

Clinical and Functional Outcomes of Posterior Cruciate Ligament Tibial Avulsion Fractures Treated with a Mini-Open Posterior Approach and Internal Fixation: A Case Series

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Learning Point of the Article:

The mini-open posterior approach provides a safe, reproducible, and technically straightforward means of achieving anatomical reduction and stable internal fixation of displaced PCL tibial avulsion fractures, yielding excellent functional and radiological outcomes and offering a practical alternative to arthroscopic fixation in resource-limited settings.

Abstract

Introduction: The posterior cruciate ligament (PCL) is a key posterior stabilizer of the knee, and its injuries commonly present as bony avulsion fractures at the tibial insertion rather than midsubstance tears. Displaced fractures (Meyers–McKeever type II–IV) generally require surgical fixation to restore posterior stability and prevent chronic laxity, pain, and premature osteoarthritis. The mini-open posterior approach allows direct visualization and anatomical reduction of the avulsed fragment while minimizing neurovascular risk.

Case Series: We present a prospective series of patients (age range 20–65 years) with displaced PCL tibial avulsion fractures treated with the mini-open posterior approach and internal fixation using cannulated cancellous screws. Injury mechanisms included road traffic accidents and sports injuries. All patients were followed for a minimum of 12 months and assessed clinically and radiologically, with functional outcomes recorded using the Lysholm and International Knee Documentation Committee (IKDC) scores. Fracture union was achieved in nearly all patients by approximately 12 weeks. Mean Lysholm score improved from 52.3 ± 10.5 preoperatively to 93.6 ± 4.2 postoperatively, and mean IKDC score improved from 48.7 ± 9.8 to 90.1 ± 5.3 . Mean flexion improved from $95.2^\circ \pm 15.4$ to $128.6^\circ \pm 8.7$. Tegner Active score increased from 2.0 ± 0.8 to 5.5 ± 0.9 . KT arthrometer improved from 8.1 ± 2.0 to 1.6 ± 0.7 . Complications were infrequent and included mild residual laxity in a small subset of patients, with no neurovascular injuries.

Conclusion: The mini-open posterior approach with internal fixation is a safe, reproducible, and clinically effective technique for displaced PCL tibial avulsion fractures, providing excellent restoration of knee stability, range of motion, and functional outcomes and remains a practical alternative to arthroscopic fixation, particularly where arthroscopic resources are limited.

Keywords: Posterior cruciate ligament, tibial avulsion fracture, mini-open posterior approach, internal fixation, Lysholm score, International Knee Documentation Committee score.

Introduction

The posterior cruciate ligament (PCL) is the primary restraint against posterior translation of the tibia relative to the femur

[1]. It originates from the lateral surface of the medial femoral condyle and inserts on the posterior tibial plateau, approximately 1–1.5 cm below the joint line, through two

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functional bundles: The anterolateral bundle, which is taut in flexion, and the posteromedial bundle, which is taut in extension.

Unlike midsubstance ligament tears seen more often in adults with high-energy trauma, PCL injuries frequently occur as bony avulsion fractures at the tibial insertion, particularly in younger patients whose ligament is relatively stronger than the underlying bone [2]. The most common mechanism is a dashboard injury sustained during road traffic accidents, in which a posteriorly directed force is applied to the proximal tibia with the knee flexed. Other mechanisms include hyperflexion injuries during sporting activity, hyperextension injuries, and falls onto a flexed knee with direct impact on the tibia.

If left untreated, displaced PCL tibial avulsion fractures can result in chronic posterior instability, anterior knee pain, and accelerated degenerative change [3]. Surgical fixation is generally indicated for displaced fractures corresponding to Meyers–McKeever type II and III injuries [2]. Open reduction and internal fixation through a posterior approach allows direct visualization of the fragment and stable anatomical fixation, and the Burks and Schaffer mini-open approach in particular minimizes neurovascular risk while providing adequate surgical exposure [4]. Although arthroscopic-assisted fixation techniques have been described, open posterior approaches continue to be widely used because of their technical simplicity, cost-effectiveness, and reproducibility, especially in resource-limited settings [5].

This study was undertaken to evaluate the clinical, functional, and radiological outcomes of patients with PCL tibial avulsion fractures treated with the mini-open posterior approach and

internal fixation.

Aims and objectives

- To evaluate the clinical outcomes of patients with PCL tibial avulsion fractures treated using a mini-open posterior approach and internal fixation
- To assess functional recovery using validated scoring systems – the Lysholm Knee Score and the International Knee Documentation Committee (IKDC) score
- To determine the effectiveness of the procedure in restoring knee stability (posterior drawer test) and range of motion (ROM)
- To analyze radiological outcomes, including time to fracture union and quality of reduction
- To identify and evaluate postoperative complications, including infection, knee stiffness, residual laxity, and hardware-related issues.

Case Series

Study design and setting

This was a prospective observational study conducted in the Department of Orthopaedics of a tertiary care teaching hospital, over a period of 18–24 months, with a minimum follow-up of 12 months for each patient.

Inclusion criteria

- Patients aged 18–65 years
- Diagnosed with PCL tibial avulsion fracture
- Meyers–McKeever type II, III, or IV fractures
- Duration of injury <12 weeks.

Exclusion criteria

- Type I (undisplaced) fractures
- Chronic injuries of more than 12-week duration
- Previous knee surgery
- Open fractures or associated neurovascular injury
- Patients medically unfit for surgery.

Surgical technique: The mini-open posterior approach

All patients were operated using the mini-open posterior approach, which utilizes the interval between the medial head of the gastrocnemius and

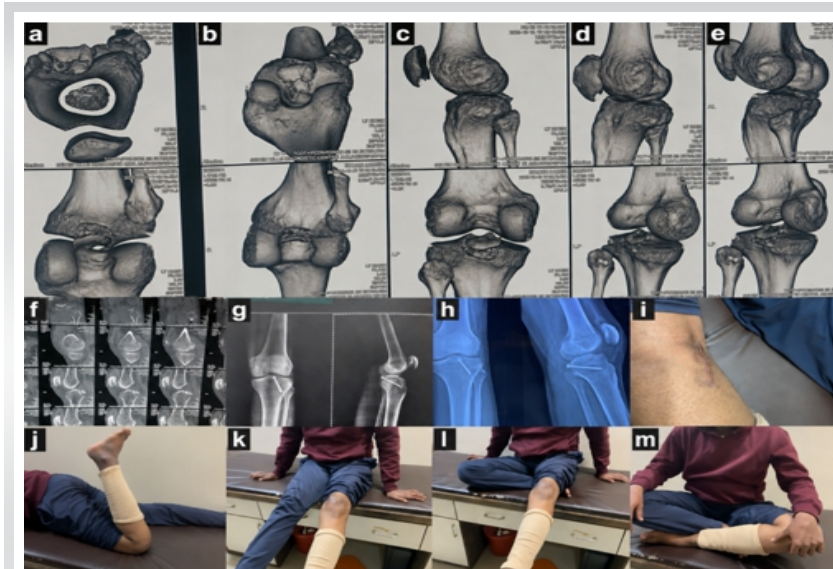


Figure 1: (a, b, c, d, e, f) pre-op workup; (g and h) post-op X-rays; (i) mini-incision; (j, k, l, m) showing range of motion on 8-week follow-up.



Figure 2: (a) pre-op X-ray; (b) post-op X-ray; (c) mini-incision; (d, e, f, g, h) Showing range of motion at post-op 8 weeks.

the semimembranosus muscle [4,6].

- Patient positioning: Prone or lateral decubitus position
- Incision: A simplified “L”-shaped or longitudinal incision was made over the popliteal fossa
- Dissection: The neurovascular bundle (popliteal artery and tibial nerve) was carefully protected by retracting the medial head of the gastrocnemius laterally, exposing the posterior capsule and the avulsed PCL fragment
- Fixation: Anatomical reduction of the fragment was achieved and fixation performed using 4.0 mm or 4.5 mm cannulated cancellous screws with washers; pull-out sutures were used occasionally for smaller, comminuted fragments.

Postoperatively, patients were mobilized in a hinged knee brace with a graduated, protected range-of-motion protocol, and progressed to full weight-bearing and active rehabilitation based on radiological evidence of healing.

Cases

Case 1

A 25-year-old male with a sports injury presented with acute posterior knee instability. Pre-operative workup confirmed a Type III PCL tibial avulsion. He underwent mini-open fixation; at 8-week follow-up, excellent ROM was demonstrated, and

radiological union was achieved at 10 weeks (Fig. 1).

Case 2

A 20-year-old male with a renal tubular acidosis (RTA) mechanism had a displaced PCL avulsion with shaft femur fracture confirmed on plain radiographs. Post-operative radiographs demonstrated anatomical reduction; mini-incision scar was cosmetically acceptable. ROM was near-normal at 8 weeks (Fig. 2).

Case 3

A 20-year-old male with RTA presented with PCL avulsion combined with a lateral condyle fracture. Both injuries were addressed surgically; post-operative radiographs confirmed satisfactory reduction of both fragments (Fig. 3).

Case 4

A 40-year-old male with RTA presented with osseous avulsion of PCL confirmed on radiographs and magnetic resonance imaging managed with open posterior approach; post-operative radiographs confirmed satisfactory reduction with good ROM at 12 weeks of follow-up (Fig. 4).

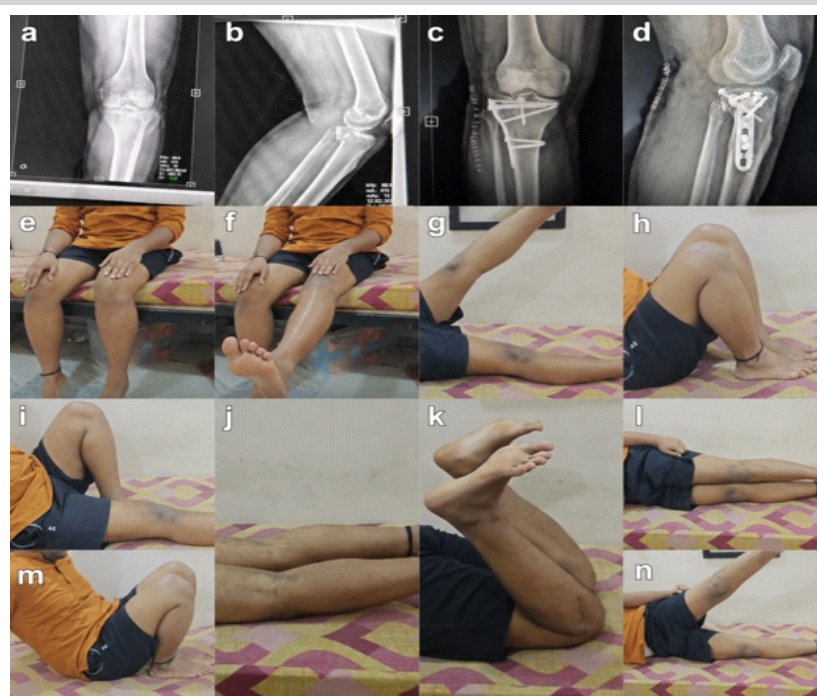


Figure 3: (a and b) pre-op X-rays; (c and d) post-op X-rays; (e, f, g, h, i, j, k, l, m, n) showing range of motion on 3-month follow-up.



Figure 4: (a and b) pre-op X-rays; (c and d) post-op X-rays; (e) incision mark; (f) sitting cross-legged; (g and h) sitting with legs hanging down the table.

Results

All patients achieved fracture union, with union confirmed radiologically in nearly all patients by approximately 12 weeks postoperatively. ROM improved consistently, with an average terminal flexion of approximately 120°–128° and full extension achieved in all patients by final follow-up. Knee stability, assessed clinically using the posterior drawer test, was well restored, with only minimal residual laxity noted in a small number of patients.

Functional outcomes, summarized in Table 1, showed marked improvement in both Lysholm and IKDC scores from the pre-operative to the 12-month post-operative assessment, consistent with previously reported outcomes for this technique [7]. The majority of patients achieved an “excellent” Lysholm grade (score range approximately 90–95) at final follow-up.

Postoperative complications were rare and are summarized in Table 2. No patient in this series developed a deep infection, hardware failure, or neurovascular injury.

Discussion

Displaced PCL tibial avulsion fractures require anatomical reduction and stable fixation to restore the native tension and function of the ligament. The mini-

open posterior approach described by Burks and Schaffer [4] remains a widely used technique for this purpose, offering several advantages over both closed management and arthroscopic-assisted fixation.

The principal advantages of the open posterior approach include direct visualization of the fracture fragment, the ability to achieve precise anatomical reduction under direct vision, strong and reliable fixation with cannulated screws, and a comparatively short learning curve for the operating surgeon. These features make it an attractive option in settings where arthroscopic expertise or equipment may be limited.

Compared with arthroscopic techniques, which are minimally invasive but technically demanding and equipment-

dependent, the open posterior approach is technically simpler, cost-effective, and reproducible across a range of surgical settings, without compromising functional outcomes [5,8]. The results of the present series with mean Lysholm scores improving from 52.3 to 93.6 and IKDC scores from 48.7 to 90.1 are comparable to outcomes reported in the existing literature for both open and arthroscopic fixation of PCL tibial avulsion fractures [7,9,10,11].

The principal limitation of the posterior approach is the theoretical risk of injury to the popliteal neurovascular bundle during dissection; however, this risk is minimized with careful

Table 1: Functional outcomes – pre-operative versus post-operative (12 months)

Parameter	Pre-operative	Post-operative (12 months)
Lysholm score	52.3±10.5	93.6±4.2
IKDC score	48.7±9.8	90.1±5.3
Range of motion – flexion (°)	95.2±15.4	128.6±8.7
Tegner activity scale	2.0±0.8	5.5±0.9
KT arthrometer score	8.1±2.0	1.6±0.7

IKDC: International Knee Documentation Committee

Table 2: Post-operative complications

Complication	Number of patients
Superficial surgical site infection	0
Residual posterior laxity (mild)	1
Knee stiffness/restricted terminal flexion	1, resolved with physiotherapy
Hardware-related irritation requiring removal	1
Neurovascular injury	None

technique and thorough knowledge of the regional anatomy [12]. Occasional need for subsequent hardware removal, due to local irritation from prominent screws or washers, was also noted as a limitation of the technique.

This series, while demonstrating consistently favorable outcomes, is limited by its small sample size and the absence of a comparative arthroscopic cohort. Larger, prospective, randomized comparative studies with longer-term follow-up are required to further define the relative roles of open and arthroscopic fixation for this injury pattern.

Conclusion

The mini-open posterior approach for fixation of PCL tibial avulsion fractures is a reliable and effective surgical technique that allows direct visualization and accurate anatomical reduction of the avulsed fragment. It consistently results in excellent clinical and functional outcomes, with high Lysholm

and IKDC scores, restoration of near-normal knee kinematics, and high patient satisfaction. The technique demonstrates high rates of fracture union and restoration of posterior knee stability, with minimal residual laxity on follow-up clinical examination.

Compared to traditional open procedures, it offers the advantages of a smaller incision, reduced soft-tissue dissection, shorter operative time, and faster rehabilitation, and it serves as a practical alternative to arthroscopic fixation, particularly in settings with limited arthroscopic resources, without compromising outcomes. The procedure is associated with a low complication rate, with rare instances of infection, neurovascular injury, or fixation failure when performed with proper technique.

Early diagnosis and timely surgical intervention remain critical to achieving optimal outcomes and preventing long-term complications such as chronic instability and degenerative joint change. Overall, the mini-open posterior approach with internal fixation is a safe, reproducible, and clinically successful method for managing displaced PCL tibial avulsion fractures, although larger randomized controlled trials with long-term follow-up are warranted to further strengthen this evidence base.

Clinical Message

The mini-open posterior approach provides a safe, reproducible, and technically straightforward means of achieving anatomical reduction and stable internal fixation of displaced PCL tibial avulsion fractures, yielding excellent functional and radiological outcomes and offering a practical alternative to arthroscopic fixation in resource-limited settings.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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