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Exploring PCL Tibial Avulsion Fractures: A Rare Case Series Demonstrating Favorable Outcomes with Mini Open Procedure Using Screw Fixation

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ABSTRACT

Introduction: Posterior cruciate ligament (PCL) tibial avulsion fractures are rare and often underdiagnosed injuries, typically affecting young, active individuals following high-energy trauma. Surgical fixation is essential, but optimal techniques depend on fragment size and morphology.

Case Presentation: We report three cases of isolated PCL tibial avulsion fractures in young adults managed via a mini-open posterior approach. Injuries were confirmed clinically and radiologically. Fixation methods were tailored to fragment characteristics.

Discussion: All patients achieved good short-term outcomes, with Lysholm scores of 86, 88, and 89 at three months postoperatively. Larger fragments were successfully stabilized with screw fixation. No complications related to neurovascular structures or fixation failure were observed.

Conclusion: Mini-open fixation is a safe and effective technique for managing PCL tibial avulsion fractures. Individualized fixation strategies based on fragment size and early rehabilitation contribute to favorable functional outcomes.

Keywords: PCL, avulsion fracture, tibial insertion, mini-open approach, fixation, Lysholm score

INTRODUCTION

Posterior cruciate ligament (PCL) injuries have historically received less clinical and academic attention compared to anterior cruciate ligament (ACL) injuries[1]. However, with the growing emphasis on knee stability and advancements in ligament reconstruction techniques, there is increasing interest in better understanding and managing PCL-related pathologies. Among these, PCL tibial avulsion fractures represent a rare and distinct subset, accounting for approximately 3% to 38% of all PCL injuries[2]. These fractures are more commonly seen in the younger population and often result from high-energy trauma or sports-related injuries[3].

Despite their clinical significance, PCL tibial avulsion fractures are often underdiagnosed, particularly in developing countries across Asia, where access to advanced imaging and specialist care may be limited[4]. This under recognition poses challenges for timely and effective treatment, potentially leading to chronic instability, altered biomechanics, and early degenerative changes of the knee joint[5].

Moreover, given their relative rarity and the lack of consensus on optimal management strategies—particularly concerning surgical technique and fixation methods—PCL tibial avulsion fractures remain a topic of ongoing debate. This case series aims to contribute to

the current understanding by presenting a series of patients with PCL tibial avulsion fractures, highlighting diagnostic challenges, surgical interventions, and functional outcomes observed during follow-up.

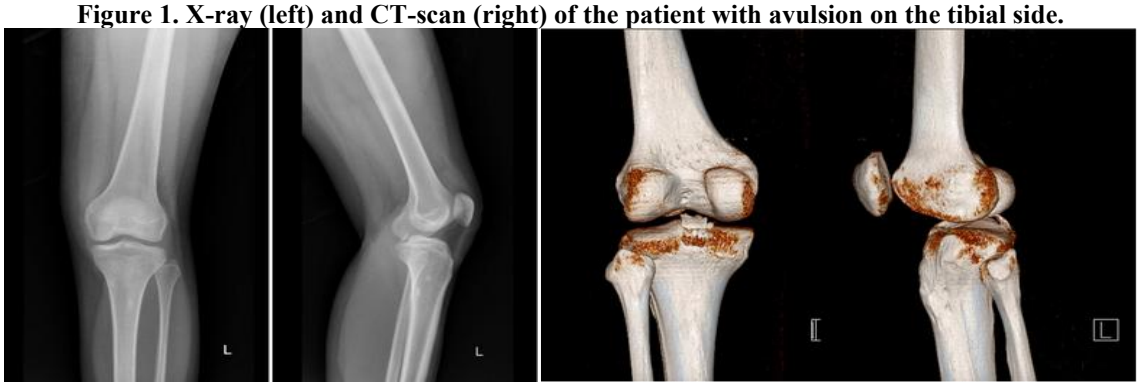
CASE PRESENTATION

The following case presentations elaborate the clinical characteristics, diagnostic findings, management, and short-term functional outcomes of three patients with isolated posterior cruciate ligament (PCL) tibial avulsion fractures treated operatively.

Case 1

A 25-year-old female paramedic presented with complaints of instability in her left knee, which had developed following a motorcycle accident occurring one month prior to admission. Clinical examination revealed a Grade 2 posterior drawer test, suggestive of an isolated PCL injury, with no evidence of ACL or collateral ligament involvement. Radiographic and MRI evaluation confirmed the diagnosis of a PCL tibial avulsion fracture. Surgical fixation was performed, and the patient underwent a structured rehabilitation program. At three months postoperatively, the Lysholm knee score was 89, indicating good functional recovery.

Figure 1. X-ray (left) and CT-scan (right) of the patient with avulsion on the tibial side.



Case 2

A 23-year-old male amateur soccer player reported discomfort and instability in his right knee while walking, following an injury sustained during a competitive match two weeks prior to presentation. Physical examination demonstrated a Grade 3 posterior drawer sign, along with a 1 cm reduction in thigh circumference on the affected side, suggesting quadriceps atrophy. Imaging studies supported the diagnosis of a PCL tibial avulsion injury. The patient underwent operative fixation followed by standardized physiotherapy. At the three-month follow-up, the Lysholm knee score was recorded at 86, denoting satisfactory functional improvement.

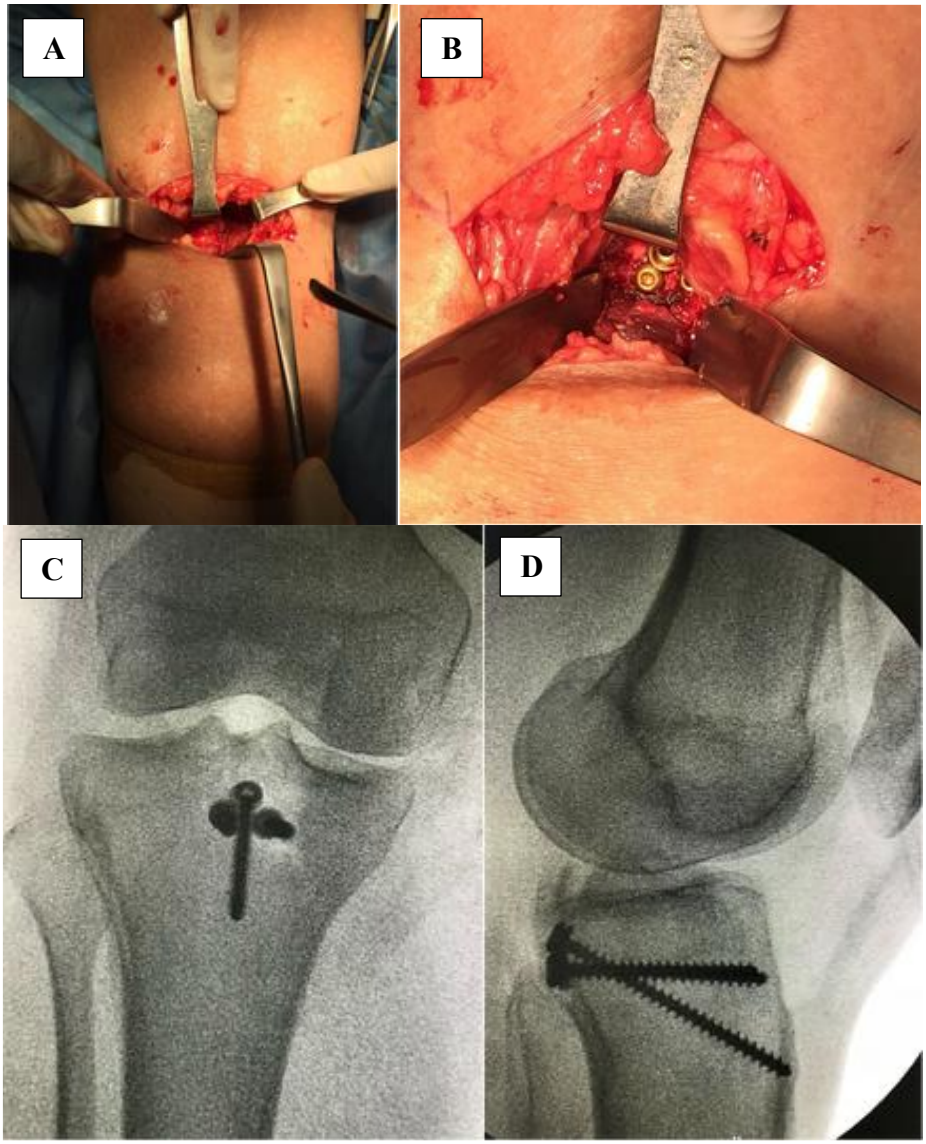
Figure 2. Physical examination of the knee and surgical incision at the posterior tibia was performed.

Case 3

A 30-year-old male recreational basketball player presented with right knee pain and instability after a fall during a jumping maneuver three months before hospital admission. Both X-ray and MRI revealed a

PCL avulsion from its tibial insertion. Clinical assessment confirmed a Grade 3 posterior drawer test and a 1 cm thigh circumference discrepancy, suggestive of muscle deconditioning. Operative treatment was performed successfully, and the patient adhered to postoperative rehabilitation. At three months post-surgery, the Lysholm score was 88, reflecting good clinical and functional outcome.

Figure 3. (A) Exposure of the avulsion site, (B) Final placement of screw construct, (C and D) Posteroanterior and Lateral C-arm view of the final screw construct.



DISCUSSION

In this case series, three patients with isolated PCL avulsion injuries were treated via a mini-open posterior approach, yielding favorable outcomes as reflected by Lysholm scores between 86 and 89 at three months postoperatively. These results are consistent with existing literature supporting the efficacy of surgical management for restoring knee stability and function in such injuries[6,7].

A critical consideration in the operative treatment of PCL avulsion fractures lies in the morphological characteristics of the avulsed fragment. Screw fixation remains the gold standard for large bony fragments; however, its use is limited in small (<10 mm), thin, or comminuted fragments due to poor bone purchase and risk of further fragmentation8. This issue is especially pertinent in high-energy injuries, such as in Case 1, where fragment comminution is

common. In such instances, augmentation with sutures or suture anchors has been recommended to enhance fixation stability while preserving fragment integrity[9].

For intermediate-sized fragments (10–20 mm), Kirschner wires (K-wires) may offer a balance between minimal invasiveness and adequate stabilization, particularly when coupled with supplementary suture fixation. Larger fragments (>20 mm), such as those likely encountered in Cases 2 and 3, are more amenable to screw fixation, with the use of two parallel cannulated screws often recommended to ensure compression and rotational stability[10].

The mini-open posterior approach used in this series allows for direct visualization and manipulation of the avulsion fragment, yet it poses inherent anatomical challenges. The proximity of the popliteal neurovascular bundle requires meticulous dissection, and optimal screw trajectory can be difficult to achieve in the constrained posterior compartment[11]. Despite these technical demands, all three patients achieved excellent early functional outcomes without neurovascular complications, affirming the safety and utility of this approach in experienced hands.

Importantly, the functional results achieved through the mini-open technique in this series are comparable to those reported in arthroscopically managed cases. Arthroscopic fixation methods, including suture-bridge and EndoButton techniques, are less invasive and permit early joint mobilization, but they require specialized equipment and a steep learning curve. Studies comparing arthroscopic and mini-open methods have demonstrated similar outcomes in terms of stability and functional scores, suggesting that open techniques remain a valid alternative, particularly in resource-limited settings[9].

In summary, fixation strategy in PCL tibial avulsion fractures should be individualized based on fragment size and morphology. While arthroscopic methods are increasingly popular, the mini-open approach remains a reliable option with proven functional benefits, as evidenced in our three cases. Early surgical intervention, secure fixation, and structured rehabilitation are key determinants of favorable outcomes.

CONCLUSION

PCL tibial avulsion fractures require prompt recognition and fixation tailored to fragment size and morphology. This case series supports the mini-open posterior approach as a safe and effective technique, offering functional outcomes comparable to arthroscopic methods. Screw fixation remains optimal for larger fragments, while suture augmentation may be indicated in smaller or comminuted cases. Early surgical intervention and structured rehabilitation are essential to achieve favorable clinical results.

Declaration by Authors

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