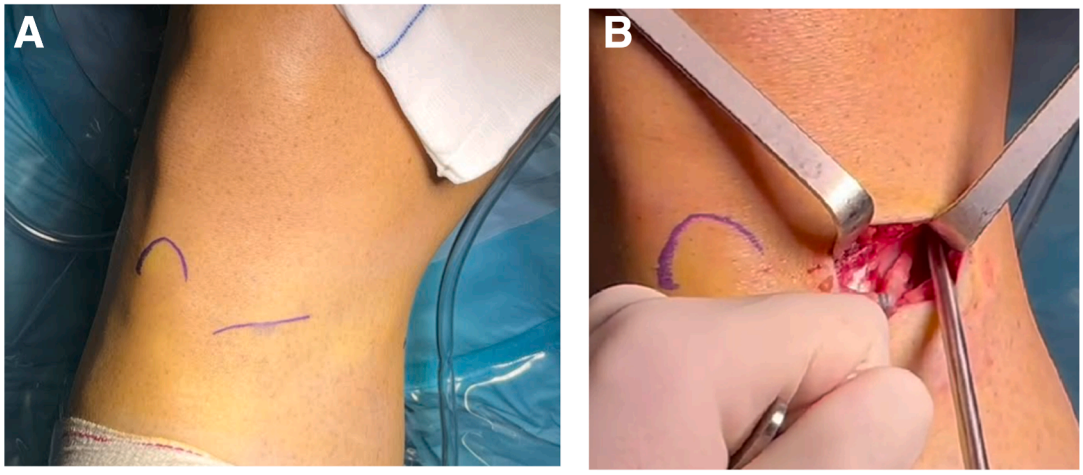

Fig 2. Oblique incision for semitendinosus tendon harvesting: medial view of right knee on leg holder. The semitendinosus graft is harvested through an oblique incision on the anteromedial surface of the tibia, with preservation of its tibial insertion. (A) The tibial tuberosity is marked, and the planned incision is drawn. (B) A suture is passed in the semitendinosus, and the tendon is harvested with an open-loop tendon stripper (Blunt Tip Tendon Stripper).

MI) is used, with preservation of its tibial insertion (Fig 2). The tendon is cleaned of muscle tissue, and the total length and quadrupled graft diameter are measured (Fig 3). A minimum graft length of 27 to 29 cm and a diameter of at least 8 mm are desirable. If the tendon is too short, a tripled configuration may be used. If the diameter is insufficient, the gracilis tendon may be harvested and used to create a tripled 2-tendon graft.

Shuttle Passage and Graft Length Measurement

A shuttle suture is passed from the femoral to the tibial tunnel (Fig 6). A second, differently colored suture (typically white) marked at 15 mm from the

Fig 3. Measurement of quadrupled graft: medial view of right knee on leg holder. The tendon is cleaned of muscle tissue, and the quadrupled graft length and diameter are measured using one suture as a loop and a diameter measuring tool.

proximal end is threaded through the shuttle (Fig 6). The white suture is pulled through both tunnels until the 15-mm mark is flush with the femoral tunnel entrance (Fig 7A). A hemostat is used to mark the white suture with the corresponding location of the semitendinosus tibial insertion (Fig 7B). The total length from the hemostat mark to the proximal end of the white suture is measured and corresponds to the length of the plasty plus the pedicle (Fig 7C). We usually use a 6-cm-long plasty, so the remainder corresponds to the pedicle length (e.g., a total length of 9 cm corresponds to a 6-cm plasty length and a 3-cm pedicle length) (Fig 7D).

Graft Preparation

With a surgical skin marker, the pedicle length plus 24 cm (for the quadrupled 6-cm graft) is marked on the semitendinosus tendon (Fig 8). The steps for quadrupled graft preparation are as follows: (1) Two adjustable loops with a button (ProCinch Adjustable Loop RT; Stryker) are required. (2) The tendon is first doubled through the first adjustable loop up to the pedicle mark and secured using baseball-type stitches with high-strength suture (No. 2 Force Fiber) (Fig 8A). (3) A second loop (ProCinch Adjustable Loop RT) is used to double the graft again. The free suture limbs are tied to the first loop and the graft to lock the construct (Fig 8B). (4) A cerclage is placed 1.5 cm from the tibial end using the same high-strength suture (No. 2 Force Fiber) (Fig 8C). (5) The femoral tunnel length is marked on the adjustable loop (Fig 9A). The desirable graft length inside the femoral socket is also marked (15 mm) using a surgical skin marker (Fig 9B).

Graft Passage and Fixation

The graft is passed through the tibial and femoral tunnels under arthroscopic control. The mark on the femoral loop indicates when the button has reached the lateral femoral cortex. The femoral loop is adjusted until at least 15 mm of graft is within the tunnel and the tibial pedicle is tensioned.

The tibial loop is connected to a revision button (G-lok XL; Stryker) and adjusted on the tibial cortex, tensioning the graft with the knee in full extension. Twenty cycling movements are performed, followed by retensioning to ensure optimal fixation. Pearls and pitfalls are summarized in Table 1.

Rehabilitation

The rehabilitation protocol is similar to that after standard ACL reconstruction techniques, with progressive weight-bearing and free range-of-motion exercises.

Discussion

Recent literature supports preserving the tibial insertion of the hamstring tendons in ACL reconstruction to optimize graft ligamentization.[4-6] Most described techniques using tibial-pedicled hamstring tendons involve both tendons and use interference screw fixation, which may impair graft vascularization.[5,12-17] In this article, we present a technique combining the advantages of single short grafts with gracilis preservation—including lower donor-site morbidity and improved knee flexion strength compared with dual hamstring harvests[7-11]—with those of tibial insertion preservation, which maintains graft vascularity and provides a second point of tibial fixation.[4-6,15]

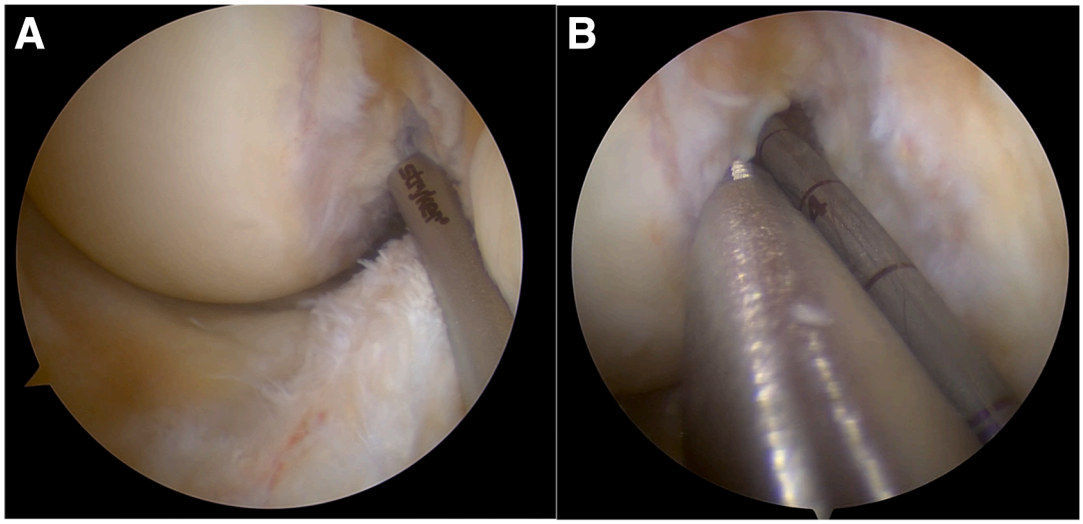

Fig 4. Femoral guide in position and femoral tunnel drilling: standard anterolateral view of right knee. The femoral tunnel is drilled inside-out using the VersiTomic A/M guide with Straight Curve via the accessory inferomedial portal. (A) A guide pin and flexible drill (VersiTomic Flexible Reamer) are used at 120° of knee flexion, targeting the center of the femoral footprint. (B) The guide pin is viewed, and the shaver is used for soft-tissue debridement at the tunnel entrance.

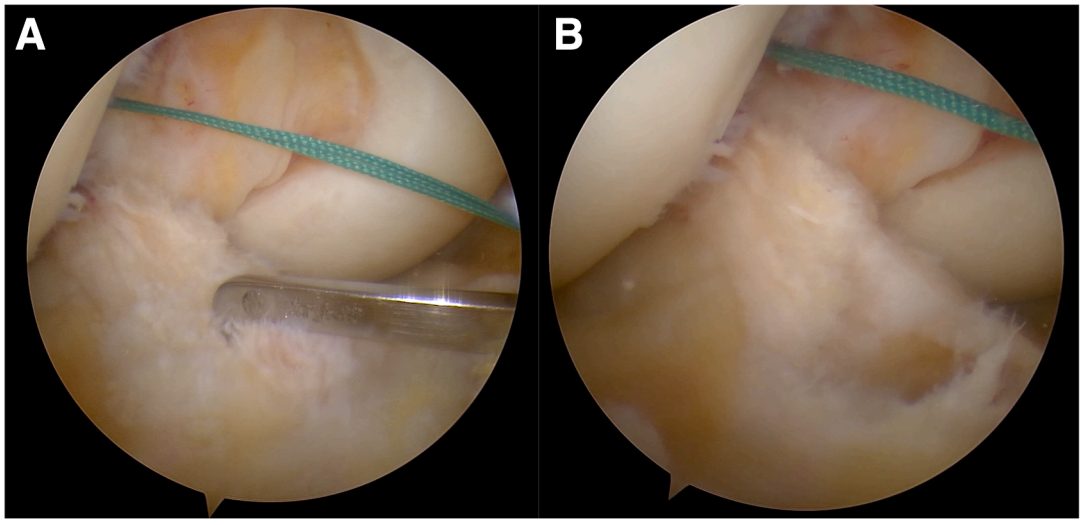

Fig 5. Tibial guide in position and tibial tunnel drilling: standard anterolateral view of right knee. (A) The tibial tunnel is drilled outside-in using a rigid guide pin and drill, with the guide (Tibial Drill Guide with Single Point Forked Arm) positioned through the anteromedial portal at 55°, targeting the center of the native footprint. (B) A full-length tunnel matching the graft diameter is created with a rigid drill.

We use an oblique incision for semitendinosus harvesting. Compared with vertical incisions, this approach reduces the risk of injuring the infrapatellar branch of the saphenous nerve[19] and improves medial access where the semitendinosus separates from the gracilis tendon.

Femoral and tibial tunnels are prepared using classic techniques. The femoral tunnel is created independently from the tibia, in an inside-out manner, through a low accessory medial portal. This technique allows the use of conventional drills rather than retrograde devices, which are costlier and have a steeper learning curve.[20] However, it requires hyperflexion and greater assistant involvement. The tibial tunnel is drilled full length, via an outside-in technique, to allow pedicled graft passage from the tibia to the femur.

The femoral socket is planned for a 15-mm graft length, a value supported by prior studies.[21] On the basis of our experience, the maximal required semitendinosus length is 29 cm: 24 cm for the quadrupled graft (6-cm plasty) and 5 cm for the pedicle. If the tendon is too short, it may be tripled alone or with the

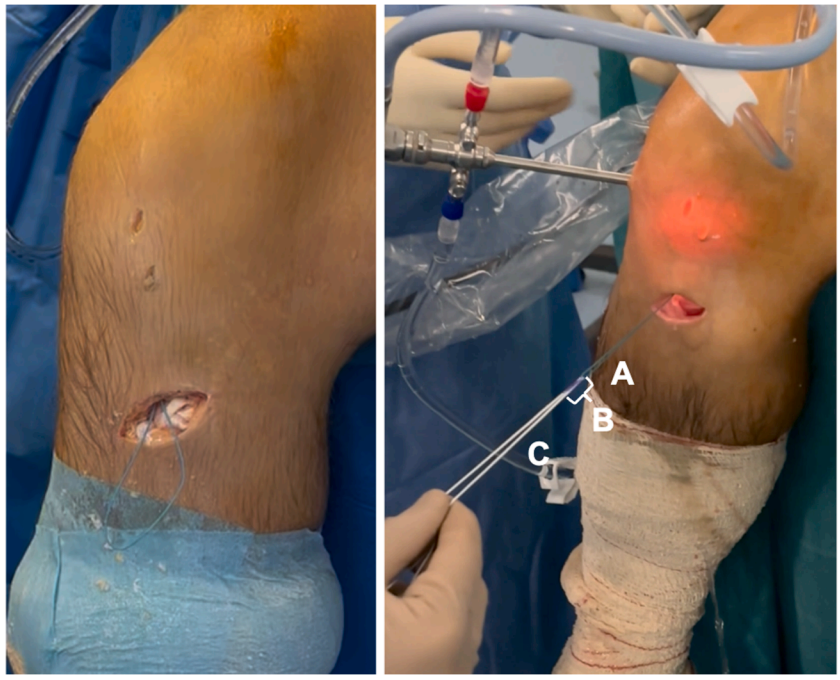

Fig 6. Shuttle suture and suture for measurement: medial view of right knee on leg holder. A shuttle suture (blue suture [A]) is passed from the femoral to the tibial tunnel. A second, differently colored suture (which is typically white [C]) marked at 15 mm (B) from the proximal end is threaded through the shuttle.

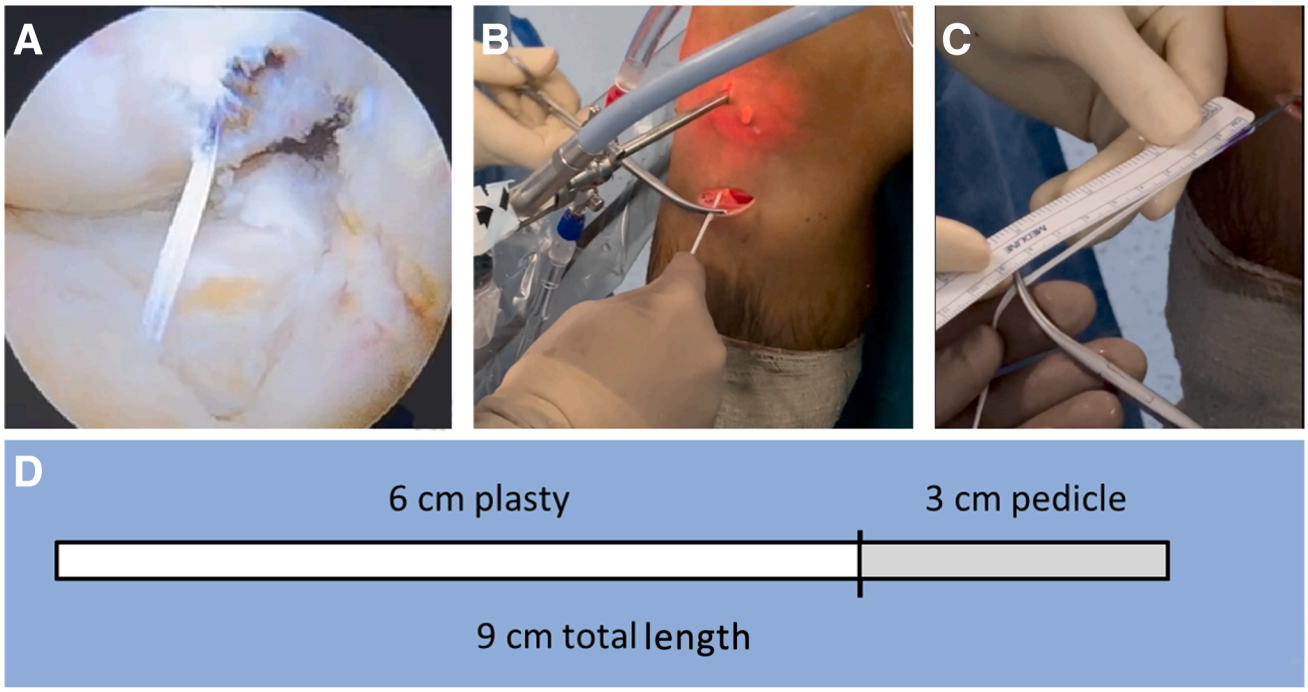

Fig 7. Plasty total length measurement and pedicle length definition. (A) Anteromedial portal view. The white suture is pulled through both tunnels until the 15-mm mark is flush with the femoral tunnel entrance (having 15 mm of suture inside the tunnel). (B) Medial view of right knee on leg holder. An hemostat is used to mark the white suture with the corresponding location of the semitendinosus tibial insertion. (C) Medial/superior view of right knee on leg holder. The total length from the hemostat mark to the proximal end of the white suture is measured and corresponds to the length of the plasty plus the pedicle. (D) We usually use a 6-cm-long plasty, so the remainder corresponds to the pedicle length (e.g., a total length of 9 cm corresponds to a 6-cm plasty length and a 3-cm pedicle length).

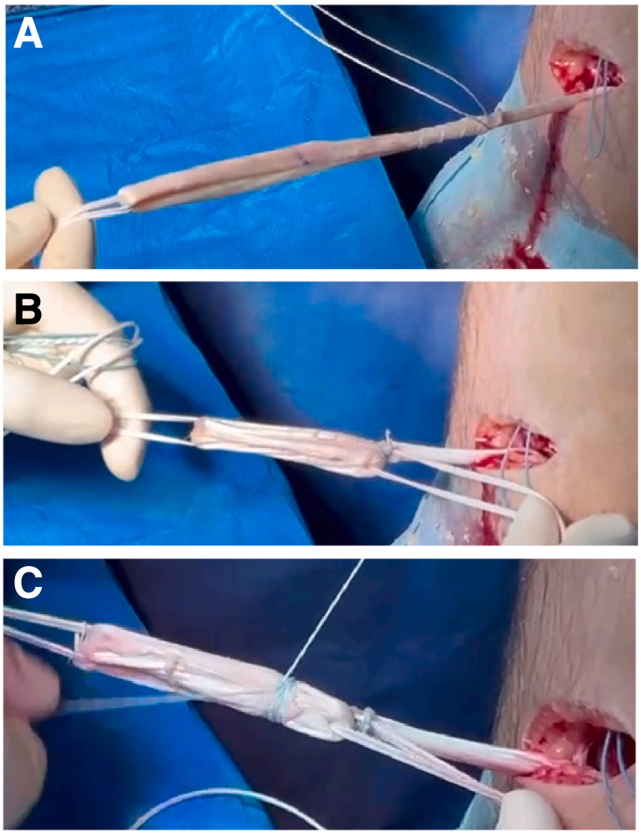

Fig 8. Graft preparation: direct view of graft preparation preserving tibial insertion of semitendinosus, using standard Mayo surgical table as support, in right knee on leg holder. (A) The tendon is first doubled through the first adjustable loop (adjustable loop 1; ProCinch Adjustable Loop RT) up to the pedicle mark and secured using baseball-type stitches with high-strength suture (No. 2 Force Fiber). (B) A second loop (adjustable loop 2; ProCinch Adjustable Loop RT) is used to double the graft again. The free suture limbs are tied to loop 1 and the graft to lock the construct. (C) A cerclage is placed 1.5 cm from the tibial end using the same high-strength suture.

Table 1. Pearls and Pitfalls

Pearls
After harvesting the semitendinosus tendon, measure its total length and the diameter of the quadrupled graft to ensure they are sufficient for the technique.
Perform a cerclage at the tibial end to increase construct stiffness.
Mark the femoral tunnel length on the graft loop to determine when the button passes the lateral femoral cortex.
Pitfalls
Add 1 mm to the diameter of the plasty measured at the beginning because sutures will be added; otherwise, the plasty may not pass through the tunnels.
Measure the total graft length from the exact origin of the semitendinosus on the tibia; otherwise, the pedicle may be short and it must be cut.
Drill a 20- to 25-mm femoral socket for a 15-mm femoral graft length to allow room for tensioning the plasty and pedicle.

gracilis to achieve a graft diameter of at least 8 mm, using techniques adapted from prior descriptions.[22]

Adjustable-loop buttons, commonly used in all-inside techniques, have shown greater elongation than fixed-loop devices in biomechanical studies,[23,24] although the difference appears to lack clinical significance.[25] In 2024, Iglesias et al.[18] described a similar short-graft technique with dual adjustable-loop fixation using a tripled semitendinosus. However, this method may not reliably yield a graft diameter of at least 8 mm, and we found no biomechanical data validating their tripling configuration.

Our technique uses a quadrupled semitendinosus graft as described by Lubowitz[26] and supported by biomechanical evidence.[23,27,28] High-strength No. 2 sutures are used to enhance construct strength,[29] and a tibial cerclage improves graft stiffness.[30] In conclusion, this technique offers a practical and reproducible approach for ACL reconstruction using a single graft with tibial insertion preservation. Advantages and limitations are summarized in Table 2.

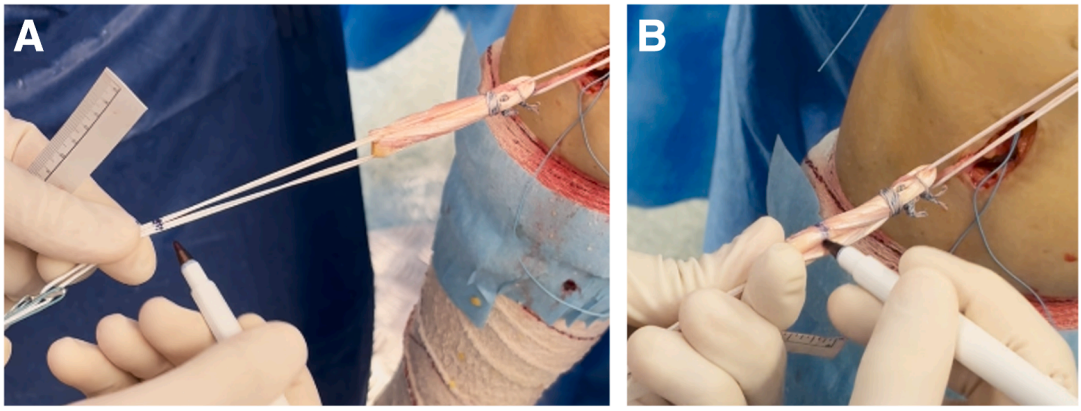

Fig 9. Graft marking: direct view of graft preparation preserving tibial insertion of semitendinosus in right knee on leg holder. (A) The femoral tunnel length is marked on the adjustable loop. (B) The desirable graft length inside the femoral socket is marked (15 mm) using a surgical skin marker

Table 2. Advantages and Limitations

Advantages
Reduced donor-site morbidity and improved knee flexion strength by using only one tendon
Larger graft diameter achieved with the same tissue by quadrupling the semitendinosus
Optimized graft ligamentization and dual tibial fixation by preserving the tibial insertion
Limitations
Requires measurement of the distance between the tibial insertion and femoral tunnel
Demands precise mathematical calculations
Tendon may be too short to allow both quadrupling and tibial pedicle preservation (alternative is tripling alone or with gracilis)

Disclosures

All authors (J.R., R.A., F.B., R.G.) 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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