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Functional Outcome of Open Reduction and Internal Fixation in Patients with Tibial Plateau Fracture

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Abstract

Introduction: Tibial plateau fractures contribute 1% of all fractures and are classically sustained with high-energy mechanisms. Injuries to the vasculature, nerves, ligaments, menisci, and surrounding compartments have all been linked to tibial plateau fractures [1]. The outcome of this study will be helpful in designing effective therapeutic protocols for patients care.

Objective: To determine the functional outcome of open reduction and internal fixation for surgical treatment of tibial plateau fracture.

Study Design: Descriptive Study

Study Setting: Department of Orthopedic surgery, Khyber Teaching Hospital, Peshawar.

Study Duration: 23-07-2023—23-07-2024

Subject and Methods: We conducted this study on 86 patients of both genders having age between 18 to 70 years presenting with tibial plateau fracture diagnosed on plain radiograph. Patient with ipsilateral femur, foot fractures and concomitant lower extremity fractures were excluded. Functional outcome of open reduction and internal fixation was determined.

Results: This study was conducted on 86 patients. The mean age of the patients was 46.98±15.82 years. According to the functional outcome we observed that 60 (69.8%) patients had excellent outcome, good outcome was seen in 15 (17.4%) patients, fair outcome was seen in 7 (8.1%) patients and poor outcome was seen in 4 (4.7%) patients.

Conclusion: From our study we conclude that the functional outcome of open reduction and internal fixation for surgical treatment of tibial plateau fracture was excellent in 60 (69.8%) patients, good 15 (17.4%), fair 7 (8.1%) and poor in 4 (4.7%) patients.

Keywords: Functional Outcome, Knee Fracture, Tibial Plateau Fracture

Introduction:

Tibial plateau fractures contribute 1% of all fractures and are classically sustained with high-energy mechanisms (1). Injuries to the vasculature, nerves, ligaments, menisci, and surrounding compartments have all been linked to tibial plateau fractures. It is not uncommon for tibial plateau fractures to necessitate orthopedic evaluation and surgical care, despite the fact that small fractures without concomitant injuries can be successfully addressed non-operatively(1).

Tibial plateau injuries typically occurred when someone takes a direct hit to the on the knee. High energy mechanisms, such as axial load from a fall onto the feet or the ground, are required to cause medial plateau injuries, as are causes of direct trauma such as car accidents or falls from great heights (2). Bicondylar fractures, rather than medial plateau fractures, are more prevalent in high-energy processes. The elderly and other individuals with osteoporosis are at increased risk for tibial plateau fractures caused by low energy processes (3).

Intra-articular fractures of the tibial plateau are relatively common. The axial or coronal compression forces that cause them. The fractures can have medical plateaus, lateral plateaus, or both, and the articular depressions and displacements can range widely. Different fractures have different morphologies and react differently to therapy (4).

High intensity trauma causes extensive soft tissue and neurovascular damage, therefore knowing the extent of the injury is crucial. Meniscal tears and ligament damage should also be evaluated alongside tibial plateau fractures (4,5).

The patella takes the brunt of the impact first, followed by the tibia and femur in varying proportions and positions, due to the fact that man has taken to traveling at high speeds while seated, with the loading edge composed of flexed hind limbs(6,7). A research observed the functional outcome (Excellent = 72.94%, Good = 14.12%, Fair = 7.06%, and **Poor = 5.88%**) among tibial plateau fracture fractures treated with open reduction and internal fixation(8).

The most common mechanism resulting in a tibial plateau fracture is a valgus force with axial loading. Of these fractures, 80% are motor vehicle–related injuries, and the remainder are sports-related injuries. Bumper- or fender-related injuries from a vehicle-pedestrian collision constitute more than 25% of tibial plateau fractures. Trauma can be direct or can be related to a fall from a height, an industrial accident, or a sports injury[9]. More than 50% of patients who sustain a tibial plateau fracture are aged 50 years or older. The increased frequency of tibial plateau fractures in older females is due to the increased prevalence of osteoporosis in these individuals. Tibial plateau fractures in younger patients are commonly the result of high-energy injuries(9).

Treatment of these fractures is governed by the vascularity (local tissue and distal), the condition of the soft tissues, and the presence or absence of compartment syndrome. Not all fractures of the tibial plateau require surgery. The first challenge in the management of upper tibial fractures is to decide between nonoperative and surgical treatment(10). In the past, long leg cast and traction mobilization were used for non-displaced, Minimally displaced or depressed fractures, Sub meniscal rim fractures and Fractures in elderly, low-demand, or osteoporotic patients; however, the Sarmiento program of functional cast bracing is now preferred(16). The general rule is fracture displacement ranging from 4-10 mm can be treated nonoperatively; however, a depressed fragment greater than 5 mm should be elevated and grafted(11). There has been a dramatic shift in the treatment of orthopedic trauma because of developments in biomechanics, implant effectiveness, internal fixation concepts, soft tissue care, antibiotics, and surgical procedures. Internal fixation of fractures has therefore become the standard of care, replacing the previously preferred conservative treatment. Tibial plateau fractures are particularly difficult because of their diversity, and complexity. The ideal technique of management is still debatable. Therefore, this study is carried out to determine the functional outcome of open reduction and internal fixation for surgical treatment of tibial plateau fracture. The outcome of this study will be helpful in designing effective therapeutic protocols for patients care.

To determine the functional outcome of open reduction and internal fixation for surgical treatment of tibial plateau fracture.

Material and Methods:
Study Setting: Department of Orthopedic surgery, Khyber Teaching Hospital, Peshawar
Study Design: Descriptive Study
Study Duration: 23-07-2023—23-07-2024
Sample Size: T The sample size was calculated using the WHO sample size calculator, based on a 5.88% prevalence of poor functional outcomes in patients with tibial plateau fractures treated with open reduction and internal fixation. With a 95% confidence level and an absolute precision of 5%, the required sample size was determined to be 86.
Sampling Technique: Convenient Non-Probability Sampling

Sample Selection
Inclusion criteria
- Gender including both male & female
- Age including 18-70 Years
- Patients with tibial plateau fracture diagnosed on plain radiograph

Exclusion criteria
- Patient with ipsilateral femur
- Patients with foot fractures
- Patients with concomitant lower extremity fractures

Data Collection Procedure
The study commenced after obtaining approval from the hospital's Institutional Review Board. Patients meeting the inclusion criteria were enrolled after informed consent was obtained. Demographic data and clinical history were recorded, followed by physical examination. Open reduction and internal fixation (ORIF) were performed using either a posteromedial or anterolateral approach, depending on the fracture pattern. Soft tissue flaps and cancellous allografts were used when necessary. Fixation involved uni- or dual-plate constructs with screw placement tailored to the fracture anatomy. Early mobilization was encouraged postoperatively. Functional outcomes were evaluated at 2 months using the Knee Society Score (KSS)[12], which assesses both knee function and patient mobility on a 100-point scale each, with higher scores indicating better outcomes

Data Analysis Procedure
IBM SPSS.23 program was used for the analysis of collected data. Frequencies and percentages were presented for categorical variables like gender, functional outcome, side of fracture, and mechanism of fracture. Mean $\pm$ Standard deviation was presented for numerical variable like age. Effect modifiers like age, gender, side of fracture, and mechanism of fracture were controlled through stratification. Post stratification chi- square was applied, using p-value ≤ 0.05 considered as significant. All the results of this study were shown in the form of tables.

Results:
This study included a total of 86 patients with a mean age of 46.98 ± 15.82 years. The majority of patients (33.7%) were between 45 and 60 years of age, followed by 24.4% in the 61–70 age group, 22.1% between 31 and 45 years, and 19.8% aged 18 to 30 years. Males represented 60.5% of the study population, while females accounted for 39.5%. Right-sided tibial plateau fractures were

slightly more frequent (51.2%) than left-sided ones (48.8%). High-energy trauma was the leading mechanism of injury, responsible for 57% of cases, while 43% were caused by low-energy mechanisms. Functional outcomes, evaluated at two months postoperatively, showed that 69.8% of patients achieved excellent recovery, 17.4% had good outcomes, 8.1% had fair results, and 4.7% experienced poor outcomes.

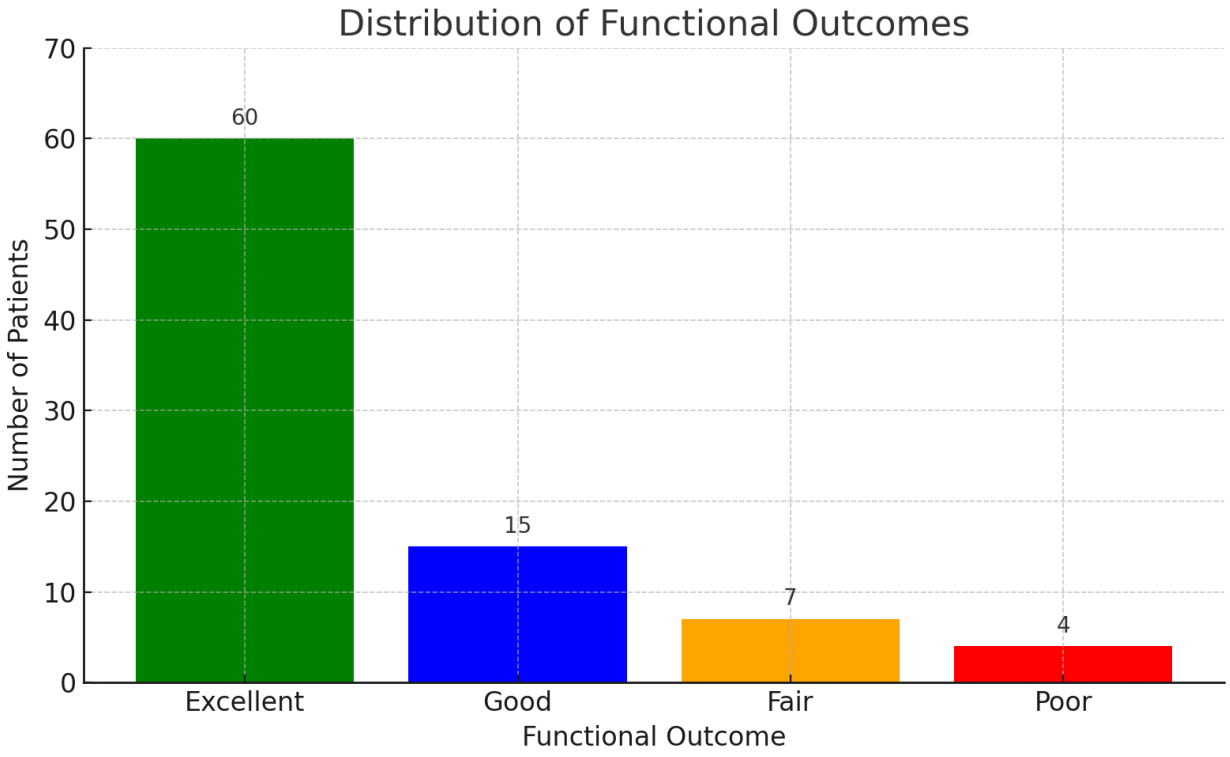

Figure 1 Shows Distribution Of Functional Outcomes Of Tibia Plateau Fracture

The bar chart (Figure 01) illustrates the distribution of postoperative functional outcomes. A clear majority of patients (69.8%) experienced excellent recovery following open reduction and internal fixation. Good and fair outcomes were observed in smaller proportions (17.4% and 8.1%, respectively), while poor outcomes were limited to only 4.7% of the study population. These findings suggest a generally favorable surgical outcome across the cohort.

Variable	**Category**	**Frequency (%)**
Gender	Male	52 (60.5%)
	Female	34 (39.5%)
Fracture Side	Right	44 (51.2%)
	Left	42 (48.8%)
Mechanism of Injury	High-energy	49 (57.0%)
	Low-energy	37 (43.0%)
Functional Outcome	Excellent	60 (69.8%)
	Good	15 (17.4%)

	Fair	7 (8.1%)
	Poor	4 (4.7%)

Table 1. Distribution of demographic variables, fracture characteristics, and functional outcomes among study participants.

The table no. 1 above summarizes key variables of the study population. It reflects a male predominance and an almost equal distribution between right and left-sided fractures. Most fractures resulted from high-energy trauma. The functional outcome profile further reinforces the effectiveness of surgical management, with a significant portion of patients demonstrating excellent recovery.

To explore potential relationships between patient characteristics and postoperative outcomes, stratified analysis and chi-square tests were performed. No statistically significant associations were observed between functional outcome and age group ($p = 0.84$), gender ($p = 0.28$), side of fracture ($p = 0.40$), or mechanism of injury ($p = 0.47$). Binary logistic regression was also applied to assess whether these variables could predict poor functional outcome; however, none of the factors demonstrated significant predictive value ($p > 0.05$). These findings confirm that the examined demographic and injury-related factors were not significantly associated with short-term functional recovery following surgery.

In conclusion, open reduction and internal fixation for tibial plateau fractures yielded favorable early functional outcomes in the majority of patients. Although stratified and multivariate analyses were conducted, no significant associations were found between demographic or injury-related variables and postoperative results. These findings suggest that with standardized surgical technique and rehabilitation, good outcomes can be consistently achieved regardless of age, gender, side, or mechanism of injury.

Discussion:

Among the many long bones in the body, the tibia is one of the most frequently injured and fractured due to its unique anatomical position—nearly one-third of its surface is subcutaneous. Tibial plateau fractures, involving the proximal part of the tibia and the weight-bearing articular surface, are particularly common when the bone is subjected to excessive axial loading and/or rotational forces. These injuries often result from high-energy trauma such as road traffic accidents, sports injuries, or falls on hard surfaces. Most tibial plateau fractures are intra-articular and require anatomical reduction and stable internal fixation [13].

Of these fractures, 50% to 70% involve the lateral plateau, 10% to 20% affect the medial plateau, and approximately 10% to 30% are bicondylar, involving both articular surfaces. These injuries not only affect the bone but also often result in damage to surrounding soft tissue structures including ligaments, joint capsule, muscles, and skin [7]. Accurate assessment of the extent and severity of injury is critical for planning treatment and estimating prognosis. Among several classification systems, the Schatzker classification remains the most widely used and accepted by orthopedic surgeons [14].

The primary goal in the treatment of tibial plateau fractures is to restore a stable, pain-free knee joint with a full range of motion. Open reduction and internal fixation (ORIF) is the standard of care in the management of displaced and unstable fractures [15]. However, outcomes vary depending on the fracture type. Schatzker type I fractures generally have a favorable prognosis, while type VI fractures, commonly associated with high-energy trauma, tend to have poorer outcomes. The surgical management of these complex fractures requires a high level of skill due

to the potential for both early (e.g., infection, loss of reduction, deep vein thrombosis) and late complications (e.g., nonunion, malunion, implant failure, post-traumatic arthritis) [16].

Tibial plateau fractures resulting from high-energy trauma are particularly challenging due to the involvement of cancellous bone, intra-articular complexity, and proximity to a major weight-bearing joint. Despite significant advancements in orthopedic techniques and implants, the treatment of these fractures remains demanding due to their complexity and associated complications [16].

Multiple studies have indicated that conservative treatment yields unsatisfactory outcomes for these injuries. The choice of surgical implant should be guided by the fracture type [43]. In Schatzker type II, III, and IV fractures without significant displacement, screw fixation may suffice. However, for displaced, depressed, or unstable fractures, open reduction with internal fixation is essential to restore anatomical alignment and facilitate early joint mobilization. Furthermore, patient compliance and dedicated physiotherapy are key contributors to successful functional recovery [17].

The current study was conducted to assess the functional outcome of ORIF in patients with tibial plateau fractures. The mean age of patients was 46.98 ± 15.82 years, ranging from 18 to 70 years, consistent with findings reported in previous literature [8]. In our cohort, 60.5% of the patients were male, which may reflect the sociocultural context in Pakistan where males are more frequently involved in outdoor activities and thus more prone to trauma-related injuries.

Regarding functional outcomes, 69.8% of patients in our study achieved excellent results, 17.4% had good outcomes, 8.1% had fair outcomes, and only 4.7% had poor outcomes. These results align closely with a prior study that reported excellent outcomes in 72.94%, good in 14.12%, fair in 7.06%, and poor in 5.88% of patients treated with ORIF [8].

To explore the association between demographic and injury-related variables and functional outcomes, chi-square tests were performed. No statistically significant relationships were found between functional outcomes and age ($p = 0.84$), gender ($p = 0.28$), side of fracture ($p = 0.40$), or mechanism of injury ($p = 0.47$). Additionally, binary logistic regression was applied to evaluate the predictive value of these variables for poor functional outcome; none showed significant associations ($p > 0.05$), suggesting that these factors did not independently influence recovery following surgery.

This study has several limitations. It was conducted at a single center, which may limit the generalizability of the findings. The follow-up duration was relatively short (2 months), which may not capture long-term complications or delayed functional impairments. Additionally, we did not stratify outcomes based on fracture classification types (e.g., Schatzker I–VI), which could have offered deeper insight into treatment responses. Lastly, patient compliance with rehabilitation was not quantitatively assessed, though it likely influenced outcomes.

Conclusion: Our study concludes that open reduction and internal fixation is an effective surgical approach for managing tibial plateau fractures, with the majority of patients (69.8%) achieving excellent functional outcomes. Additionally, 17.4% of patients had good outcomes, 8.1% had fair outcomes, and only 4.7% experienced poor results, indicating a generally favorable prognosis with this treatment modality.

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