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Functional outcomes of posterior cruciate ligament tibial avulsion fractures treated with open reduction and internal fixation and screw fixation: a retrospective study

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ABSTRACT

Background: Posterior cruciate ligament (PCL) avulsion injuries can result in significant knee instability and long-term functional impairment if inadequately treated. Open reduction and internal fixation (ORIF) is widely employed to achieve anatomical restoration and preserve the native ligament. This study aimed to evaluate the clinical and functional outcomes of ORIF in patients with acute PCL avulsion injuries.
Methods: A retrospective study was conducted at a tertiary healthcare center including 30 patients treated with ORIF for acute PCL avulsion injuries between 2022 and 2025. Inclusion criteria comprised MRI-confirmed tibial PCL avulsion fractures and a minimum 12-month follow-up. Patients with chronic injuries or prior knee pathology were excluded. Functional outcomes were assessed using the Cincinnati knee rating system (CKRS), international knee documentation committee (IKDC) score, and Lysholm score preoperatively and at 12 months postoperatively.
Results: The cohort consisted of 24 males (80%) and 6 females (20%), with a mean age of 34.6±11.8 years. Road traffic accidents were the most common mechanism of injury (50%). Preoperative mean scores were CKRS 46.1±7.9, IKDC 49.3±7.2, and Lysholm 14.2±4.5. At 12 months, significant improvement was observed: CKRS 84.3±5.9, IKDC 86.7±5.5, and Lysholm 93.8±6.4 ($p<0.001$).
Conclusions: ORIF provides significant functional improvement and reliable restoration of knee stability in acute PCL avulsion injuries. Early surgical intervention combined with structured rehabilitation results in favorable one-year outcomes.

Keywords: Posterior cruciate ligament injuries, Knee joint, Open reduction and internal fixation, Recovery of function, Orthopedic procedures

INTRODUCTION

Posterior cruciate ligament (PCL) injuries represent a relatively uncommon but clinically significant subset of knee ligament injuries.[1] The PCL is the primary stabilizer preventing posterior translation of the tibia relative to the femur and contributes substantially to rotational stability of the knee joint. Biomechanically, it is recognized as the strongest ligament of the knee, providing approximately 90–95% of the resistance to posterior tibial displacement.[2] Injury to this structure can therefore lead to persistent instability, altered joint kinematics, and long-term degenerative changes if not managed appropriately.[3]

PCL injuries most commonly result from high-energy trauma, including road traffic accidents, sports-related impacts, and falls from height. A classic mechanism involves a direct blow to the anterior tibia with the knee flexed, such as a dashboard injury during motor vehicle collisions.[4] In athletes, hyperflexion or hyperextension injuries may also disrupt the ligament. PCL injuries may occur in isolation but are frequently associated with multi-

ligamentous knee injuries, meniscal tears, or fractures around the knee joint. Among these, tibial avulsion fractures of the PCL insertion represent a distinct injury pattern in which the ligament remains intact but is detached along with a fragment of bone from its tibial attachment.[5]

The management of PCL injuries depends on the severity and chronicity of the injury, as well as the presence of associated structural damage.[6] Low-grade or partial tears are often managed conservatively with bracing, quadriceps strengthening, and progressive rehabilitation.[7] However, high-grade tears, complete ruptures, and tibial avulsion fractures generally require surgical intervention to restore anatomical alignment and joint stability.[8] Failure to adequately address these injuries can result in chronic posterior instability, altered gait mechanics, and early onset osteoarthritis. Open reduction and internal fixation (ORIF) is widely regarded as a reliable surgical technique for the treatment of PCL tibial avulsion fractures. Unlike reconstruction procedures that replace the ligament with a graft, ORIF allows for direct anatomical reduction and stable fixation of the avulsed fragment, thereby preserving the native ligament and its proprioceptive function. The procedure is typically performed through a posterior approach, enabling direct visualization of the fracture site and secure fixation using cannulated screws or suture anchors. Early surgical stabilization facilitates biological healing and may enhance long-term functional outcomes.[9] Although several studies have reported favorable results following ORIF for PCL avulsion injuries, variability exists in reported functional outcomes and sample sizes. Furthermore, timely surgical intervention and structured postoperative rehabilitation play critical roles in determining clinical success.[10]

The present study aims to evaluate the clinical and functional outcomes of patients undergoing ORIF for acute PCL avulsion injuries at a tertiary healthcare center. By assessing standardized outcome measures over a 12-month follow-up period, this study seeks to contribute further evidence regarding the effectiveness of ORIF in restoring knee stability and function.

METHODS

This retrospective assessment of cases was conducted at a tertiary health care centre, analysing patients who underwent ORIF for PCL injuries between 2022 and 2025.

The inclusion criteria for the study included: patients diagnosed with acute PCL injuries confirmed via magnetic resonance imaging (MRI) and radiographic studies, patients with tibial avulsion fractures of the PCL, patients with high-grade PCL tears requiring surgical fixation, and patients who completed at least 12 months of follow-up.

The exclusion criteria were: patients with isolated low-grade PCL injuries managed conservatively, patients with chronic PCL injuries (>6 months post-injury), and patients with previous knee surgeries or pre-existing knee pathologies affecting outcomes.

A total of 30 patients presented with PCL avulsion injury and were treated with ORIF at the institution during the period of the study. Records showed that all patients underwent surgical treatment using a limited open approach. The procedure involved a posterior approach to the knee, allowing direct visualization of the PCL injury. The ligament was anatomically reduced, and fixation was performed using cannulated screws in cases of bony avulsion. Postoperatively, patients followed a standardized rehabilitation program, including - weeks 1–6: immobilization with a knee brace in extension, non-weight-bearing or partial weight-bearing as tolerated, weeks 6–12: progressive range-of-motion exercises, quadriceps strengthening, and controlled weight-bearing, months 3–6: gradual return to full weight-bearing, introduction of functional strengthening, and proprioceptive training, and months 6–12: advanced strengthening, sports-specific training, and return to full activities as tolerated.

Clinical and radiographic assessments were performed at 3, 6, and 12 months postoperatively. Functional outcomes were measured using the Cincinnati knee rating system, Lysholm knee score and the international knee documentation committee (IKDC) score at12 months.

RESULTS

A total of 30 patients with acute PCL avulsion injuries underwent ORIF and completed a minimum follow-up period of 12 months. The cohort consisted predominantly of males, with 24 patients (80%) and 6 females (20%). The mean age of the participants was 34.6±11.8 years, and the mean body mass index (BMI) was 25.1±5.7 kg/m². The most common mechanism of injury was road traffic accidents, accounting for 15 cases (50%), followed by sports-related injuries in 12 patients (40%) and falls in 3 patients (10%). The mean duration between injury and surgical intervention was 4.6±2.5 days, reflecting early operative management in the majority of cases (Table 1).

Table 1: Sociodemographic characteristics of the study participants (n=30).

Parameters	Frequency /mean	Percentage/ SD
Males	24	80
Mean age (kg)	34.6	11.8
Mean BMI (kg/m^2)	25.1	5.7
Mechanism of injury		
Road traffic accident	15	50
Sports injury	12	40
Fall injury	3	30

Preoperative functional assessment revealed significantly impaired knee function across all scoring systems. The

mean CKRS score was 46.1±7.9, the mean IKDC score was 49.3±7.2, and the mean Lysholm score was 14.2±4.5, indicating poor functional status prior to surgical intervention (Table 2).

Table 2: Preoperative characteristics of the study participants (n=30).

Characteristics	Frequency /mean	Percentage/ SD
Mean duration of injury (days)	4.6	2.5
Mean Cincinnati knee rating system score	46.1	7.9
Mean IKDC score	49.3	7.2
Mean Lysholm score	14.2	4.5

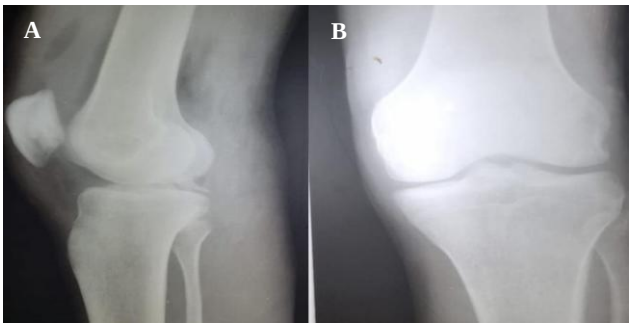

Figure 1 (A and B): Pre-operative radiograph.

At the 12-month postoperative follow-up, substantial improvement was observed in all functional outcome measures. The mean CKRS score increased to 84.3±5.9, the mean IKDC score improved to 86.7±5.5, and the mean Lysholm score rose markedly to 93.8±6.4. These findings demonstrate considerable recovery of knee stability, function, and patient-reported outcomes following ORIF (Table 3).

Comparative analysis between preoperative and postoperative scores demonstrated statistically significant improvements in all evaluated parameters. The mean CKRS score improved by 38.2 points (from 46.1 to 84.3), the IKDC score increased by 37.4 points (from 49.3 to 86.7), and the Lysholm score improved by 79.6 points (from 14.2 to 93.8). All improvements were highly statistically significant ($p<0.001$) (Table 4).

Table 3: Postoperative characteristics of the study participants at 12 months' follow-up (n=30).

Characteristics	Frequency /mean	Percentage/ SD
Mean postoperative Cincinnati knee rating system score	84.3	5.9
Mean postoperative IKDC score	86.7	5.5
Mean postoperative Lysholm score	93.8	6.4

Figure 2 (A and B): Intra operative minimally open incision.

Figure 3 (A and B): Post-operative radiograph.

Table 4: Improvement of knee injury related parameters over time (n=30).

Characteristics	Preoperative		Postoperative		P value
	Mean	SD	Mean	SD	
Mean Cincinnati knee rating system score	46.1	7.9	84.3	5.9	<0.001*
Mean IKDC score	49.3	7.2	86.7	5.5	<0.001*
Mean Lysholm score	14.2	4.5	93.8	6.4	<0.001*

*Statistically significant

DISCUSSION

This study evaluated the clinical, radiological, and functional outcomes of ORIF in a cohort of 30 patients with PCL avulsion injuries. The findings demonstrated substantial and statistically significant improvements in knee function at 12 months postoperatively, reinforcing the effectiveness of ORIF in restoring joint stability and patient-reported functional performance.

The demographic profile of the present cohort showed a clear male predominance (80%), with a mean age of

34.6±11.8 years. These findings are consistent with previous literature, including Joshi et al, who reported a similar mean age (33.9 years) and male preponderance among patients undergoing surgical management for PCL avulsion injuries.[11]

The predominance of young male patients likely reflects increased exposure to high-energy trauma and sports-related activities in this population. In the current study, road traffic accidents accounted for 50% of injuries, followed by sports-related trauma (40%) and falls (10%). This pattern aligns with Rezazadeh et al, who identified motor vehicle accidents as the most frequent mechanism of injury in their series.[12]

Preoperatively, patients exhibited markedly impaired knee function, with mean scores of 46.1±7.9 for the CKRS, 49.3±7.2 for the IKDC score, and 14.2±4.5 for the Lysholm score. These values reflect significant functional limitation and instability prior to surgical intervention and are comparable to the findings of Bali et al, who reported similarly low baseline functional scores in patients with untreated or delayed PCL avulsion injuries. Importantly, the mean duration between injury and surgery in the present study was 4.6±2.5 days, indicating early operative management. Early fixation has been associated with improved healing and superior functional outcomes. Yang et al emphasized that patients undergoing ORIF within three weeks of injury achieved better postoperative recovery compared to those treated later, supporting the rationale for prompt surgical stabilization.[13]

At 12 months postoperatively, there was a marked and statistically significant improvement in all functional parameters. The mean CKRS improved to 84.3±5.9, IKDC to 86.7±5.5, and Lysholm to 93.8±6.4 ($p<0.001$ for all comparisons). These improvements represent substantial gains in knee stability, pain reduction, and overall functional capacity. The magnitude of improvement observed in this larger cohort further strengthens the evidence supporting ORIF.

The postoperative Lysholm score in the present study is comparable to that reported by Joshi et al, where excellent to good outcomes were achieved in the majority of patients.[6] Similarly, Rezazadeh et al reported that a significant proportion of patients achieved normal or near-normal knee function following ORIF.[7]

The findings of this study also corroborate those of Sundararajan et al, who found no significant difference in functional outcomes between ORIF and arthroscopic reduction and internal fixation (ARIF), while noting practical advantages of ORIF such as shorter operative time and lower technical complexity.[14]

Furthermore, Ivansyah et al emphasized the importance of timely surgical intervention in preventing long-term instability and degenerative changes, reinforcing the value of early ORIF.[15]

CONCLUSION

The findings of this study demonstrate that ORIF provides favorable functional outcomes in PCL avulsion injuries, with significant improvements in knee stability and mobility.

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