

Sutured Tape Pull-Through Technique in Arthroscopic Fixation of Neglected ACL Avulsion: A Technical Note

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Abstract

Introduction: Anterior cruciate ligament (ACL) avulsion fractures, although rare, can cause significant knee instability if untreated. High-energy trauma is the primary cause, often requiring surgical intervention for neglected cases. This case report presents a neglected ACL avulsion fracture treated with Arthroscopic Reduction Internal Fixation (ARIF) using suture tape pull-through.

Case Presentation: A 22-year-old female presented with right knee pain and instability for three months following a motorcycle accident five months earlier. Clinical examination revealed ACL instability. Plain radiographs and MRI confirmed avulsion of the tibial eminence, confirmed by plain radiographs and MRI showing avulsion of the tibial eminence with a partial tear of the posterolateral ACL bundle. The patient underwent ARIF using a suture tape pull-through technique. The avulsed fragment was anatomically reduced and fixed with a double-stranded Ethibond suture and endobutton. Postoperative radiographs confirmed stable fixation. Six weeks following surgery, active range of motion was initiated, and by the end of seven weeks, the patient was gradually progressed to full weight bearing.

Discussion: Neglected ACL avulsion fractures pose challenges due to chronic instability. The arthroscopic approach minimizes soft tissue disruption and enhances joint visualization, which is crucial in complex cases. The suture tape pull-through technique ensures robust fixation, biomechanical stability, and preserves native alignment. This technique avoids common complications associated with traditional methods, such as implant migration or failure. Postoperative rehabilitation ensured progressive recovery, and the patient demonstrated marked improvement in stability and function.

Conclusion: ARIF using the suture tape pull-through technique is an effective, minimally invasive approach for managing neglected ACL avulsion fractures. This case underscores its utility in ensuring anatomical reduction, stable fixation, and early recovery, supporting its role as a preferred treatment option for delayed presentations.

Keywords: Anterior Cruciate Ligament, Avulsion, ARIF, Case Report

Introduction

Anterior cruciate ligament (ACL) avulsion injuries are relatively rare but can result in significant knee instability, particularly when neglected. These injuries are predominantly seen in younger populations, especially adolescents and young adults, where the tibial eminence is weaker compared to the ACL itself. Epidemiological studies estimate that ACL avulsion fractures account for 3-5% of all ACL injuries, with a higher prevalence among pediatric and adolescent groups due to their unique skeletal anatomy and biomechanical factors.^{1,2}

High-energy trauma, such as motor vehicle accidents,

sports injuries, or falls from a height, is the primary mechanism leading to ACL avulsion fractures. Activities involving sudden deceleration, hyperextension, or rotational forces on the knee are commonly implicated. Males are generally more affected than females, which may be related to higher participation in high-impact sports and occupational hazards. In adult populations, neglected ACL avulsions are frequently associated with high-energy trauma such as traffic accidents or falls, and these injuries may coexist with other intra-articular knee injuries. Understanding the age, sex, and activity profile of patients prone to

neglected ACL avulsions helps in optimizing treatment strategies and tailoring post-operative rehabilitation for functional recovery.^{3,4}

When left untreated, these injuries can lead to chronic instability, reduced functional capacity, and long-term complications such as early-onset osteoarthritis.⁵ Surgical intervention is often required for neglected cases to restore knee biomechanics and prevent further deterioration. Arthroscopic Reduction Internal Fixation (ARIF) has emerged as a minimally invasive surgical approach, providing precise anatomical reduction and stable fixation while promoting faster recovery.^{6,7}

Neglected anterior cruciate ligament (ACL) avulsion fractures, often resulting from delayed diagnosis or inadequate initial treatment, pose significant challenges due to associated fibrosis, malalignment, and joint instability.⁸ Traditional open reduction and internal fixation methods can lead to increased morbidity due to soft-tissue injury and arthrotomy. Consequently, arthroscopic techniques have gained popularity for their minimally invasive nature and favourable outcomes.^{9,10} Keywords based on MeSH: "Anterior Cruciate Ligament Injuries," "Arthroscopy," "Ligament Injuries," "Fracture Fixation," "Sutures."

This report highlights the application of ARIF using a suture tape pull-through technique for a neglected ACL avulsion fracture, detailing the surgical steps, challenges, and outcomes.

Case Presentation

A 22-year-old female patient presented to our outpatient clinic complaining of right knee pain for 3 months ago, as well as instability in her knee when walking up and down stairs. She had a history of motorcycle accident since 5 months ago and she would not come to hospital. Anterior drawer test, Lachman test, and pivot shift test were suggestive of ACL instability on physical examination. A plain radiograph showed avulsion of the ACL from its full insertion (Figure 1). The patient also had magnetic resonance imaging results avulsion fracture of the right medial tubercle with a partial thickness tear of the posterolateral bundle of the ACL (Figure 2). The patient was performed arthroscopic reduction internal fixation using suture tape with a pull through technique.

Position and Portal Placement

A tourniquet was applied to the affected knee and the



Figure 1. Lateral Knee X-Ray Showed Fractured Tibial Eminence (Green Circle).



Figure 2. Preoperative MRI T2 Weighted Magnetic Resonance Imaging Scans Showed ACL Avulsion (Green Arrow).

patient was positioned supine on the operating table under spinal anesthesia. Anterolateral (AL) and anteromedial (AM) portals were established for diagnostic knee arthroscopy. Arthroscopes are introduced through the AL portal, which is also used to insert instruments, while instruments are introduced through the AM portal.

Identification of Fragment

Using a probe inserted through the AM portal, the avulsed ACL fragment was identified (Figure 3). The authors debrided the soft tissue for the soft tissue by using a shaver and cauterized the bleeding spot from the fragment.

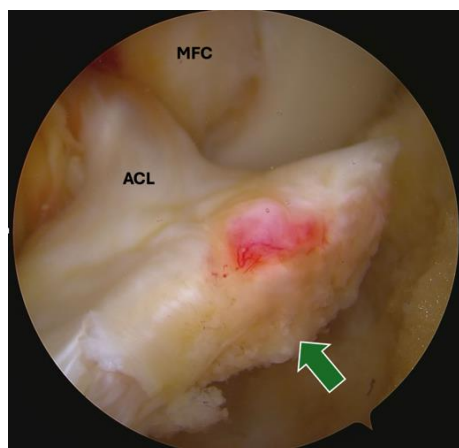


Figure 3. Arthroscopic Image of Right Knee, Viewed from Anterolateral Portal, Showing a Fracture Line Extending from The Medial to the Posterolateral Aspect of the Tibial Eminence.

Fixation Using Sutures and Anchor Placement

A suture hook (Arthrex), loaded with a polydioxanone suture (PDS; Ethicon), is inserted through the anteromedial (AM) portal and positioned just above the ACL insertion site. The suture hook penetrated the medial side of the AM fibers and exit from the anterior two-thirds of the posterolateral fibers (Figure 4A-B).

A double-stranded No. 5 Ethibond was then shuttled into place using apolydioxanone suture. Both ends of the Ethibond are pulled externally through the AM portal, creating a loop outside the joint (Figure 4 C). The Ethibond ends are then fed through the loop and back into the joint, encircling the anterior two-thirds of the ACL.

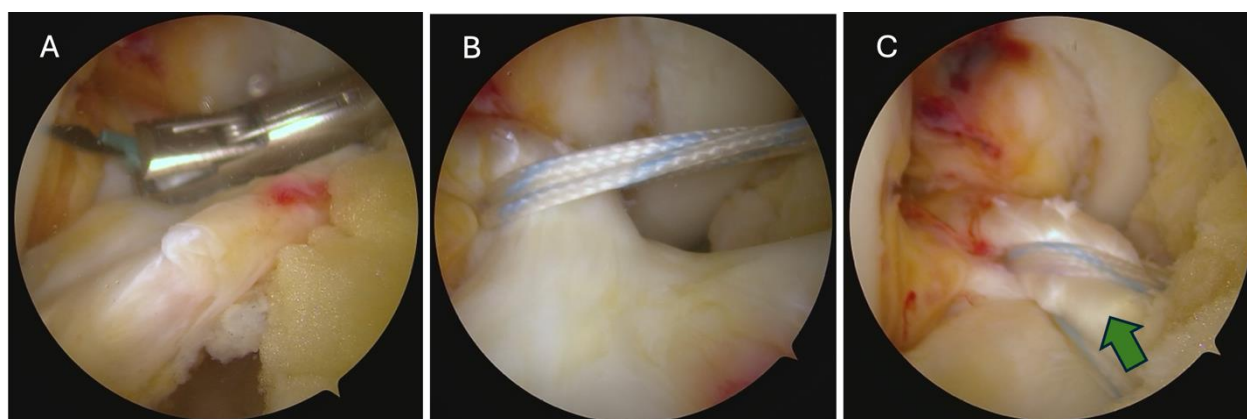


Figure 4. (A - B) Arthroscopic image showing double-stranded No. 5 Ethibond suture shuttled into place by polydioxanone suture, encircling approximately three-fourths of the anterior cruciate ligament (ACL) substance just above its insertion. (C) Free end of Ethibond suture was passed beneath the transverse meniscal ligament (TML) and along longitudinal axis of anterior cruciate ligament. The green arrow indicates the Ethibond suture loop.

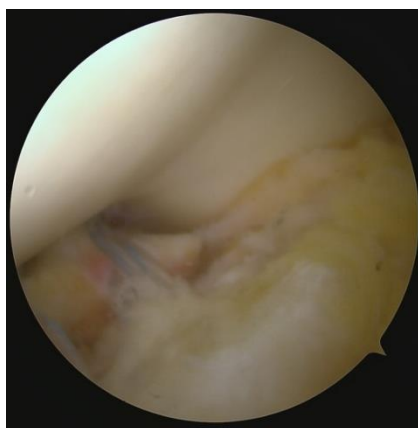


Figure 5. Arthroscopic Image Showing the Avulsion Fragment was Repositioned Well and Stable at the Inserted Point.

The anterior tibial slope bone area, located just beneath the transverse meniscal ligament and 0.5 to 0.8 cm anterior



Figure 6. A Plain X-Ray Post-Operative Showed the Endobutton had Fixated the Avulsion Fragment Properly.

to the ACL insertion (Figure 5). An Endobutton was placed at 90° degrees of knee flexion to lock double-

stranded Ethibond end (Figure 6). Proper tension was maintained on the sutures to achieve anatomic reduction of the avulsed fragment.

Final Evaluation and Wound Closure

Under the arthroscopic procedure, stable fixation was seen on the patient's knee flexion and extension. After the arthroscope and instrument have been removed, the knee is irrigated to remove any debris. Portal incisions were closed in a subcuticular fashion with No. 3-0 sutures and protected with adhesive tapes.

Post-Operative Rehabilitation Program

The injured leg is immobilized in a full-extension (0°) and 30° of flexion using a knee brace with no weight bearing for three weeks. The patient was instructed to utilize crutches. Range-of-motion exercises, either passive or aided, were initiated during this time and progressively increased. After that, partial weight-bearing starts. Active range of motion exercises are initiated six weeks postoperatively, with gradual progression to full weight-bearing by the end of the seventh week, as tolerated by the patient.

Discussion

Neglected ACL avulsion fractures pose unique challenges due to prolonged instability and potential for chronic functional impairment. Early identification and treatment are often hindered by delayed presentation, as observed in this case. The arthroscopic approach offers distinct advantages, including minimal soft tissue disruption, reduced morbidity, and superior visualization of the joint structures, which is particularly beneficial in neglected injuries with complex fracture morphology.^{11,12}

The suture tape pull-through technique employed in this case provided robust fixation by evenly distributing tension across the avulsed fragment. The use of an Endobutton for anchoring the suture tape ensured biomechanical stability while preserving the native anatomical alignment. This method minimizes the risk of complications such as implant migration or failure, which are more common in traditional screw-based techniques.^{10,13}

In comparison, traditional screw fixation methods for ACL avulsion fractures provide adequate biomechanical strength and satisfactory long-term outcomes. However, they are associated with certain complication rates,

including hardware-related issues. Alternative fixation techniques, such as TightRope fixation, may offer comparable or superior biomechanical stability and could potentially reduce specific complications associated with screw fixation. Further research is warranted to comprehensively compare these methods in terms of clinical outcomes and complication rates^{14,15}→ here is the comparison

Traditional screw fixation methods, such as interference screws, have been widely used in the management of anterior cruciate ligament (ACL) avulsion fractures. Studies have evaluated the biomechanical properties of various fixation methods for ACL avulsion fractures. A biomechanical comparison involving porcine knees assessed three fixation techniques: anterograde screw fixation, suture fixation, and TightRope fixation. The results indicated that the maximum load to failure was 311.7 ± 120.3 N for the screw fixation group, 367 ± 115.8 N for the suture group, and 402.5 ± 117.6 N for the TightRope group. These findings suggest that while screw fixation provides substantial strength, alternative methods like TightRope fixation may offer superior biomechanical stability.¹⁵

Postoperative rehabilitation plays a crucial role in restoring knee function. The gradual progression from immobilization to weight-bearing ensures adequate healing of the repaired ligament while preventing complications such as stiffness or reinjury. In this case, the patient demonstrated marked improvement in knee stability and function within the expected recovery timeline, underscoring the effectiveness of the chosen technique.^{16,17}

A review of the literature indicates that ARIF is particularly advantageous in managing ACL avulsion fractures, with outcomes that are comparable or superior to open reduction techniques. However, the success of this method relies heavily on precise surgical execution and adherence to post-operative rehabilitation protocols. This case supports the utility of ARIF in addressing neglected ACL injuries, reinforcing its role as a viable option for patients with delayed presentations.

Conclusion

The suture tape pull-through technique for arthroscopic reduction and internal fixation offers a minimally invasive and efficient solution for treating

neglected ACL avulsion fractures. This approach facilitates precise anatomical alignment, secure fixation, and promotes early return of function. The positive result observed in this case is six weeks following surgery, active range of motion is started, and by the end of seven weeks, the patient has gradually progressed to full weight-bearing. Further research involving larger patient populations is needed to establish the long-term clinical outcomes and safety profile of this method. → findings.

Limitation of Study

The long outcome patient is not mentioned in this study.

With some refinements in clarity, structure, and detail, it can effectively contribute to the medical literature.

Author's Contributor

KMLM: expert, conceptual, review; F: literature search, review, paper preparation.

Conflict of Interest

The authors declare no conflicts of interest.

References

1. Stokes DJ, Strassman AK, Shinsako KK, Difelice GS, Frank RM. Tibial Spine Avulsion Fracture Fixation Using a Re-tensionable All-Suture Construct. *Arthrosc Tech.* 2024;13(7):102983. doi:10.1016/j.eats.2024.102983
2. Patel MR, Butala UK, Thakor NS, Bansod RR, Dhotre RA. Arthroscopic fixation of anterior cruciate ligament tibial avulsion fractures: the suture "bridge" pull out technique and evaluation of results. *Int J Res Orthop.* 2017;3(5):979. doi:10.18203/issn.2455-4510.intjresorthop20173375
3. Park JP, Böttcher J, Burman ML, Martin R, Martineau PA. Posterolateral Tibial Plateau Slope in Tibial Plateau Ligament Injuries. *Arthrosc Tech.* 2020;9(9):e1249-58. doi:10.1016/j.eats.2020.05.003
4. Azeez MQA, Prasad GS. Arthroscopic fixation of anterior cruciate ligament tibial avulsion fractures using fibre wire with endobutton. *Int J Orthop Sci.* 2018;4(4):713-8. doi:10.22271/ortho.2018.v4.i4i.85
5. Jeevan MP, John JT. Effects of neglected anterior cruciate ligament tears on medial and lateral meniscus. *Int J Res Orthop.* 2020;6(4):687-92.
6. Jiang L, Chen E, Huang L, Wang C. Arthroscopy-Assisted Reduction Percutaneous Internal Fixation Versus Open Reduction Internal Fixation for Tibial Plateau Fracture A Systematic Review and Meta-analysis. *Orthop J Sport Med.* 2020;9(12):1-7. doi:10.1177/23259671211027838
7. Wu L, Xu H, Li B, Xu B. Improved arthroscopic high-strength suture fixation for the treatment of posterior cruciate ligament avulsion fracture. *J Orthop Surg.* 2022;30(2):1-7. doi:10.1177/10225536221101701
8. Boutsiadis A, Karataglis D, Agathangelidis F, Ditsios K, Papadopoulos P. Arthroscopic 4-point suture fixation of anterior cruciate ligament tibial avulsion fractures. *Arthrosc Tech.* 2014;3(6):e683-7. doi:10.1016/j.eats.2014.08.008
9. Mortazavi SMJ, Hasani Satehi S, Vosoughi F, Rezaei Dogahe R, Besharaty S. Arthroscopic Fixation of Anterior Cruciate Ligament Avulsion Fracture Using FiberWire Suture With Suture Disc. *Arthrosc Tech.* 2021;10(7):e1709-15. doi:10.1016/j.eats.2021.03.018
10. Du Y, Wang Z, Wu S, Zhou P, Li Z, Yang J, et al. The modified suture-bridge technique for treating avulsion fracture of minors tibial eminence of anterior cruciate ligament: a retrospective study. *J Orthop Surg Res.* 2024;19(1):412. doi:10.1186/s13018-024-04914-6
11. ulkarni RW, Reddy GT, Gajabar S, Talikoti SD. Tibial spine avulsion fractures in adults treated with ACL reconstruction. *Int J Sci Res.* 2023;12(06):47-53.
12. Jagtap S, Arora C. All-Inside Anterior Cruciate Ligament Tibial Avulsion Repair. *Arthrosc Tech.* 2021;10(2):e333-9. doi:10.1016/j.eats.2020.10.014
13. Kelly S, DeFroda S, Nuelle CW. Arthroscopic Assisted Anterior Cruciate Ligament Tibial Spine Avulsion Reduction and Cortical Button Fixation. *Arthrosc Tech.* 2023;12(7):e1033-8. doi:10.1016/j.eats.2023.02.052
14. Barié A, Köpf M, Jaber A, Moradi B, Schmitt H, Huber J, et al. Long-term follow-up after anterior cruciate ligament reconstruction using a press-fit quadriceps tendon-patellar bone autograft. *BMC Musculoskelet Disord.* 2018;19(1):368.. doi:10.1186/s12891-018-2271-8
15. Ezechieli M, Schäfer M, Becher C, Dratzidis A, Glaab R, Ryf C, et al. Biomechanical comparison of different fixation techniques for reconstruction of tibial avulsion fractures of the anterior cruciate ligament. *Int Orthop.* 2013;37(5):919-23. doi:10.1007/s00264-013-1835-3
16. Kumar V, Verma A, Sheoran A, Devgan A, Gupta A. A prospective study evaluating combined arthroscopic anterior cruciate ligament reconstruction and anterolateral extra-articular tenodesis in athletes. *J Orthop Reports.* 2025;4(3):100314. doi:10.1016/j.jorep.2024.100314
17. Febyan, Wiradiputra AE, Aryana IGNW. Arthroscopic reduction and internal fixation of tibial eminence avulsion fracture with depression of tibia plateau involvement: Our experience with modified combined technique. *J Orthop Rep.* 2022;1(4):100080. doi:10.1016/j.jorep.2022.100080