

Original Research Article

Complications and associated risk factors of open reduction and internal fixation among adult patients with tibial plateau fractures

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ABSTRACT

Background: Tibial plateau fractures are complex injuries that often require open reduction and internal fixation (ORIF) for optimal recovery. However, complications and risk factors associated with ORIF can significantly impact patient outcomes. This study aimed to evaluate the complications and associated risk factors of open reduction and internal fixation and their effect on functional recovery in adult patients with tibial plateau fractures.

Methods: This prospective observational study was conducted in the Department of Orthopaedics and Traumatology, Chittagong Medical College Hospital, Chattogram, Bangladesh, from January 2018 to December 2019. This study included 50 adult patients of both genders with high-energy tibial plateau fractures through a consecutive sampling technique. Functional outcomes were assessed over six months and statistical associations with risk factors were examined.

Results: The mean age of patients was 43.95 ± 10.89 years, with a male predominance (76%). The most common fracture type was Type VI (72%) and the majority were closed fractures (84%). The average time from injury to surgery was 11.05 ± 3.203 days, with a mean operative duration of 107 ± 12.074 minutes. At six months, 82% of patients achieved excellent functional outcomes, while 10% had good and 4% each had moderate and poor outcomes. The mean fracture union time was 15.39 ± 1.614 weeks. Infection significantly affected recovery ($p=0.008$), with 92.7% of infection-free patients achieving excellent results, whereas 33.3% of those with superficial infections had moderate outcomes and all patients with deep infections had poor outcomes. Gender also had a significant impact ($p=0.047$), with 80.4% of males achieving excellent outcomes compared to 19.5% of females.

Conclusions: The findings show that ORIF in tibial plateau fractures generally results in favorable outcomes, but factors like gender and post-operative infections significantly influence recovery. Effective infection control and individualized patient management may enhance surgical success and functional outcomes.

Keywords: Complications, Open reduction and internal fixation, Risk factors, Tibial plateau fractures

INTRODUCTION

Tibial plateau fractures are commonly seen injuries in orthopedic departments, accounting for 36.5% of tibial and

fibula fractures and 1.66% of total fractures in adults.¹ Fractures of the tibial plateau affect the articular surface of the proximal tibia and can vary greatly in severity. Some are relatively minor and heal well with non-surgical treatment, while others are complex and pose significant

challenges even for highly experienced surgeons.² Being a subcutaneous bone, the tibia is more exposed to fractures which are often complex.³⁻⁵ Intra-articular fractures of the proximal end of the tibia i.e., 'plateau fractures', are serious and complex injuries and difficult to treat.⁴ The tibial plateau was the weight-bearing area of the knee joint, if not treated properly, it would cause serious consequences.

The most commonly used operative treatment for fracture of the tibial plateau is open reduction and internal fixation (ORIF). Surgical management of tibial plateau fractures aims to restore mechanical alignment, reduce the articular surface anatomically and preserve a healthy soft-tissue envelope. Stable fixation and early post-operative motion of the knee joint are important for a satisfactory prognosis.⁶⁻⁹ However, high-energy tibial plateau fractures are always accompanied by soft tissue damage, compartment syndrome and vascular and neurological injuries, presenting a great challenge to orthopedic surgeons. Despite the continuous evolution of treatment strategies and internal fixation for this injury, poor outcomes were still reported in the literature.¹⁰⁻¹²

Several treatment methods, such as definitive external fixation, dual plating and intramedullary nailing, are widely used and have shown good results in the literature. New techniques continue to emerge, but the ideal treatment approach remains controversial. Various surgical approaches and fixation methods have been developed to treat Schatzker type V and VI tibial plateau fractures. Open reduction and internal fixation help restore joint alignment, maintain articular congruity and allow for early knee mobilization. However, when performed through damaged soft tissues, these procedures can sometimes lead to significant wound complications.² Surgical treatment for tibial plateau fractures can lead to several complications, including surgical site infections (SSI), traumatic myositis ossificans, post-traumatic osteoarthritis, joint stiffness and delayed or non-union.^{10,11} Among these, deep SSIs are the most common. Studies report infection rates after internal fixation ranging from 2% to 23.6%.¹²⁻¹⁵ Some research even suggests that proximal tibia fractures themselves increase the risk of SSIs.¹⁶ Infections can cause significant pain and deformities, severely impacting a patient's quality of life. That's why it's crucial to identify the risk factors associated with open reduction and internal fixation of tibial plateau fractures.

In this study, we aimed to evaluate the complications and associated risk factors of open reduction and internal fixation and their effect on functional recovery in adult patients with tibial plateau fractures.

METHODS

Study type

This was a prospective observational study.

Study place

The study was conducted in the Department of Orthopaedics and Traumatology, Chittagong Medical College Hospital, Chattogram, Bangladesh.

Study duration

The study period was from January 2018 to December 2019.

Sample size

This study included 50 adult patients of both genders with high-energy tibial plateau fractures through a consecutive sampling technique.

These are the following criteria to be eligible for enrollment as our study participants.

Inclusion criteria

Patients aged more than 18 years, patients with closed Schatzker type V and VI tibial plateau fractures, patients with open fractures up to Gustilo-Anderson type I. Patients who were willing to participate were included in the study.

Exclusion criteria

Patients with the ipsilateral neuro-vascular deficit, patients with dislocation of the knee joint, patients with compartment syndrome, patients with any history of acute illness (e.g., renal or pancreatic diseases, ischemic heart disease, asthma, COPD, etc.) were excluded from our study.

Data collection

History was taken and clinical examination was performed following the standard procedure of clinical methods. A questionnaire was prepared considering the key variables like age, gender, side & mechanism of injury, type of injury, close/open injury, fracture blister, comorbidities, the time interval from injury to fixation, duration of operation and functional outcome of surgery which were verified by the guide.

A consecutive type of non-probability sampling technique was used according to the availability of the patients. After proper counseling and anesthesia fitness patients were operated on. Post-operative follow-up was given in 2nd week, 6th week, 3rd month and 6th month. The Oxford knee scoring system was used to evaluate the knee function of our study subjects.

Surgical procedure

All patients underwent surgery using an anterolateral approach for the lateral plate and either a medial or posteromedial approach for the second plate. The

procedures were performed under regional, spinal or general anesthesia. Patients were positioned on a radiolucent table in a supine position, with a sandbag placed under the ipsilateral gluteal region for the anterolateral approach and under the contralateral hip for the posteromedial approach. A tourniquet was inflated during all surgeries to minimize bleeding.

For the medial approach, a one-inch longitudinal skin incision was made to allow for a minimally invasive procedure. The medial or posteromedial fragment was carefully exposed by lifting the pesanserinus with a periosteal elevator.

Once the fragment was properly aligned, a small buttress plate was placed underneath the pesanserinus and secured to the bone using stab incisions. Adequate visualization of the fragments was ensured to achieve accurate anatomical reduction. Depending on the case, either a T-buttress plate or a 3.5 mm locking proximal medial tibial plate was used.

For the anterolateral approach, a curved longitudinal incision was made, starting from the lateral femoral epicondyle, curving over Gerdy's tubercle and extending parallel to the tibial shin, just lateral to it. After securing the implants, the wound was closed over a suction drain to manage post-surgical drainage. Finally, a long leg back slab was applied to support the limb and aid in healing.

Statistical analysis

All data were recorded systematically in preformed data collection form. Quantitative data was expressed as mean and standard deviation and qualitative data was expressed as frequency distribution and percentage. Continuous variables were compared by Student's t-test between two parameters and analysis of variance (ANOVA) test when parameters were more than two.

Qualitative variables were analyzed by Chi-square test. Statistical analysis was performed by using SPSS 25 (Statistical Package for Social Sciences) for Windows version 10. The study was approved by the Ethical Review Committee of Chittagong Medical College Hospital.

RESULTS

Table 1 shows that the mean age of the participants was 43.95 ± 10.89 years. Most patients were males (76%), compared to females (24%). The mechanism of injury of all patients was road traffic accidents (RTA). The right side was affected in 74% of cases, while the left side was involved in 26%.

Type VI fractures were more prevalent (72%), while type V fractures accounted for 28%. The injury pattern showed that 84% of cases were closed fractures, whereas 16% were open fractures. Fracture blisters were observed in 14% of patients. In terms of co-morbidities, 16% of

patients had diabetes mellitus (DM) and 4% had hypertension (HTN).

Table 2 shows that the mean $\pm$ SD interval from injury to fixators in the study subjects was 11.05 ± 3.203 days with a range between 7-19 days. The mean $\pm$ SD duration of operation was 107 ± 12.074 minutes (range: 90-130 minutes). At the 6th month final follow-up, out of 50 patients, the excellent outcome was in 41 (82%) patients and good outcomes were in 05 (10.0%) patients, both moderate and poor outcomes were found in 02 (4%) patients.

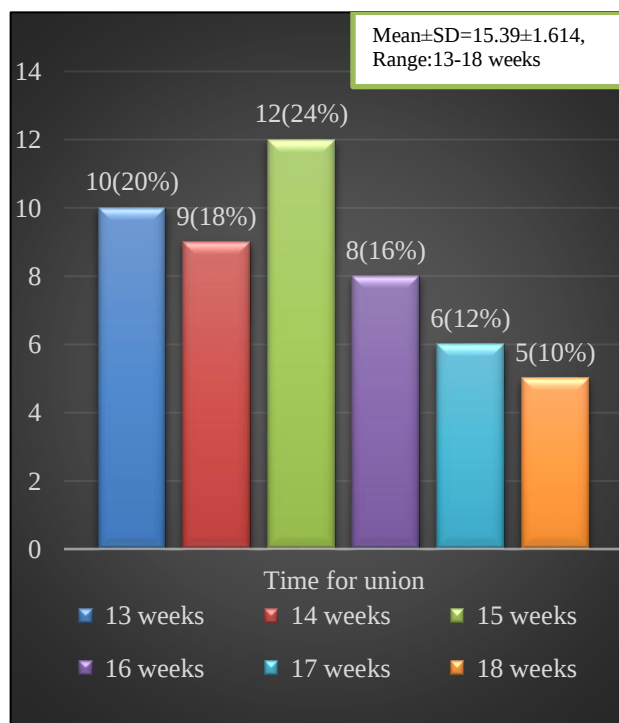


Figure 1: Time taken for fracture union (n=50).

Table 3 shows the mean $\pm$ SD and range of ROM at 2nd week ($61.00^\circ \pm 21.740^\circ$, 20° - 100°), at 6th week ($88.95^\circ \pm 22.335^\circ$, 30° - 120°), at 3rd month ($111.39^\circ \pm 21.130^\circ$, 50° - 135°) and at 6th month ($119.72^\circ \pm 20.542^\circ$, 60° - 140°).

Figure 1 shows that out of 50 patients, 12 (24%) patients needed 15 weeks for fracture union, followed by 10 (20%) patients who needed 13 weeks, 9 (18%) patients needed 14 weeks, 8 (16%) patients needed 16 weeks, 6 (12%) patients needed 17 weeks and only 5 (10%) patients needed 18 weeks. The mean $\pm$ SD time for fracture union was 15.39 ± 1.614 weeks. The range of time taken for fracture union was 13-18 weeks.

The above table shows that out of 50 patients, 42 (84%) had no infection, 6 (12%) had a superficial infection and 2 (4%) had a deep infection. No patients had non-union and implant failure.

Table 5 shows that the age of patients did not show a statistically significant association with functional outcomes ($p=0.102$). Gender had a significant impact ($p=0.047$), with 80.4% of males achieving excellent outcomes, compared to 19.5% of females. Similarly, co-morbidities showed no significant influence ($p=0.066$), but patients without co-morbidities had the highest rate of

excellent outcomes (87.8%). Infection was a significant factor ($p=0.008$). Patients without infections had the best outcomes, with 92.7% and 80% achieving excellent and good results. All patients (100%) with moderate outcomes had superficial infections, while 100% of deep infection cases had poor functional outcomes.

Table 1: Baseline characteristics of our study subjects.

Baseline	N	P (%)
Mean age (years), Range	43.95±10.89	(26-60 years)
Gender		
Male	38	76.0
Female	12	24.0
Mechanism of injury		
RTA	50	100.0
Side of injury		
Right	37	74.0
Left	13	26.0
Type of injury		
Type V	14	28.0
Type VI	36	72.0
Pattern of injury		
Closed	42	84.0
Open	08	16.0
Fracture blister		
Present	07	14.0
Absent	43	86.0
Co-morbidities		
Hypertension	2	4.0
DM	8	16.0
Absent	40	80.0

Table 2: Distribution of the patients by the time interval from injury to fixation, duration of operation and functional outcome (n=50).

The time interval for fixation	N	P(%)
Mean±SD	11.05±3.203	
Range	7-19 days	
Duration of operation		
Mean±SD	107.0±12.074	
Range	90-130 minutes	
Functional outcome at 6 months		
Excellent	41	82.0
Good	5	10.0
Moderate	2	4.0
Poor	2	4.0

Table 3: ROM of knee joint at 2nd week , 6th week , 3rd month and 6th month (n= 50).

Variable	Mean±SD	Range
ROM at 2nd week	61.00°±21.740°	20°-100°
ROM at 6th week	88.95°±22.335°	30°-120°
ROM at 3rd month	111.39°±21.130°	50°-135°
ROM at 6th month	119.72°±20.542°	60°-140°

Table 4: Post-operative complications of our study patients.

Complications	N	P (%)
Infection		
No infection	42	84.0
Superficial infection	6	12.0
Deep infection	2	4.0
Non-union		
Yes	0	0.0
No	50	100.0
Implant failure		
Yes	0	0.0
No	50	100.0

Table 5: Univariate analysis of risk factors associated with outcome (n=50).

Variables	Functional outcome				P value
	Poor=2	Moderate=2	Good=5	Excellent=41	
Age					
	60.00±0.000	55.00±4.415	53.00±6.245	42.43±10.196	0.102 (ns)
Gender					
Male	0 (0%)	2 (100.0%)	3 (60.0%)	33 (80.4%)	0.047 (s)
Female	2 (100.0%)	0 (0%)	2 (40.0%)	8 (19.5%)	
Total	2 (4.0%)	2 (4.0%)	5 (10.0%)	41 (82.0%)	
Co-morbidities					
Absent	0 (0%)	0 (0%)	4(80.0%)	36 (87.8%)	0.066 (ns)
HTN	0 (0%)	0 (0%)	0 (0%)	2 (4.8%)	
DM	2 (100.0%)	2 (100.0%)	1 (20.0%)	3 (7.3%)	
Total	2 (4.0%)	2 (4.0%)	5 (10.0%)	41 (82.0%)	
Infection					
No infection	0 (0%)	0 (0%)	4 (80.0%)	38 (92.7%)	0.008 (s)
Superficial infection	0 (0%)	2 (100.0%)	1 (20.0%)	3 (7.3%)	
Deep infection	2 (100.0%)	0 (0%)	0 (0%)	0 (0%)	
Total	2 (4.0%)	2 (4.0%)	5 (10.0%)	41 (82.0%)	

ns=non-significant; s=significant

DISCUSSION

This prospective observational study was conducted on 50 adult patients presented with high-energy tibial plateau fractures treated by open reduction and internal fixation (ORIF) using dual plates through anterolateral and posteromedial incisions to evaluate the complications and associated risk factors of ORIF.

In the present study, the mean age of the patients was 43.95±10.894 years. A recent study by Nawaz et al, found that mean±SD of age was calculated as 31.25±7.29 years.¹⁷ Another recent study conducted by Tahir et al stated the mean age of the patients was 45.08±10.52.¹⁸ Yu et al also showed the mean age was 45.2 years.¹⁹ Out of 50 patients, 76% were male and 24% were female. Nawaz et al showed that 63 (70%) were male and 27 (30%) were females.¹⁷ Tahir et al showed in their study the male-to-female distribution was 107/30 (78.1% and 21.89%).¹⁸ Rohra et al found out of 34 patients, 29 (85.29%) were males and 5 (14.71%) were females.²⁰ In the present study, all the

patients got trauma by RTA. Tahir et al showed regarding the mechanism of injury, road traffic accidents (RTA) were the primary cause of injury 96 (70.07%), falls were 21 (15.32%) and gunshots were 18 (13.13%).¹⁸ Rohra et al, (2016) also found that the tibial plateau fractures were most commonly due to RTA.²⁰ The present study's mean time from injury to fixation was 11.05±3.203 days. These results are consistent with prior research, such as Rohra et al, who reported an average surgical timing of 6.5 days and Yu et al, who documented an average of 10.4 days.^{19,20} The mean duration of surgery in the present study was 107.0±12.074 minutes, which is notably shorter than the 158.4 minutes reported by Yu et al.¹⁹

In the present study, at the 6th-month final follow-up, the excellent outcome was in 41 (82%) patients and the good outcome was in 05 (10%) patients. Tahir et al reported that 12 (17.6%) patients had excellent outcomes, 34 (50%) patients had good outcomes and 12 (17.6%) and 10 (14.7%) patients had fair and poor outcomes respectively.¹⁸ Rohra et al reported that 29 patients

(85.29%) had excellent and 5 patients (14.71%) had good objective knee society scores.²⁰

Bone grafting was performed in 20% of cases, exclusively using autografts, whereas 80% of patients did not require bone grafting. These findings are comparable to previous studies, such as Rohra et al, where 26.47% of patients required bone grafting (17.65% autograft, 8.82% allograft).²⁰ Yu et al reported a higher rate of autografting (64.8%) with no cases of allografting.¹⁹ The mean time for fracture healing in the present study was 15.39 ± 1.614 weeks, which is in agreement with previous studies. Rohra et al reported an average union time of 15.7 weeks, Cho et al noted a mean healing time of 16 weeks and Yu et al documented a mean union time of 15.4 weeks.¹⁹⁻²¹

The range of motion (ROM) outcomes in this study demonstrated progressive improvement over time. In the second week, the mean ROM was $61.00^\circ \pm 21.740^\circ$ (range: 20° - 100°), increasing to $88.95^\circ \pm 22.335^\circ$ (range: 30° - 120°) at six weeks, $111.39^\circ \pm 21.130^\circ$ (range: 50° - 135°) at three months and $119.72^\circ \pm 20.542^\circ$ (range: 60° - 140°) at six months. These findings are consistent with previous reports, such as Tahir et al, (2019), who found an average knee flexion of $115.51^\circ \pm 16.82^\circ$ at 24 months.¹⁸ Cho et al reported a mean ROM of 122.5° , while Yu et al, (2009) documented a mean ROM of 107.6° (range: 85° - 130°).^{19,21}

In terms of complications, no cases of nonunion, delayed union or implant failure were observed in this study. However, superficial infections occurred in 12% of patients, while 4% experienced deep infections. These results correspond with findings from Rohra et al, where no nonunion cases were reported and two cases of superficial infections were observed at six months.²⁰ Similarly, Oh et al found that superficial infections resolved after plate removal, with no reported deep infections.²² This study found that functional outcome after 6th-month follow-up was associated with a mean 60 years of age, female sex, history of diabetes and post-operative infection had a greater chance of having poor functional outcome than their counterpart.

This study was a single-center study. We took a small sample size due to the short study period. After evaluating those patients, we did not follow up with them for the long term and did not know other possible interference that may happen in the long term with these patients.

CONCLUSION

The findings show that open reduction and internal fixation (ORIF) for tibial plateau fractures generally lead to good functional outcomes. In this study, the majority of patients achieved excellent recovery (82%), with a mean fracture union time of 15.39 weeks. However, post-operative infections and comorbidities were major complications, while gender differences played a role, with males achieving better results than females. ORIF remains an effective treatment for tibial plateau fractures,

minimizing complications particularly infections through careful surgical technique, post-operative monitoring and patient-specific management are crucial to ensure the best possible recovery.

Further study with a prospective and longitudinal study design including a larger sample size needs to be done to validate the findings of our study.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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