

Clinical and Radiological Outcome of Tibial Plateau Fractures Managed with Locking Compression PlatesKatikitala Aravind¹, K. Shri Ram Reddy², Krishna Bhargava Vem³¹Assistant Professor, Department of Orthopaedics, Apollo Institute of Medical Sciences and Research, Hyderabad, Telangana, India²Senior Resident, Department of Orthopaedics, Apollo Institute of Medical Sciences and Research Hyderabad, Telangana, India³Associate Professor, Department of Orthopaedics, Apollo Institute of Medical Sciences and Research, Hyderabad, Telangana, India

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Conflict of interest: Nil

Abstract:

Introduction: In recent years, the use of LCPs (Locking Compression Plates) has emerged as a promising treatment approach for tibial plateau fractures. LCPs provide rigid fixation and allow for the preservation of the fracture biology, which may improve the overall clinical and radiological outcome. This work was carried out to study the functional outcome of the fracture of proximal tibia and to evaluate the advantages and disadvantages in terms of positive outcome of fracture union, patient compliance and complication of surgical correction with locking compression plates.

Materials and Methods: This was a prospective study conducted over a period of 18 months involving 34 adults aged 18 - 65 years having closed tibial fracture of Schatzkers type 1-5 treated with MIPPO (Minimally Invasive Percutaneous Plate Osteosynthesis). Patients were followed up for a period of 6 months with both clinical and radiological parameters according to Rasmussen's score.

Results: Rasmussen's scores were higher for Schatzker II-III (~29) than for Schatzker V-VI (~25). Patients with simple fractures regained ROM of ~130°, while complex fractures exhibited significant variability (90–120°). Fracture union occurred within 14–20 weeks in most patients. Early weight-bearing (~12 weeks) was achieved in Schatzker II-III but delayed for Schatzker V-VI (~16–20 weeks) to ensure stability. Complex fractures (Schatzker VI) showed higher complication rates (~20%) compared to simpler ones (~10%).

Conclusion: Excellent clinical and radiological outcomes of tibial plateau fractures managed with locking compression plates were observed, as evidenced by better Rasmussen's score, faster union, better range of motion and early weight-bearing especially among Schatzker I and II cases, when the surgery is performed early with minimal complications.

Keywords: Tibial Plateau Fractures, Locking Compression Plates, Rasmussen's Score.

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Introduction

The proximal tibia is a complex and essential component of the knee joint, comprising several distinct anatomical structures that work together to facilitate movement, provide stability, and transmit weight-bearing forces. Fractures of the proximal tibia are complex injuries that often result from high-energy trauma and can lead to significant functional impairment if not properly managed and require a comprehensive understanding of the anatomy, classification, mechanisms of injury, clinical presentation, and management strategies. Successful treatment of these fractures is crucial to optimize patient outcomes and minimize the risk of long-term complications. Complications and outcomes of proximal tibia fractures are associated with a high

risk of complications, including post-traumatic osteoarthritis, loss of knee function, and infection.[1]

Tibial plateau fractures are complex injuries that often result from high-energy trauma and can lead to significant functional impairment if not properly managed. In recent years, the use of LCPs (Locking Compression Plates) has emerged as a promising treatment approach for tibial plateau fractures. LCPs provide rigid fixation and allow for the preservation of the fracture biology, which may improve the overall clinical and radiological outcome. However, the literature on the long-term results of LCP management for tibial plateau fractures in adults is

limited, and more research is needed to fully understand the efficacy of this treatment strategy. While LCPs have demonstrated numerous advantages, challenges remain. Infection, loss of reduction, hardware failure, and post-traumatic arthritis are notable complications.[2] The prevalence of these issues varies by fracture type, patient comorbidities, and surgical technique. Parkkinen et al. (2017) conducted a meta-analysis revealing that smoking, diabetes, and delayed surgery significantly increase complication risks. Chan et al.,[3] identified infection rates of upto 8% in their analysis of 200 cases, highlighting the role of preoperative skin condition in influencing outcomes. Recent comparative studies, such as those by Yu et al. [4] evaluate LCPs against other modern fixation systems, like hybrid external fixation. LCPs generally provide superior functional outcomes, especially in high-energy fractures requiring precise alignment and stable fixation.

This work was carried out to study the functional outcome of the fracture of proximal tibia and to evaluate the advantages and disadvantages in terms of positive outcome of fracture union, patient compliance and complication of surgical correction with locking compression plates.

Materials and Methods

This was a prospective study conducted over a period of 18 months involving 34 adults aged 18 - 65 years having closed tibial fracture of Schatzkers type 1-5. Patients below 18 years age (skeletally immature) and more than 65 years age were excluded from the study. Those with open fractures, pathological fractures and neurovascular injury were

also excluded. 4 patients were lost to follow-up, leaving 30 patients included in the study.

After enrollment, history and detailed physical examination were carried out to determine any associated ligamentous injuries, neurovascular injuries and compartment syndrome. Anteroposterior and lateral radiographs were taken to assess the type of tibial plateau fracture. All the patients diagnosed to have tibial plateau fractures were treated with MIPPO. Patients were followed up for a period of 6 months with both clinical and radiological parameters according to Rasmussen's score.

Results

Patients were in the age group 23 to 69 years, with the average being 48.23 years. 4 patients within the age group of 20 to 30 years, 7 patients between the ages of 31 to 40 years, 8 patients between the ages of 41 and 50 years, 5 patients between the ages of 51 and 60 years, 6 patients between the ages of 61 and 70 years. In our study there were 23 male patients and 7 female patients.

Majority (n=16, 53.3%) of them had left side injury while the rest had injuries on their right side (n=14, 46.6%). Mode of injury of 23 patients was RTA; only 7 patients had slip and fall. Type II fractures were the most frequent, accounting for 10 cases (39%). Type III and Type VI fractures were observed in 4 cases each, making up 15% each of the total. Type IV fractures occurred in 5 cases (19%), while Type V fractures were noted in 7 cases, representing 27% of the total.

Table 1: Schatzker's Classification

Type	Number	%
Type II	10	39%
Type III	4	15%
Type IV	5	19%
Type V	7	27%
Type VI	4	15%

Ten of our patients had other associated injuries at the time of initial presentation. The most common associated injury was fibula fractures in six patients. The other associated injuries were a fracture of the distal tibia, tri malleolar fracture, shaft fracture of femur, distal radius fracture. Two of these ten patients had more than one associated injury. All the associated injuries were treated.

The majority of patients, 19 cases (65%), underwent surgery within one week; 7 cases (23%) had surgery between one and two weeks; and 4 cases (12%) underwent surgery after more than two weeks. The post-operative results were designated as excellent,

good, fair and poor according to pain, walking capacity, range of motion and stability of the knee using Rasmussen's grading system. Similarly, Rasmussen's radiological scoring done by assessing articular congruity, condylar widening, and valgus/varus angulation. In our study the average functional knee score was 26.41. Rasmussen's average radiological score was 16.56.

In our study comprising of 30 patients, 14 patients [47%] had excellent results, 10 patients [33%] had good results, 4 patients [13%] had fair results and 2 patients [7%] had poor result as shown in the graph and table below.

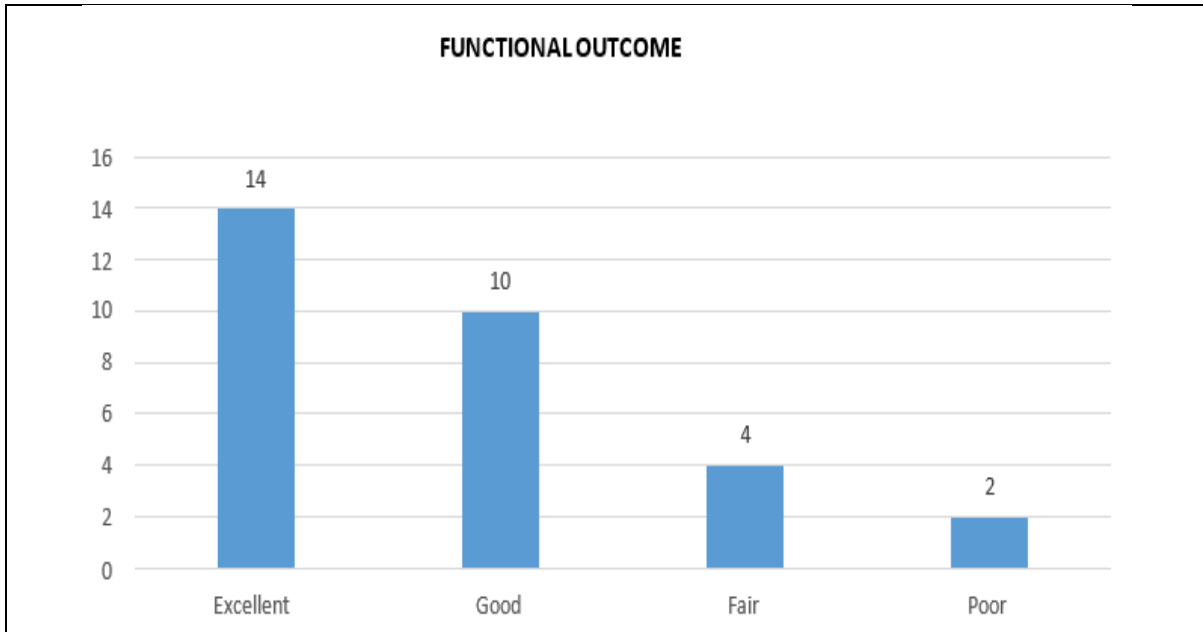


Figure 1: Functional Outcome of the Study Participants

All fractures in this study united without requiring any additional procedures. The average time taken for fracture union was 15.34 weeks.

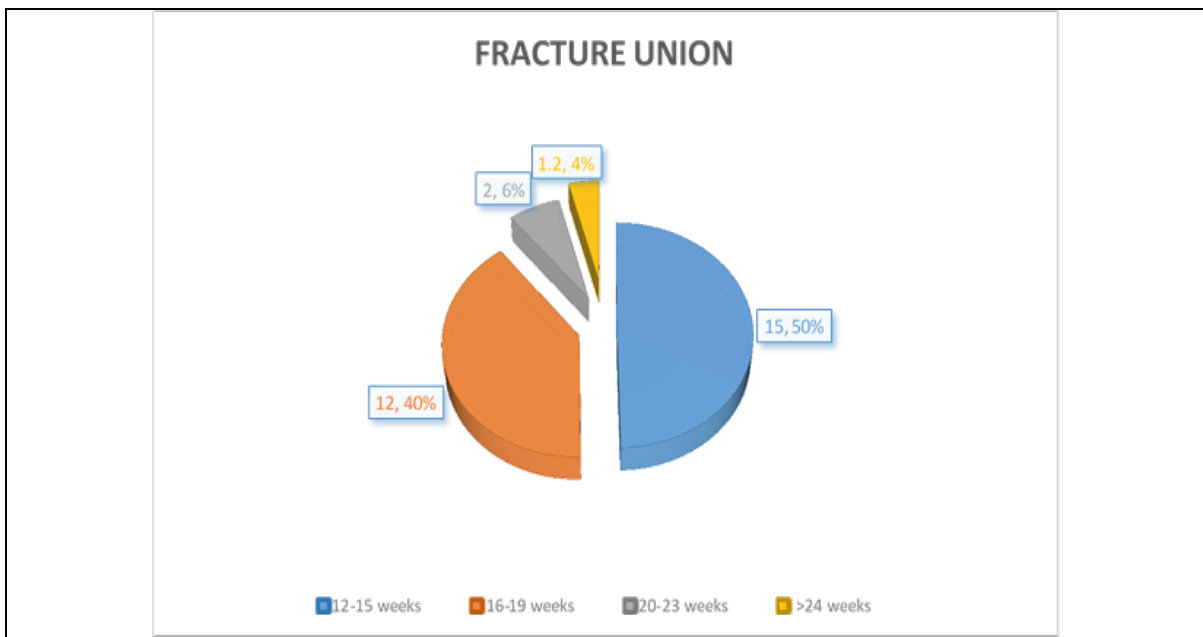


Figure 2: Time Taken for Fracture Union

The average range of movement achieved was 120 degrees. 6 patients achieved slightly more than 130 degrees of flexion, 10 achieved almost 130 degrees,

9 achieved almost 120 degrees, 5 patients had movement of only 90 degrees of flexion.

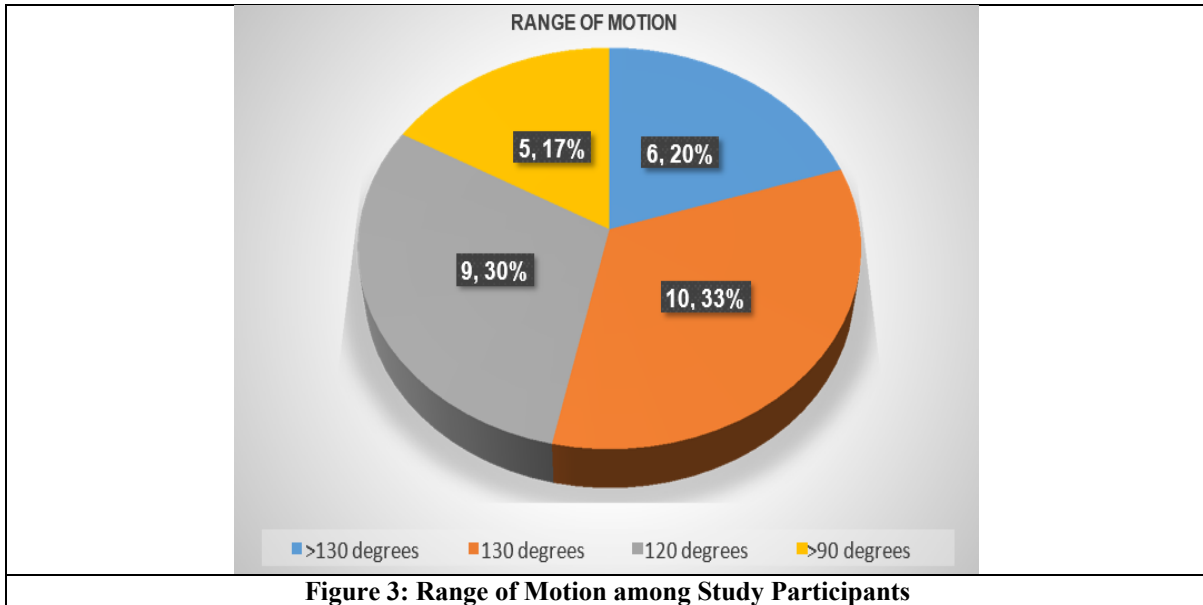


Figure 3: Range of Motion among Study Participants

The timeline for full weight-bearing walking among patients varied: 14 patients were able to bear full weight within 14 weeks, 13 patients achieved this

between 15 and 18 weeks, and 3 patients required more than 18 weeks to reach this milestone.

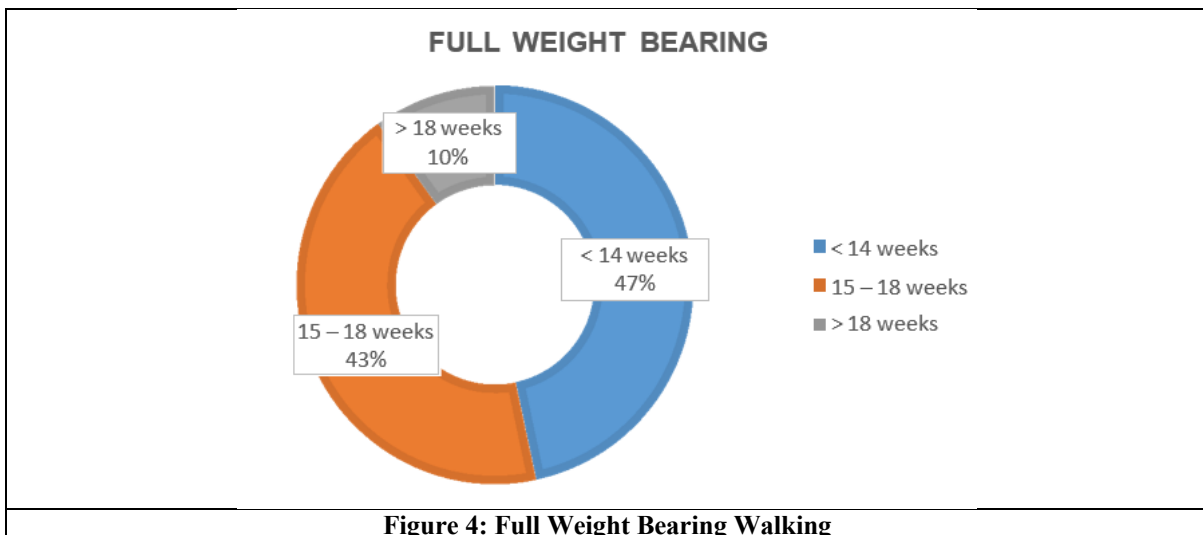


Figure 4: Full Weight Bearing Walking

Younger patients (20-40) predominantly had excellent outcomes, while older patients (41+)

experienced more fair and poor outcomes, potentially reflecting age-related recovery factors.

Table 2: Outcome Based on Age

Age Range	Excellent	Good	Fair	Poor	Total
20-40	6	1	1	0	8
41-60	6	4	1	1	12
61+	1	4	1	0	6

The various complications encountered in our study as listed in the figure below.

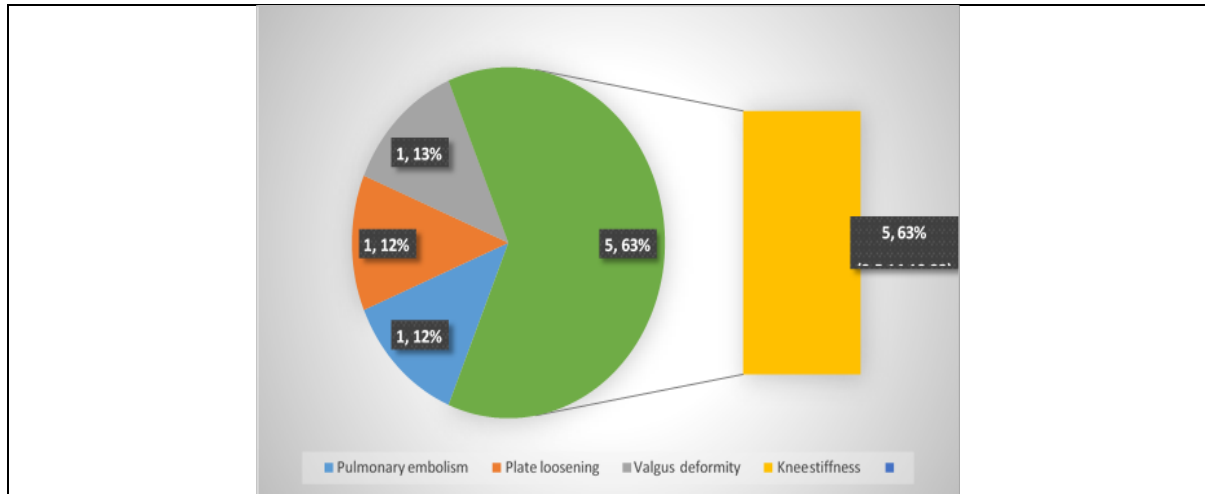


Figure 5: Complications



Figure 1: Preparation, Painting and Draping



Figure 2: Incision



Figure 3: Plate Passed Through Percutaneous Technique



Figure 4: Drilling with The Help of Sleeve



Figure 5: Placement of Screws



Figure 6: Screws Passed through Small Stab Incisions

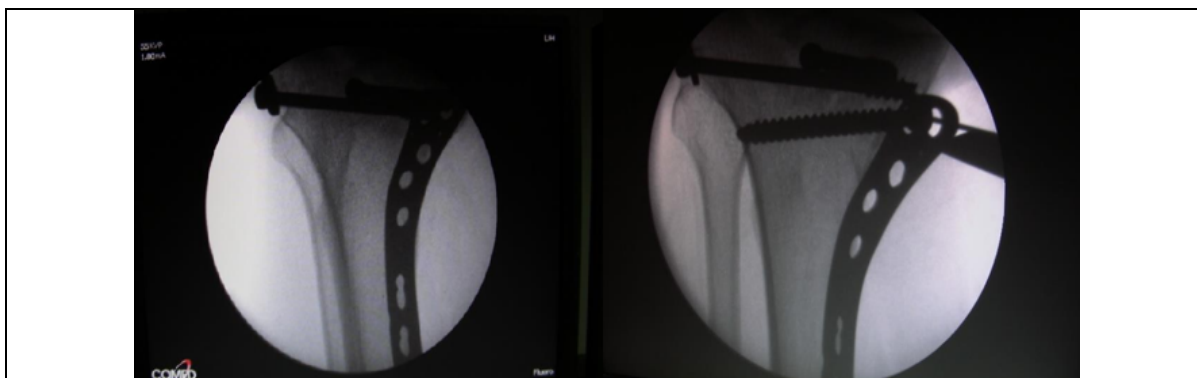
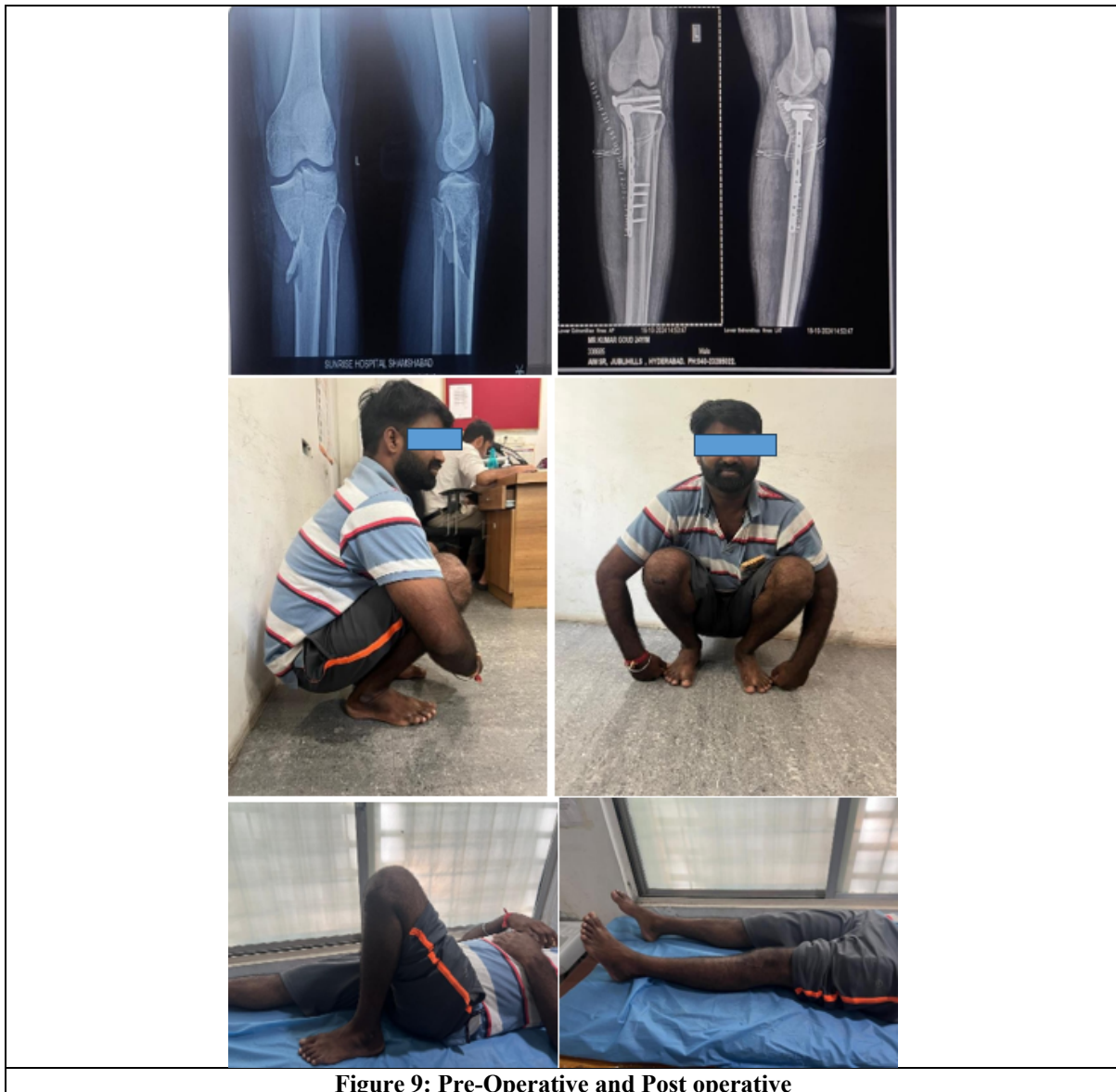
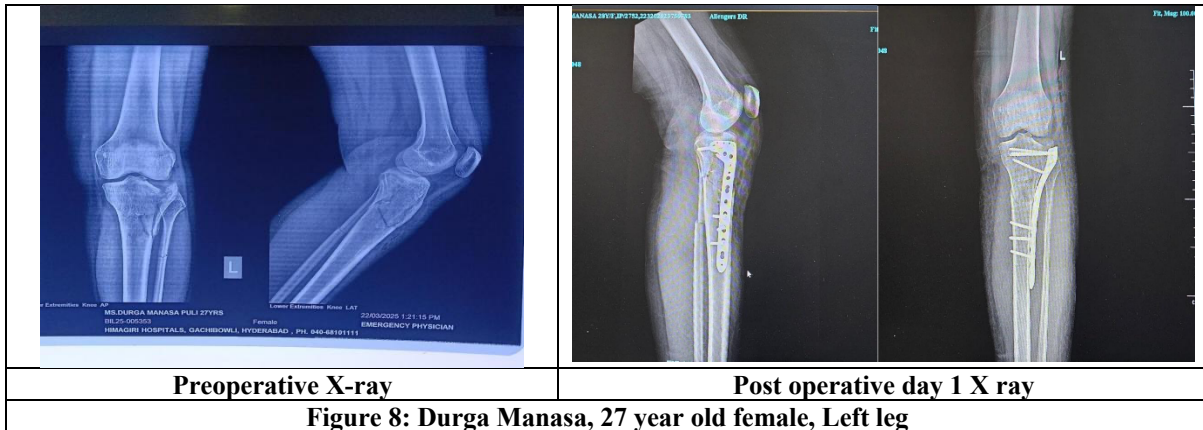


Figure 7: Skin Closed with Non Absorbable Sutures



Discussion

This study investigated functional and radiological outcomes in patients with tibial plateau fractures managed surgically, focusing on fracture type, patient demographics, and post-operative metrics.

The analysis uses metrics such as Rasmussen’s scores, ROM (Range of Motion), weight-bearing timelines, and complication rates.

Patients included in the cohort were in the age group 23 to 69 years with average being 48.23 years. This

was similar to the observation in Lee J et al.,[5] wherein the average age was 42 years. Younger patients (20–40) predominantly had excellent outcomes, while older patients (41+) experienced more fair and poor outcomes, potentially reflecting age-related recovery factors. Manidakis et al.,[6] and Yao et al.,[7] also made a similar observation.

The time interval between injury and surgery significantly affects outcomes in tibial plateau fractures. Delayed intervention can lead to complications like stiffness, infection, and poor functional results, while very early interventions can risk soft tissue injury. In our study, surgery interval between 2-7 days was associated with >80% excellent outcomes. Surgeries delayed >14 days led to poorer Rasmussen scores (knee stiffness, union delay). Our study aligns with findings from other research: surgeries performed earlier (especially <7 days) result in better functional and radiological outcomes, provided the soft tissue conditions are optimal. Delays beyond two weeks notably reduce patient outcomes. [2,6,8]

The Schatzker classification is essential in predicting prognosis after tibial plateau fractures. Outcomes tend to correlate with fracture complexity, soft tissue damage, and subsequent surgical intervention. Simple Schatzker fractures achieved consistently better outcomes-90% of patients reported excellent Rasmussen scores, in line with other studies reporting outcomes of 80–85% than complex injuries in which ~65% achieved good-to-excellent outcomes. Higher rates of stiffness and extended recovery periods were observed in this group. [2,6-8]

The ROM is a key metric in evaluating functional recovery after tibial plateau fracture fixation. Different studies emphasize how fracture type, treatment protocol, and rehabilitation impact ROM outcomes. ROM in simple fractures consistently ranged 120–130°, aligning with all comparative studies (e.g., Yao et al.,[7] ~130°, Manidakis et al.,[6] ~130°). In our study, ROM outcomes in complex fractures ranged from 90–120°, slightly lower than the comparative studies like Yao et al. (~115°). Most studies, including ours, found better ROM (~130°) in both simple and moderately complex fractures when surgeries occurred early. ROM outcomes (~110–120°) declined as fracture complexity increased, but Schatzker II-IV still performed reasonably well. Delayed surgery negatively impacted ROM (~90–100°), especially in Schatzker V-VI cases.

Complete union was observed in most cases within 16–20 weeks. Functional outcomes stabilized by 12 months. The follow-up periods across various studies highlight the importance of monitoring for both short- and long-term outcomes in tibial plateau fractures. Barei et al. [2] followed patients for 12–24

months, emphasizing the evaluation of long-term outcomes, union rates, and the development of PTA (Post-Traumatic Arthritis). Manidakis et al.,[6] extended their follow-ups to 24–36 months, finding that while results were similar at 12 months, the longer follow-up revealed an increased prevalence of PTA in complex fractures by 36 months. Fracture union times vary according to the complexity of tibial plateau fractures, with higher Schatzker types generally requiring longer healing durations. Comparable to Barei et al., Schatzker V-VI had longer healing durations but still aligned with union benchmarks. Barei et al., (2006) reported union times between 14–20 weeks, with Schatzker II-III fractures achieving union around 14 weeks, while Schatzker IV-VI fractures required 16–20 weeks due to factors such as comminution and soft tissue damage. Similarly, Manidakis et al., (2010) observed union times of 16–20 weeks, with simpler fractures healing in approximately 14 weeks and complex fractures, particularly Schatzker V and VI, taking 18–20 weeks, often aided by hybrid fixation techniques. In the 2024 study, union times ranged from 12–20 weeks, with Schatzker II-III fractures uniting in ~14 weeks and Schatzker V-VI fractures around ~16 weeks, findings comparable to those of Barei et al., indicating that while more complex fractures take longer to heal, the outcomes remain consistent with established union benchmarks. The timing for FWB (Full Weight-Bearing) after tibial plateau fractures varies depending on the complexity of the fracture. Consistent with other studies, delayed FWB (16–20 weeks) improved outcomes in Schatzker VI and 12–14 weeks in Schatzker II and III. Barei et al.,[2] reported FWB initiation between 10–14 weeks, with Schatzker II-III fractures achieving FWB at 12 weeks and Schatzker IV-VI fractures at 14–16 weeks. They observed that earlier FWB was associated with improved mobility in simpler fractures. Manidakis et al.,[6] found similar patterns, with FWB introduced at 12 weeks for Schatzker II-III fractures and 16-18 weeks for more complex fractures, emphasizing the need for cautious weight-bearing in severe cases. Our study reported FWB initiation between 12–24 weeks, with Schatzker II-III fractures achieving FWB at 12–14 weeks and Schatzker IV-VI fractures at 16–20 weeks.

The Rasmussen scores, both clinical and radiological, reveal differences in outcomes between simpler and more complex tibial plateau fractures. Higher clinical scores in our study indicate good surgical and rehabilitation practices, similar to other studies. Barei et al. [2] reported average clinical scores of ~30 and radiological scores of ~20 for Schatzker II-III fractures, whereas Schatzker IV-VI fractures had lower clinical scores of ~26 and radiological scores of ~16. The reduced scores in higher Schatzker types were attributed to challenges in restoring congruent articular surfaces. Manidakis

et al.,[6] observed clinical scores of ~28 and radiological scores of ~18 for Schatzker II-III fractures, compared to ~24 and ~14, respectively, for Schatzker IV-VI fractures, noting that poor radiological outcomes, particularly in Schatzker VI fractures, reflected increased deformities and impeded recovery. In our study, clinical scores were ~29 for Schatzker II-III fractures and ~25 for Schatzker IV-VI fractures, while radiological scores were ~18 and ~16, respectively. These higher clinical scores reflect effective surgical techniques and rehabilitation practices, aligning with the trends reported in prior studies.

The overall complication rates in tibial plateau fractures highlight the increased risks associated with complex fracture types. In the present study, Schatzker VI had higher complication rates, consistent with findings from Barei and Manidakis Barei et al.,[2] reported a complication rate of 20–25%, with infection, stiffness, and malunion as the key complications. Complex fractures (Schatzker V-VI) contributed significantly to these complications, often requiring reoperation.

Manidakis et al.,[6] observed a similar complication rate of approximately 22%, with common issues including soft tissue necrosis, arthritis, and hardware failure, particularly in cases with delayed surgical intervention beyond 14 days. In our study, the complication rate ranged from 15–20%, with knee stiffness and valgus deformity being the primary issues. As in previous studies, Schatzker VI fractures exhibited the highest complication rates, aligning with the findings of Barei and Manidakis and underscoring the challenges of managing complex fracture patterns.

Conclusion

This study reinforces the observation of excellent clinical and radiological outcome of tibial plateau fractures managed with locking compression plates, as evidenced by better Rasmussen's score, faster

union, better range of motion and early weight bearing especially among Schatzker I and II cases, when the surgery is performed early, with minimal complications. Future research involving larger number of patients will enhance understanding of the patterns in tibial plateau fracture outcomes and the importance of individualized treatment, timely intervention, and meticulous postoperative care in optimizing long-term recovery.

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