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OUTCOMES OF SURGICAL TREATMENT OF POSTERIOR CRUCIATE LIGAMENT TIBIAL AVULSION FRACTURES USING SCREW FIXATION AT 108 MILITARY CENTRAL HOSPITAL

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ABSTRACT

Objective: *To evaluate the results of open surgery (reduction and fixation with cannulated cancellous screws) in the treatment of posterior cruciate ligament tibial avulsion fractures at Military Central Hospital 108.*

Subjects and methods: *A retrospective descriptive study was conducted on 29 patients with posterior cruciate ligament tibial avulsion fractures who had indications for and underwent open reduction and fixation of the posterior cruciate ligament tibial avulsion fracture using cannulated cancellous screws at Military Central Hospital 108 from January 2022 to December 2025. Treatment outcomes were evaluated according to the Lysholm score, IKDC classification, range of motion, postoperative knee laxity, bone union status, ability to return to pre-injury activities, and postoperative complications.*

Results: *The mean age of the study patients was 31.31 ± 8.39 years, with males accounting for 82.8%; most injuries were caused by traffic accidents (72.4%). The mean postoperative follow-up period was 13.51 ± 1.52 months. The Lysholm score improved significantly (from 28.10 ± 2.45 to 89.52 ± 3.11 points, with a mean increase of 61.41 ± 4.28 points, $p < 0.001$). The proportion of patients with good and excellent postoperative Lysholm scores was 93.1%; IKDC classification grades A and B accounted for 93.1%; knee range of motion ≥ 120° was achieved in 93.1%; and 82.8% had no residual knee laxity. Within 6 months after surgery, 100% of patients achieved bone union; 86.2% returned to their pre-injury activity level; and 1 patient was noted to have mild joint effusion.*

Conclusion: *Open reduction and fixation with cannulated cancellous screws for the treatment of posterior cruciate ligament tibial avulsion fractures is safe and yields favorable outcomes, helping to restore good function, provide stable fixation, achieve a high bone union rate, and maintain a low complication rate.*

Keywords: Posterior cruciate ligament, tibial avulsion fracture, cannulated cancellous screw, Lysholm score.

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1. INTRODUCTION

The posterior cruciate ligament (PCL) is a structure that helps maintain knee stability and is the primary restraint against excessive posterior displacement of the tibial plateau relative to the femur. PCL injuries can significantly affect both the stability and function of the knee [1]. Posterior cruciate ligament tibial avulsion fracture is a relatively uncommon injury, usually occurring after high-energy trauma, particularly traffic accidents involving motorcycles [2]. The typical injury mechanism is an anterior-to-posterior force applied to the proximal tibia while the knee is in flexion or hyperextension, causing tension on the PCL to exceed its threshold and resulting in avulsion of the bony attachment at the ligament insertion site [3, 4].

The choice of treatment mainly depends on the degree of displacement of the fracture fragment. Conservative treatment may be considered for non-displaced cases. Surgery is commonly indicated for displaced fractures in order to restore the anatomical insertion of the ligament, re-establish knee stability, and reduce long-term complications such as malunion, nonunion, chronic instability, and post-traumatic osteo-arthritis [5]. Currently, various surgical techniques are used for the treatment of PCL tibial avulsion fractures. Among them, open reduction and internal fixation using cannulated cancellous screws is widely performed because it allows direct visualization of the fracture fragment,

accurate anatomical reduction, stable fixation, and broad applicability in orthopedic trauma centers [2].

At Military Central Hospital 108, this surgical method has been routinely implemented for many years and has shown favorable clinical outcomes; however, data evaluating treatment efficacy and functional recovery in patients remain limited. Therefore, we conducted this study to evaluate the treatment outcomes of PCL tibial avulsion fractures managed with open reduction and internal fixation using cannulated cancellous screws at Military Central Hospital 108.

2. SUBJECTS AND METHODS

2.1. Subjects

29 patients diagnosed with posterior cruciate ligament (PCL) tibial avulsion fractures, who had indications for and underwent open reduction and internal fixation using cannulated cancellous screws at Military Central Hospital 108 from January 2022 to December 2025, were included in the study.

- Inclusion criteria: Patients with isolated PCL tibial avulsion fractures; age from 15 to 60 years; complete medical records and preoperative radiographs or computed tomography (CT) scans; agreement to participate in the study and attend scheduled postoperative follow-up visits.

- Exclusion criteria: Patients with open fractures or associated ligament injuries of the knee; associated femoral or tibial fractures; previous surgery on the affected knee; incomplete postoperative follow-up data; or refusal to participate in the study.

2.2. Methods

- Study design: A retrospective cross-sectional descriptive study. Data were collected from medical records, operative reports, preoperative radiographs or CT scans, and postoperative follow-up examinations. All information was recorded using a standardized data collection form.

- Sample size and sampling method: Convenience sampling was used, including all patients meeting the selection criteria during the study period. In total, 29 eligible patients were included in the study.

- Study variables and evaluation criteria:

+ General characteristics of patients: age, sex, mechanism of injury, injured side, time from injury to surgery, and postoperative follow-up duration.

+ Knee function (before and after surgery): evaluated using the Lysholm score [6], classified into four categories: excellent (> 90 points), good (84-90 points), fair (65-83 points), and poor (< 65 points). Improvement in the Lysholm score was calculated as the difference between postoperative and preoperative scores. Knee function was also assessed according to the International Knee Documentation Committee (IKDC) classification [7], including grade A (normal), grade B (nearly normal), grade C (abnormal), and grade D (severely abnormal).

+ Postoperative recovery: evaluated based on knee range of motion, postoperative knee laxity, ability to return to pre-injury activity level, radiographic bone union, and postoperative complications. Knee range of motion was classified into three groups: > 130°; 120-130°; and ≤ 120° with extension deficit. Postoperative knee laxity was classified according to the degree of posterior tibial displacement into grade 0, grade I, grade II, and grade III.

- Statistical analysis: Data were entered and analyzed using SPSS software version 16.0. Quantitative variables were presented as mean ± standard deviation ($\bar{X}$ ± SD). Qualitative variables were expressed as frequencies and percentages. Preoperative and postoperative Lysholm scores were compared using an appropriate test for paired data. Qualitative variables were analyzed using the χ^2 test or Fisher's exact test. A p-value < 0.05 was considered statistically significant.

3. RESULTS

3.1. General characteristics

Table 1 shows that the 29 study patients ranged in age from 15 to 60 years, with a mean age of 31.31 ± 8.39 years; the majority were male (82.8%). The most common mechanism of injury was traffic accidents (72.4%), followed by domestic accidents and sports-related injuries. Most patients underwent early surgery, with 55.2% operated on within the first 3 days after injury. The mean postoperative follow-up duration was 13.51 ± 1.52 months.

Table 1. General characteristics of patients

Characteristics (n = 29)		Results
Age (years)	Min-max	15-60
	$\bar{X}$ ± SD	31.31 ± 8.39
Sex (n, %)	Male	24 (82.8)
	Female	5 (17.2)

Characteristics (n = 29)		Results
Mechanism of injury (n, %)	Traffic accident	21 (72.4)
	Domestic accident	5 (17.2)
	Sports injury	3 (10.4)
Injured side (n, %)	Right	19 (65.5)
	Left	10 (34.5)
Time to surgery (n, %)	< 3 days	16 (55.2)
	3-7 days	8 (27.6)
	8-21 days	5 (17.2)
Follow-up duration (months) ($\bar{X}$ ± SD)		13.51 ± 1.52

3.2. Knee function before and after surgery

Table 2. Knee function before and after surgery

Knee function		Pre-op	Post-op	p
Lysholm score (n, %)	> 90	0	10 (34.5)	< 0.001
	84-90	0	17 (58.6)	
	65-83	0	2 (6.9)	
	< 65	29 (100.0)	0	
	Mean ± SD	28.10 ± 2.45	89.52 ± 3.11	
	Mean improvement	61.41 ± 4.28		
IKDC classification (n, %)	A	0	22 (75.9)	< 0.001
	B	0	5 (17.2)	
	C	11 (37.9)	2 (6.9)	
	D	18 (62.1)	0	

After surgery, knee function improved markedly according to the Lysholm score. The mean Lysholm score increased from 28.10 ± 2.45 points before surgery to 89.52 ± 3.11 points after surgery, with a mean improvement of 61.41 ± 4.28 points; the difference was statistically significant ($p < 0.001$). Before surgery, knee function in all patients was classified as poor. After surgery, most patients achieved good and excellent outcomes (93.1%).

According to the IKDC classification, before surgery, knee function in most patients was classified as grade D (62.1%) or grade C (37.9%), with no cases classified as grade A or B. After surgery, the results improved significantly, with 75.9% of patients classified as grade A and 17.2% as grade B; only 6.9% remained grade C and no patients were classified as grade D. The change in IKDC classification before and after surgery was statistically significant ($p < 0.001$).

3.3. Postoperative recovery outcomes and complications

Table 3. Postoperative recovery outcomes

Evaluation criteria		Results
Range of motion (n, %)	> 130°	21 (72.4)
	120-130°	6 (20.7)
	≤ 120° with extension deficit	2 (6.9)
Postoperative knee laxity (n, %)	Grade 0	24 (82.8)
	Grade I (< 5 mm)	5 (17.2)
	Grade II (5-10 mm)	0
	Grade III (> 10 mm)	0
	Mean ± SD (mm)	0.80 ± 0.31

After surgery, most patients achieved good recovery of knee range of motion (72.4% achieved ROM > 130° and 20.7% achieved ROM of 120-130°; only 6.9% had ROM ≤ 120° with extension deficit). Postoperative knee stability also showed favorable outcomes: 82.8% of patients had no knee laxity and 17.2% had grade I laxity; no patients were found to have grade II or grade III laxity. A total of 86.2% of patients returned to their pre-injury activity level. Postoperative complications were uncommon, with only one patient presenting with mild joint effusion. All patients achieved radiographic bone union at 6 months after surgery.

4. DISCUSSION

4.1. General characteristics of the study patients

In our study, PCL tibial avulsion fractures were mainly observed in young patients, with a mean age of 31.31 ± 8.39 years. This result is consistent with many previous studies [6, 8]. This similarity suggests that PCL tibial avulsion fractures are commonly associated with high-energy trauma in young individuals rather than degenerative injuries in older patients.

Male patients predominated in our study, which is similar to previous reports [7, 9, 10]. Traffic accidents were the most common cause of injury (72.4%), markedly higher than domestic accidents (17.2%) and sports-related injuries (10.4%). This finding is consistent with the typical injury mechanism of PCL injuries, in which a direct anterior-to-posterior force applied to the proximal tibia while the knee is flexed results in avulsion of the tibial insertion of the PCL [4]. Previous studies have also identified traffic accidents as the main cause of injury [2, 5, 6, 8, 10].

Most patients in our study underwent early surgery (55.2% within the first 3 days and 82.8%

within the first week). This is an important advantage because early surgery may reduce the difficulty of fracture reduction, minimize soft tissue contracture around the fracture site, and facilitate anatomical fixation [3]. The mean postoperative follow-up duration was 13.51 ± 1.52 months, similar to that reported in several previous studies [5, 6, 8], allowing a relatively comprehensive assessment of short-term functional recovery after surgery.

4.2. Changes in knee function before and after surgery

In this study, knee function improved markedly after surgery, with the mean Lysholm score increasing from 28.10 ± 2.45 points preoperatively to 89.52 ± 3.11 points postoperatively, representing a mean improvement of 61.41 ± 4.28 points; the difference was statistically significant ($p < 0.001$). Before surgery, 100% of patients had poor knee function, whereas after surgery, no patient remained in the poor category and most achieved good or excellent outcomes (93.1%). These findings indicate that anatomical reduction and stable fixation of the fracture fragment using cannulated cancellous screws significantly improved knee function in patients with PCL tibial avulsion fractures.

Assessment of postoperative knee functional recovery according to the IKDC classification demonstrated similar improvement. Before surgery, no injured knees were classified as grade A or B; most were classified as grade D (62.1%) or grade C (37.9%). After surgery, 75.9% of patients recovered to grade A and 17.2% to grade B; only 6.9% remained grade C and no cases were classified as grade D. Thus, 93.1% of patients achieved normal or nearly normal IKDC grades after surgery. These results reflect the highly favorable effectiveness of this treatment Our findings are consistent with many previous studies on open reduction and screw fixation for PCL tibial avulsion fractures. Sachin Joshi et al [6] reported that 11/14 patients achieved excellent outcomes, 2/14 achieved good outcomes, and 1/14 achieved a fair outcome, with a mean postoperative Lysholm score of 97 ± 7.6 points. Satyen Joshi et al. [7] reported that the mean Tegner-Lysholm score increased from 36.90 points preoperatively to 95.37 points at 6 months after surgery, with an excellent and good outcome rate of 93.33%. Jha and Thapa [8] reported a postoperative Lysholm score of 95.26 ± 5.44 points, including 15 patients with excellent outcomes and 4 with good outcomes. Ghilley et al. (2022) [10] also reported excellent outcomes in 63.6% of cases, good outcomes in 27.3%, and fair outcomes in 9.1%, with no poor outcomes.

Although the mean postoperative Lysholm score in our study was lower than that reported in some previous studies, the rates of good and excellent outcomes were comparable. This difference may be related to differences in study population characteristics, timing of postoperative assessment, and adherence to rehabilitation programs. The presence of 2 patients with fair Lysholm outcomes and 2 patients with grade C IKDC classification indicates that surgery markedly improved knee function, although complete functional recovery was not achieved in all cases.

4.3. Postoperative recovery outcomes and complications

Most patients in our study achieved good knee range of motion after surgery. A total of 93.1% of patients achieved a range of motion of 120° or greater; only 2 patients (6.9%) had knee ROM ≤ 120° with extension deficit. These findings indicate that screw fixation not only restores the anatomy of the PCL tibial insertion but also facilitates recovery of knee motion in most patients. Our results are consistent with previous reports. Jha and Thapa [8] reported a mean postoperative ROM of 125.42° ± 6.37°, with no cases of extension deficit. Ghilley et al. [10] reported that most patients achieved good ROM, with 8/11 knees reaching ROM ≥ 140°, 2 knees achieving 130-140°, and 1 knee achieving 120-130°. Sachin Joshi et al [6] reported a mean postoperative knee flexion of 121.7° ± 9.18°, and all patients achieved full extension. These authors also observed that knee flexion was often poorer in patients with delayed presentation or poor compliance with rehabilitation programs. Therefore, in addition to anatomical reduction and stable fixation, postoperative rehabilitation plays an important role in preventing joint stiffness and optimizing clinical outcomes.

Postoperative knee stability is also an important criterion reflecting functional recovery of the PCL. In this study, 82.8% of patients had no residual knee laxity after surgery, and no patients demonstrated grade II or grade III laxity; the mean posterior laxity was 0.80 ± 0.31 mm. These findings are clinically important because mild residual laxity may still persist in some patients but does not significantly affect daily activities, particularly when knee function and mobility have improved satisfactorily.

Compared with other studies, the rate of postoperative knee laxity in our study was

acceptable. Sachin Joshi et al [6] reported mild grade I instability in 4/14 patients after surgery. Satyen Joshi et al [7] reported that 70% of patients had a negative posterior drawer test, 20% had grade I laxity, and 10% had grade II laxity, although no patients complained of clinical knee instability. Jha and Thapa [8] reported stable knees in 16/19 patients, with only 3 patients showing grade I laxity. These findings suggest that screw fixation effectively restores knee stability, while no moderate or severe instability was observed in this study.

Regarding bone union, all patients in our study achieved union within 6 months, reflecting the effectiveness of screw fixation in maintaining reduction and providing compression across the avulsion fragment. These findings are similar to those reported by Sachin Joshi et al [6] who observed bone union in all 14 patients at the final follow-up. Satyen Joshi et al [7] reported radiographic union in all patients at 3 months after surgery. Jha and Thapa [8] also observed bone union in all 19 patients at 3 months postoperatively. Vishwakarma et al [9] found that most patients achieved bone union within 12 weeks, with a mean union time of approximately 10 weeks; delayed union occurred in 5.88% of cases, but all eventually achieved union without additional intervention.

The rate of return to pre-injury activity level was 86.2%, indicating that functional recovery was reflected not only by clinical scores but also by the ability to resume daily activities and work. This result is consistent with the study by Satyen Joshi et al [7] in which patients were able to return to physical activities or heavy labor after rehabilitation.

Postoperative complications were uncommon in our study, with only one patient developing mild joint effusion and no cases of infection, neurovascular injury, or knee stiffness. Previous studies have also reported low complication rates, mostly involving minor complications. Sachin Joshi et al [6] reported 2 cases of superficial infection, 2 cases of pain, and 1 case of postoperative swelling. Satyen Joshi et al [7] reported 1 patient with wound necrosis (managed by debridement and resuturing). Jha and Thapa [8] reported 2 patients with persistent mild pain during walking and 3 patients with superficial infection, with no severe complications observed. Ghilley et al [10] reported 1 patient with knee stiffness and no cases of infection, deep vein thrombosis, or neurovascular injury.

5. CONCLUSION

Open reduction and internal fixation using cannulated cancellous screws for the treatment of posterior cruciate ligament tibial avulsion fractures at Military Central Hospital 108 yielded favorable outcomes. After surgery, knee function improved markedly, as demonstrated by the significant increase in Lysholm scores and the high proportion of patients achieving normal or nearly normal IKDC grades. This technique also provided good recovery of knee range of motion and stability, with most patients having no residual laxity or only mild laxity after surgery. All patients achieved bone union at 6 months postoperatively, and most were able to return to their pre-injury activity level. The postoperative complication rate was low.

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