Technical Note

All-Suture Cortical Button Fixation in All-Inside Anterior Cruciate Ligament Reconstruction With Quadriceps Tendon Autograft

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Abstract: The all-inside anterior cruciate ligament reconstruction technique has gained popularity because of its ability to preserve bone stock, accommodate shorter graft lengths, and reduce postoperative pain. Traditionally, this technique uses metallic cortical suspensory buttons for graft fixation, which are reliable but may cause soft-tissue irritation and hardware prominence. A recent modification to traditional all-inside suspensory fixation uses all-suture cortical buttons, eliminating the need for metallic or screw-based implants while maintaining secure fixation. This Technical Note describes an all-inside anterior cruciate ligament reconstruction technique that uses an all—soft tissue quadriceps tendon autograft, secured with only suture-based buttons (no metal, no plastic) on both the femoral and tibial sides.

The method of graft fixation is one of the most critical determinants of clinical success in anterior cruciate ligament reconstruction (ACLR).[1] In efforts to optimize outcomes, fixation methods for ACLR have evolved significantly over the past decades, with suspensory cortical button fixation becoming widely used because of its high strength and low profile.[2-4] However, traditional metallic buttons can fail at the suture-button interface, present challenges during deployment on the femoral cortex, and may cause soft-tissue irritation or hardware prominence, sometimes requiring additional surgery.[5,6] In addition, concerns about metal sensitivity place some patients at risk of adverse reactions.[7]

The next evolution in this technology is the all-suture cortical button, known as a Soft-Button (SB), which offers dynamic length adjustment, the ability to reflip the button, and enhanced conformity to bony surfaces. This design can theoretically improve graft security while reducing the risk of soft tissue irritation or hardware prominence that may occur with traditional metallic buttons.

This Technical Note describes the surgical technique for ACLR using an all-soft tissue quadriceps tendon (QT) autograft combined with suspensory fixation using SBs for both femoral and tibial fixation. Emphasis is placed on the specific steps required to deploy and tension the SB implants. This approach provides a reproducible method for ACLR using SB fixation technology.

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Surgical Technique

Surgical Position

The patient is placed supine with all bony prominences padded. After examination under anesthesia, a high-thigh tourniquet is applied, and key landmarks, including anteromedial and anterolateral portal sites, are marked.

Diagnostic Arthroscopy and Graft Harvest

When a positive pivot shift is appreciated, graft harvest is begun. Alternatively, diagnostic arthroscopy can be performed first to confirm ACL rupture and assess for any concomitant intra-articular pathologies. During graft harvest, an approximately 2- to 3-cm incision is made just proximal to the proximal pole of the patella, and an all-soft tissue QT autograft is harvested, following the technique described by Stokes et al.[8]

Graft Preparation

On the back table, the harvested QT graft is secured on a graft preparation board. Graft preparation is performed identically to the technique described by Stokes et al.,[9] with the main difference being the use of the FiberTag TightRope Soft-Button implant (Arthrex), which features all-suture cortical buttons (Fig 1). Both femoral and tibial ends are secured with FiberTag sutures and whipstitches. The final graft construct includes (Fig 2) the following:

- a yellow radiopaque SB for cortical fixation;
- a blue leading suture on both femoral and tibial sides, used for shuttling the graft through bone tunnels;
- white tensioning limbs for advancing the graft after button deployment;

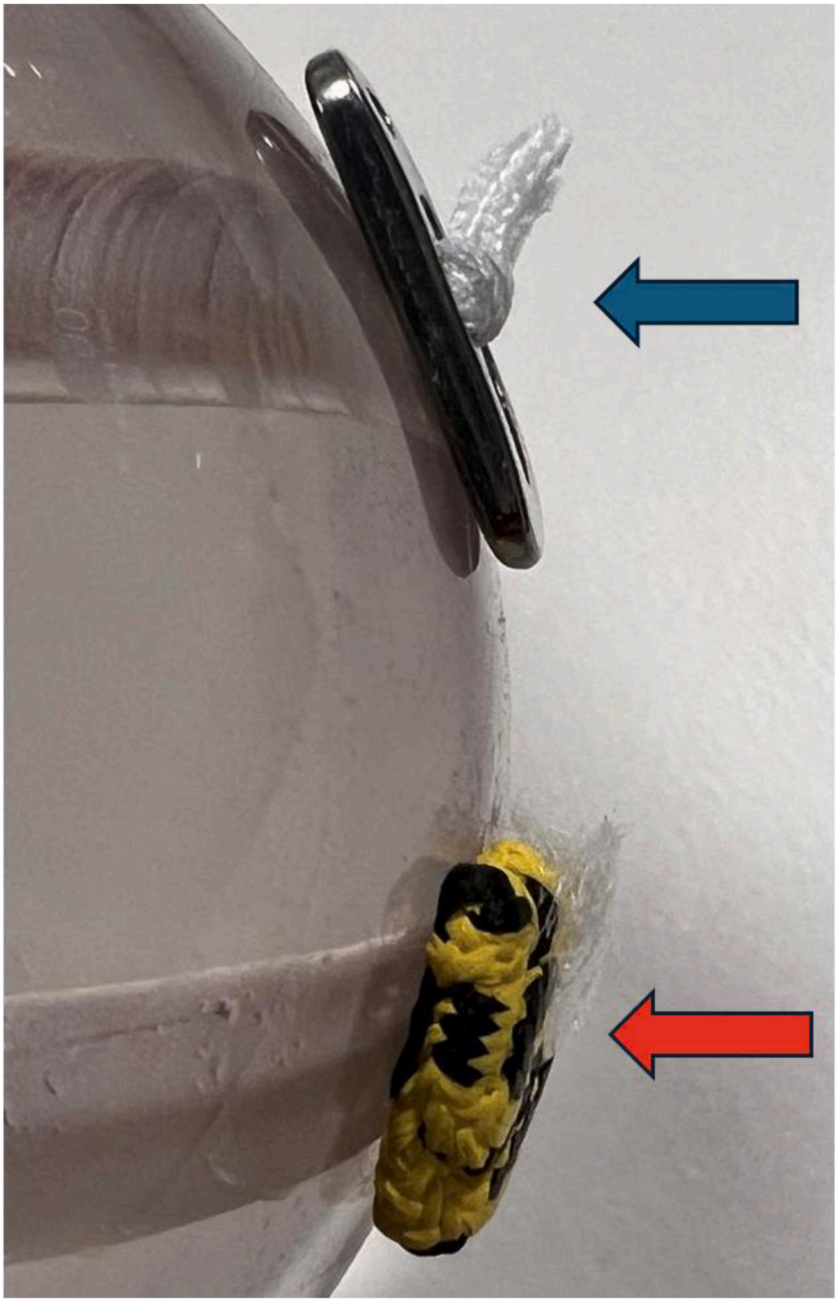

Fig 1. External comparison of suspensory fixation devices. Red arrow shows the deployed all-suture cortical button, showing its low profile and smooth contour against the cortical bone surface. Blue arrow shows the traditional fixed loop "flip" button.

Fig 2. Final anterior cruciate ligament graft construct. The construct includes yellow radiopaque Soft-Button (SB) implant (red arrow) for both tibia and femoral fixation, blue leading suture (blue arrow) for shuttling graft through bone tunnels on both tibial and femoral sides, white tensioning strands (purple arrow), which are pulled to shorten the FiberTag attached to the graft, black/white auxiliary suture (orange arrow), which allows adjustment of the SB by elongating the button when tension is applied in opposite direction against blue leading suture, and the preloaded suture for graft augmentation (green arrow).

- a black/white auxiliary elongation suture, which allows adjustment of the SB by elongating the all-suture button when tension is applied in opposite directions against the blue leading suture; and
- optional suture tape for ligament augmentation.

Tunnel Preparation

The senior author drills the femoral tunnel via the anteromedial portal with the knee hyperflexed. After removing residual ACL tissue, the femoral footprint is marked and confirmed arthroscopically. A 2.7-mm guide pin is placed with a 1- to 2-mm back wall, and an all-inside tunnel is drilled to 22 to 25 mm using a rigid reamer sized to the graft (9 mm). The outer cortex is over-reamed with a 4.0-mm reamer for button passage, bone debris is cleared, and a passing suture is placed through the lateral cortex for later graft passage.

For the tibial tunnel, a retrograde reamer (FlipCutter III; Arthrex) is advanced from the anteromedial tibial cortex to the ACL footprint using a tibial aiming guide, with placement confirmed arthroscopically. Once visualized, the blade is opened to the desired size, and an all-inside tunnel matching the graft diameter (e.g., 9 mm) is drilled in retrograde fashion while preserving the anterior cortex. Debris is cleared, and a passing suture is introduced through the tibial tunnel and retrieved out the anteromedial portal for later graft passage.

Femoral Graft Passage

Before graft and SB passage, the SB is elongated by pulling the blue leading suture and the black/white auxiliary suture in opposite directions to ensure smooth tunnel passage (Fig 3). Once the SB is elongated, the blue leading suture and white tensioning strands are passed through the anteromedial portal and routed up the femoral tunnel using the previously placed passing suture (Fig 4). Of note, the suture tape limbs (for the internal brace augmentation technique) and the black/white auxiliary suture limbs (used for elongation of the SB) are not passed with the other sutures through the femoral tunnel. They are instead maintained through the anteromedial portal. (Table 1)

During SB passage, tension is maintained on the leading blue sutures (along with the white sutures) with one hand, while the other hand holds onto the opposite end of the graft, to keep the SB elongated. The SB is advanced through the femoral tunnel until the SB exits the lateral femoral cortex (Fig 5). Slack can be reduced on the black/white auxiliary sutures as needed as the SB is passed. Visualization from the anteromedial portal confirms that the button has cleared the lateral cortex. As with all suspensory cortical buttons, ensuring clearance of the lateral cortex before deploying the device is crucial.

To deploy (i.e., bunch up) the SB and secure it against the femoral cortex, either the opposite end of the graft or the suture tape is pulled. It is essential not to pull on the black/white auxiliary suture at this stage, as doing so may undeploy the SB implant and pull it back into the tunnel. Once the SB is deployed and secured against the lateral femoral cortex, if desired, an intraoperative fluoroscopy image can confirm the placement of the SB, which is designed with radiopacity to help with identification of the implant (Fig 6). Once a satisfactory position of the SB is confirmed, the trailing black/white auxiliary suture can be removed by pulling on one limb (both limbs are already out of the medial portal). At this point, the SB can no longer be undeployed, as the black/white

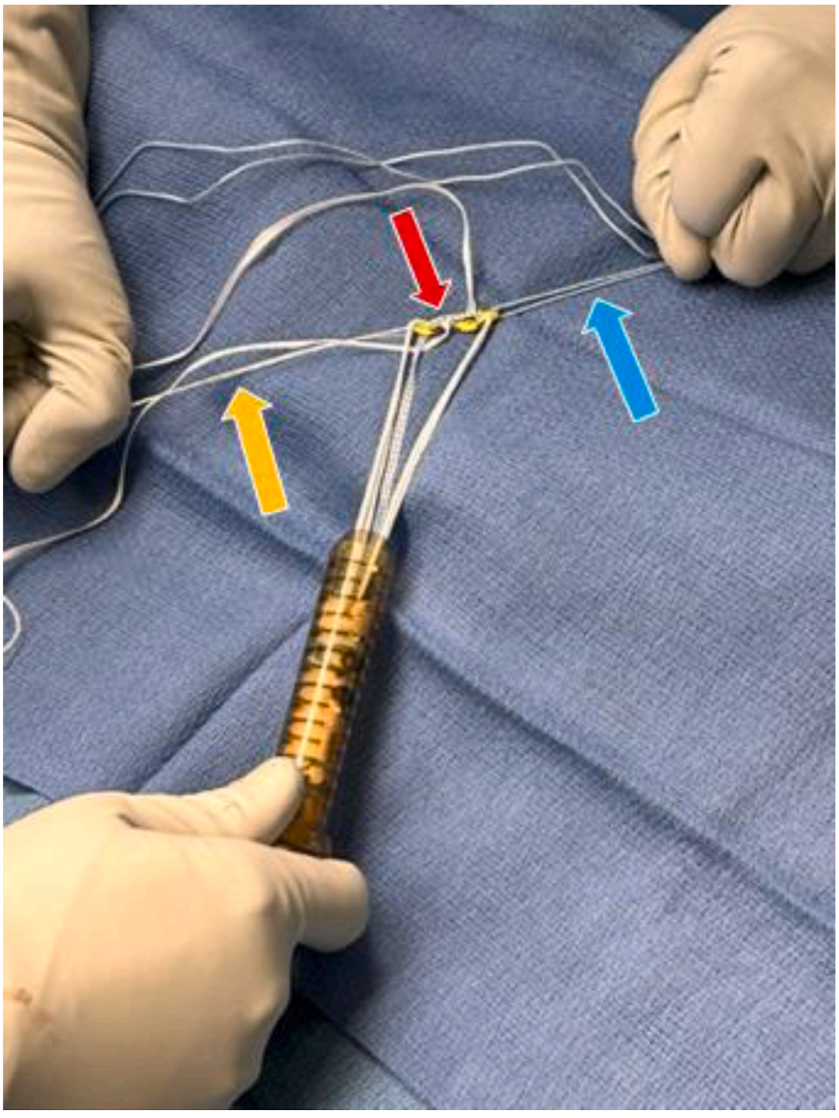

Fig 3. Elongation of the Soft-Button (SB). Before graft passage, the black/white auxiliary suture (orange arrow) and blue leading suture (blue arrow) are pulled in opposite directions to allow the SB (red arrow) to elongate and permit smooth passage through its respective bone tunnel.

auxiliary suture is necessary to re-elongate the SB in the event of improper placement. The graft is then tensioned into the femoral tunnel by alternately pulling the white tightrope tensioning strands until approximately 15 to 20 mm of graft is in the tunnel. Final tightening does not occur until the tibial passage is complete.

Tibial Graft Passage

Attention is turned to the tibial graft passage. Before passage, the button is elongated by pulling the blue leading suture and black/white auxiliary in opposite directions (Fig 2). The tibial-sided white tensioning strands, blue leading suture, and suture tape are gathered and passed through the tibial tunnel using the previously placed passing suture. The black/white auxiliary suture remains outside the portal to control elongation, with gentle tension maintained against the blue leading suture during passage. When elongated, a firm pull on all limbs of the tensioning device and blue leading suture allows the button to exit retrograde through the 3.5-mm cortical hole created by the FlipCutter and be visualized in the tibial incision (Fig 7).

Once the SB emerges from the tibial tunnel, the graft is cycled approximately 15 to 20 times. Next, to tension the tibial SB down to the tibial cortex, the tip of a needle driver (or probe) can be placed behind the button to provide counter-tension against the SB sutures as they are tensioned. As the SB approaches the tibial cortex, it is pinched to flatten it against the bone.

If performing the suture augmentation technique, the suture tapes are secured approximately 1 cm distal to the tibial tunnel aperture into a 4.75-mm PEEK (polyether ether ketone) SwiveLock suture anchor with the knee in full extension. Final tibial graft

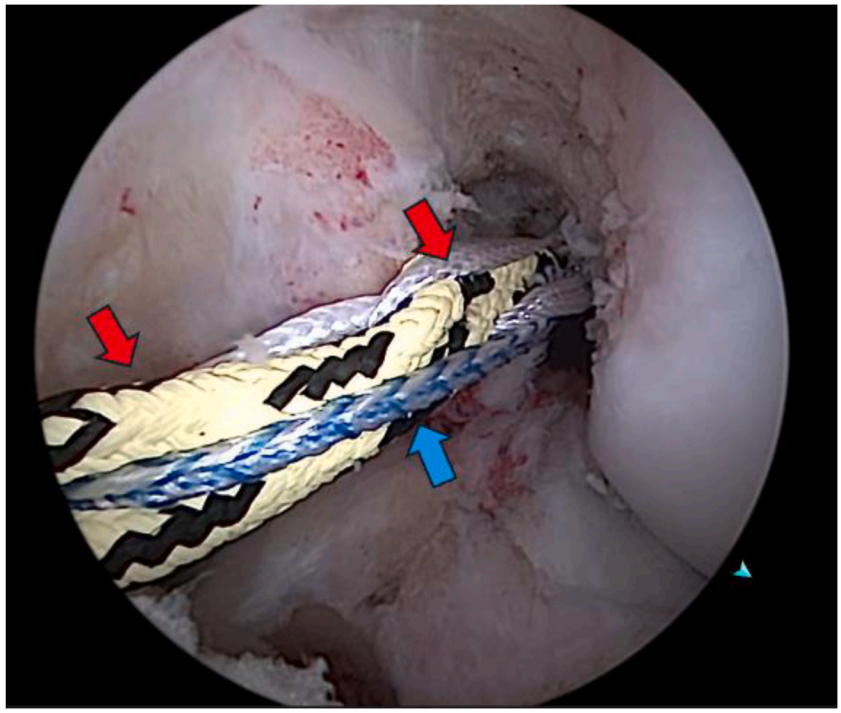

Fig 4. Viewed from the anteromedial portal, multiple red arrows identify the elongated cortical button within the joint before tunnel passage. The blue arrow highlights the passing suture used to shuttle the construct.

tensioning is then performed by pulling the white tensioning sutures to seat the SB against the tibial cortex, which is further flattened with a dull bone tamp. After confirming proper SB placement, the black/white auxiliary suture is removed, femoral tensioning is completed if needed, and the blue leading sutures from both SBs are removed to finalize fixation.

Closure

All surgical incisions are irrigated and closed in a layered fashion. Sterile dressings are then applied, and the patient is placed in a hinge knee brace.

Table 1. Pearls and Pitfalls of Soft-Button (SB) Fixation in Anterior Cruciate Ligament Reconstruction

Pearls	Pitfalls
Ensure the SB is fully elongated by pulling the blue leading suture and black/white auxiliary suture in opposite directions before graft passage.	Attempting graft passage without first fully elongating the SB.
Maintain tension on the black/white auxiliary suture during passage to keep the SB elongated, especially when advancing the button through tunnels.	Losing tension on the black/white suture during passage may allow the SB to bunch prematurely, complicating graft passage.
Confirm complete SB deployment arthroscopically or fluoroscopically before removing the black/white suture.	Removing the black/white suture prematurely eliminates the option to elongate and reposition the SB if needed.

Discussion

Proper ACL graft fixation remains crucial to minimizing graft failure and ensuring reliable outcomes.[10,11] Among the many fixation methods, suspensory cortical buttons are widely used, in part because of their patient-reported outcomes, low profile, relative ease of use, and excellent biomechanical strength.[12-16] Traditionally, these cortical buttons have been metallic; however, concerns about hardware prominence, soft-tissue irritation, metal sensitivity, and issues such as suture-button interface failure or challenges with deployment or bone contact have spurred further innovation.[6,17,18] The all-suture suspensory fixation system represents such an evolution, aiming to enhance fixation while minimizing implant-related morbidity.

The all-suture suspensory fixation system offers several advantages. Eliminating metal implants may reduce irritation, concerns about metal sensitivity, and the weak metal-suture interface seen in traditional designs.[5] The device can be undeployed and redeployed if needed, is radiopaque for placement confirmation, and can be reshaped for a low-profile fit against cortical bone. It is compatible with standard ACLR techniques, requires no changes in instrumentation, and may be advantageous in revision surgery, where metallic implants can be challenging to remove and cause debris.[19] Without metal, postoperative magnetic resonance imaging scanning is free from artifact. Collectively, these features aim to improve fixation security and efficiency while minimizing implant-related morbidity. (Table 2)

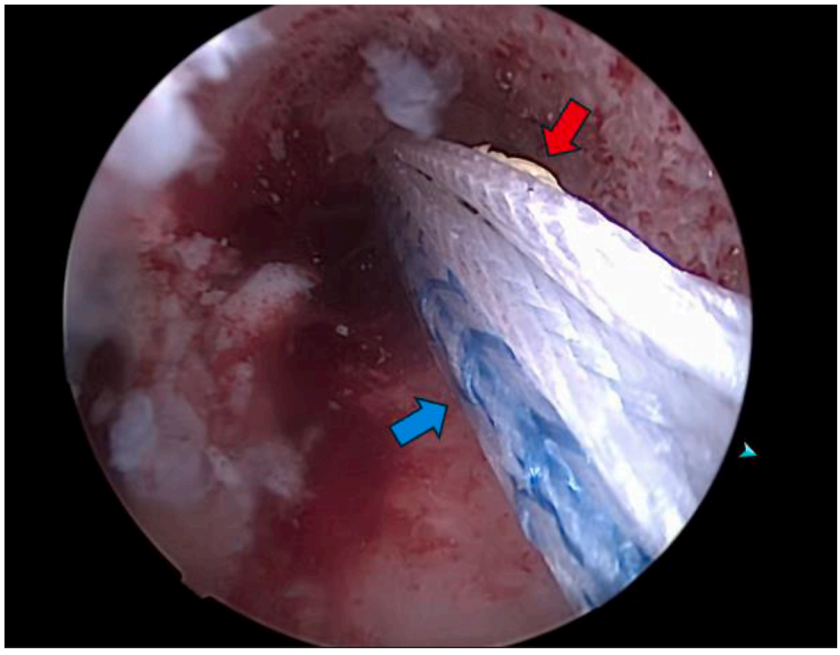

Fig 5. The elongated all-suture cortical button (red arrow) is visualized as it advances toward the lateral femoral cortex before deployment. The blue arrow identifies the passing suture guiding button passage through the femoral tunnel.

Limitations include the need for precise graft preparation, implant deployment, and tunnel creation, as well as limited long-term clinical data compared with metallic devices. Further research is needed to assess durability and patient-reported outcomes.

Disclosures

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: R.M.F. reports board membership with American Academy of Orthopaedic

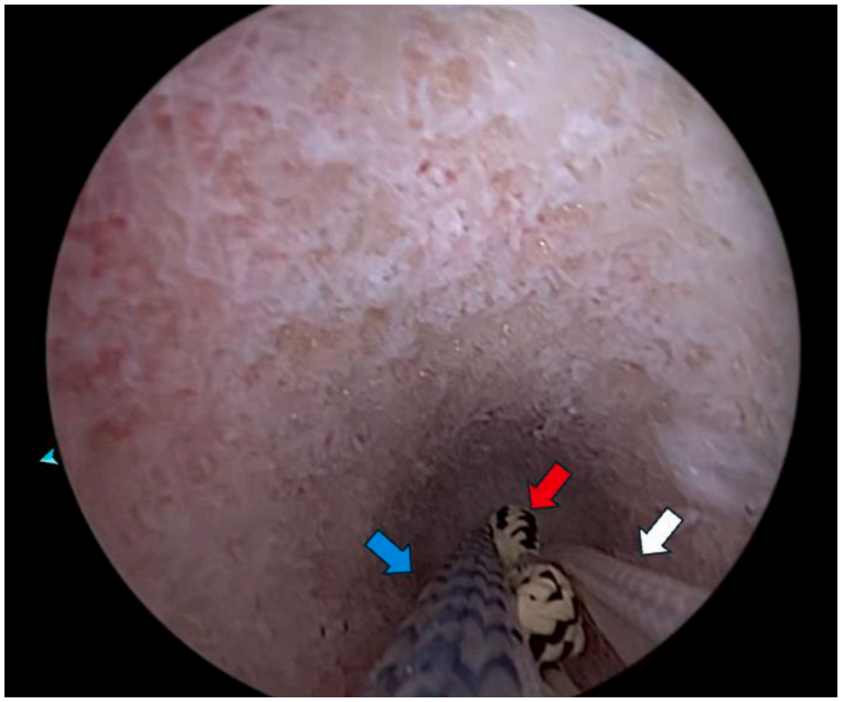

Fig 6. Postoperative radiographs after SB ACL reconstruction. AP (left) and lateral (right) views of the knee show the position of the radiopaque SB (red arrow) well seated on the lateral femoral and medial tibial cortices in a bunched formation. (ACL, anterior cruciate ligament; AP, anteroposterior; SB, SoftButton.)

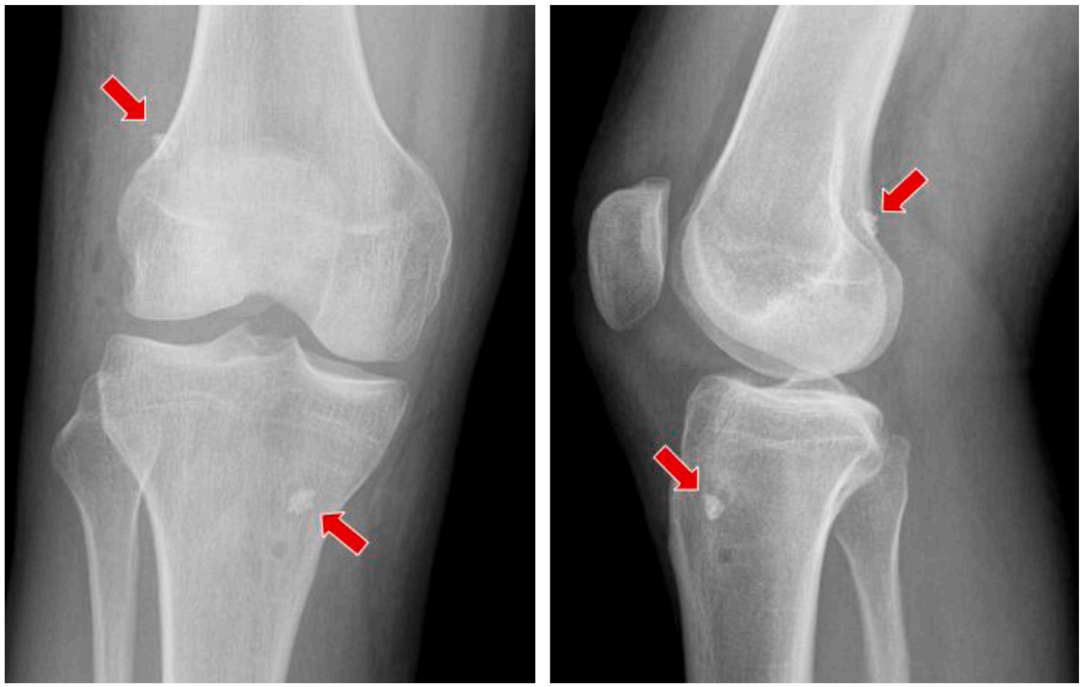

Fig 7. Arthroscopic view down the tibial tunnel from the anteromedial portal. The elongated all-suture suspensory button (red arrow) is shown just before exiting the tibial cortex. The white tensioning suture (white arrow) and the blue passing suture (blue arrow) are also visualized as they exit the tibial tunnel, guiding the passage of the guiding button and the advancement of the graft.

Surgeons, American Orthopaedic Society for Sports Medicine, American Shoulder and Elbow Surgeons, Arthroscopy Association of North America, International Cartilage Regeneration & Joint Preservation Society, International Society of Arthroscopy Knee Surgery and Orthopaedic Sports Medicine, *Journal of Shoulder and Elbow Surgery*, and *Orthopedics Today*; consulting or advisory with and speaking and lecture fees from AlloSource and JRF Ortho; consulting or advisory, funding grants, and speaking and lecture fees from Arthrex; and speaking and lecture fees from Ossur. J.J.M. reports other Professional Activities from Vericel and Arthrex; Social Media Committee and Council of Delegates for American Orthopaedic Society for Sports Medicine; and editorial board, *Journal of Cartilage and Joint Preservation*. J.B. reports consulting or advisory with Arthrex. A.K. reports consulting or advisory and equity or stocks with Arthrex; board or committee member, Arthroscopy Association of North America and International Cartilage Repair Society; and Editorial or governing board, Springer and *American Journal of Sports Medicine*. All other authors (E.H.R., J.C.H., B.M.M.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Table 2. Advantages and Disadvantages of Soft-Button (SB) Fixation in Anterior Cruciate Ligament Reconstruction

Advantages	Disadvantages
Eliminates metal implants, potentially reducing hardware-related complications such as soft tissue irritation or prominence.	Requires meticulous technique to avoid premature SB deployment or incomplete flipping during passage.
Allows ability to reflip the button if repositioning is necessary.	Limited long-term clinical outcome data specifically for all-suture SB devices compared to traditional metallic buttons.
Radiopaque SB material enables intraoperative fluoroscopic confirmation of button positioning.	Newer implant cost
SutureTape provides optional augmentation for additional graft protection	Learning curve for surgeons unfamiliar with managing multiple sutures and the mechanics of the all-suture SB system.

Declaration of Generative AI and AI-assisted Technologies in the Writing Process

During the preparation of this work, the authors used Microsoft CoPilot to assist with editing and language refinement for portions of the manuscript text to improve clarity and readability. After using this tool, the authors reviewed and edited the content as needed

and take full responsibility for the content of the publication.

References

1. Jagodzinski M, Krettek C. Evolving techniques in ACL graft fixation. *Tech Orthop* 2013;28:119.
2. McDermott E, DeFoor MT, Blaber OK, Aman ZS, DePhillipo NN, Dekker TJ. Biomechanical comparison of anterior cruciate ligament reconstruction fixation methods and implications on clinical outcomes. *Ann Jt* 2023;8.
3. Ehrensberger M, Hohman DW, Duncan K, Howard C, Bisson L. Biomechanical comparison of femoral fixation devices for anterior cruciate ligament reconstruction using a novel testing method. *Clin Biomech* 2013;28:193-198.
4. Fu CW, Chen WC, Lu YC. Is all-inside with suspensory cortical button fixation a superior technique for anterior cruciate ligament reconstruction surgery? A systematic review and meta-analysis. *BMC Musculoskelet Disord* 2020;21.
5. Deichsel A, Leibrandt L, Raschke MJ, et al. Biomechanical stability of third-generation adjustable suture loop devices versus continuous loop button device for cortical fixation of ACL tendon grafts. *Orthop J Sport Med* 2024;12(4).
6. Taketomi S, Inui H, Hirota J, et al. Iliotibial band irritation caused by the EndoButton after anatomic double-bundle anterior cruciate ligament reconstruction: Report of two cases. *Knee* 2013;20:291-294.
7. Tajima T, Hosoki M, Miyagi M, et al. Correlation between pierced earrings and the prevalence of metal allergies at Tokushima University Hospital: A 15-year retrospective analysis. *Sci Rep* 2025 151. 2025;15:1-11.
8. Stokes DJ, Cram TR, Elrick BP, Schantz K, Shinsako KK, Frank RM. Anterior cruciate ligament reconstruction basics: Quadriceps tendon (all-soft tissue) autograft harvest—part 1. *Arthrosc Tech* 2024;13(12).
9. Stokes DJ, Elrick BP, Cram TR, Schantz K, Shinsako KK, Frank RM. Anterior cruciate ligament reconstruction basics: Quadriceps tendon (all-soft tissue) autograft preparation—part 2. *Arthrosc Tech* 2024;13(12).
10. Jiang H, Ma G, Li Q, Hu Y, Li J, Tang X. Cortical button versus cross-pin femoral fixation for hamstring anterior cruciate ligament reconstruction: A meta-analysis of randomized controlled trials. *Am J Sports Med* 2018;46:2277-2284.
11. Hagemans FJA, Jonkers FJ, van Dam MJJ, von Gerhardt AL, van der List JP. Clinical and radiographic outcomes of anterior cruciate ligament reconstruction with hamstring tendon graft and femoral cortical button fixation at minimum 20-year follow-up. *Am J Sports Med* 2020;48:2962-2969.
12. Browning WM, Kluczynski MA, Curatolo C, Marzo JM. suspensory versus aperture fixation of a quadrupled hamstring tendon autograft in anterior cruciate ligament reconstruction: A meta-analysis. *Am J Sports Med* 2017;45(10):2418-2427.
13. Lubowitz JH, Schwartzberg R, Smith P. Randomized controlled trial comparing all-inside anterior cruciate ligament reconstruction technique with anterior cruciate ligament reconstruction with a full tibial tunnel. *Arthroscopy* 2013;29:1195-1200.
14. Saccomanno MF, Shin JJ, Mascarenhas R, et al. Clinical and functional outcomes after anterior cruciate ligament reconstruction using cortical button fixation versus transfemoral suspensory fixation: A systematic review of randomized controlled trials. *Arthrosc J Arthrosc Relat Surg* 2014;30:1491-1498.
15. Connaughton AJ, Geeslin AG, Uggen CW. All-inside ACL reconstruction: How does it compare to standard ACL reconstruction techniques? *J Orthop* 2017;14:241-246.
16. Nie S, Zhou S, Huang W. Femoral fixation methods for hamstring graft in anterior cruciate ligament reconstruction: A network meta-analysis of controlled clinical trials. *PLoS One* 2022;17:e0275097.
17. Eichinger M, Ploner M, Degenhart G, et al. Tunnel widening after ACL reconstruction with different fixation techniques: Aperture fixation with biodegradable interference screws versus all-inside technique with suspensory cortical buttons. 5-year data from a prospective randomized trial. *Arch Orthop Trauma Surg* 2023;143:6707.
18. Mayr R, Smekal V, Koidl C, et al. Tunnel widening after ACL reconstruction with aperture screw fixation or all-inside reconstruction with suspensory cortical button fixation: Volumetric measurements on CT and MRI scans. *Knee* 2017;24:1047-1054.
19. Cosgarea AJ, Thomas D, Jones M. Femoral interference screw removal complicating revision anterior cruciate ligament reconstruction. *Arthroscopy* 2000;16:1-5.