A Study of Functional Outcome of Tibial Plateau Fractures Managed with Bicondylar Plating

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ABSTRACT

Introduction: Tibial plateau fractures represent complex orthopedic injuries with significant implications for knee function and mobility. Their management is challenging due to the fractures 'impact on the weight-bearing surface of the knee joint. Recent advancements, including bicondylar plating techniques, aim to restore joint integrity and ensure optimal functional outcomes. This study focuses on evaluating the clinical, radiological, and functional outcomes of high-velocity tibial plateau fractures managed surgically with bicondylar plating. **Methodology:** This retrospective cohort study was conducted at a tertiary care center from March 2022 to September 2023, involving 41 patients. Inclusion criteria were patients aged 20–60 years with high-velocity tibial plateau fractures having >2 mm articular surface depression/displacement. Exclusion criteria included open fractures, pathological fractures, pre-existing joint diseases, and neurovascular injuries. All patients underwent surgical management via open reduction and internal fixation with bicondylar plating. Clinical, radiological, and functional evaluations were conducted using tools like the Knee Society Score (KSS) and radiographic assessments. Data were statistically analyzed to explore relationships between fracture type, surgical intervention quality, and functional outcomes. **Results:** The study demonstrated satisfactory outcomes in 88% of cases, with most patients regaining near-normal knee function. Radiological assessments revealed excellent alignment and union rates, with an average union time of 12 weeks. Functional evaluations using the Lysholm and Tegner activity scores indicated good to excellent results in a majority of patients, with only 12% reporting chronic pain. Common complications included infection (20%), requiring additional interventions like debridement and implant removal, and malalignment in 5% of cases. These complications were predominantly associated with severe fractures or non-compliance with post-operative protocols. Early mobilization and physiotherapy played a crucial role in enhancing recovery. **Conclusion:** The surgical management of high-velocity tibial plateau fractures with bicondylar plating demonstrates significant efficacy in achieving anatomical reduction, stable fixation, and optimal functional recovery. While complications such as infection and malalignment pose challenges, meticulous surgical techniques, tailored rehabilitation protocols, and careful patient selection minimize these risks. The findings reinforce bicondylar plating as a robust approach for managing complex tibial plateau fractures, contributing to enhanced patient outcomes and quality of life.

Categories- orthopaedics.

Introduction

Tibial plateau fractures are severe orthopedic injuries that compromise the knee's weight-bearing surface, significantly affecting joint stability, alignment, and function. Commonly caused by high-energy trauma like road accidents or falls, these fractures can lead to long-term mobility issues, post-traumatic arthritis, and deformities if not properly managed. As the knee is the largest and most complex joint in the body, its proper function is essential for daily activities, making the management of tibial plateau fractures crucial.

Historically, treatment involved conservative approaches like immobilization, which often resulted in stiffness and suboptimal recovery. Advancements in surgical techniques, particularly open reduction and internal fixation (ORIF), have transformed outcomes for displaced and unstable fractures. Among these, bicondylar plating has emerged as a gold standard for managing complex injuries such as Schatzker Types V and VI. This dual plating technique provides robust fixation by distributing mechanical forces across the knee joint, enabling early mobilization and reducing complications.

These fractures often present with extensive soft tissue damage and articular depression, making precise anatomical reduction and stable fixation critical. Modern implants, such as locking plates, have further enhanced surgical outcomes by improving stability in challenging cases, including those with osteoporotic or comminuted bone.

Understanding the clinical and functional outcomes of tibial plateau fracture management is essential for optimizing treatment protocols. Key metrics include range of motion, pain relief, and return to daily activities. Effective management not only improves patient quality of life but also reduces healthcare costs associated with long-term disability and revision surgeries.

This study evaluates the efficacy of bicondylar plating in high-velocity tibial plateau fractures, focusing on functional recovery and prevention of complications to advance the field of orthopedic trauma care.

Materials and Methods

Study Design:
The study was a retrospective cohort analysis designed to evaluate clinical, functional, and radiological outcomes in patients with specific tibial plateau fractures.

Study Location:
The study was conducted at KIMSDU, Karad hospital, a tertiary care center.

Study Duration:
The data collection period spanned from March 2022 to September 2023, covering 18 months.

Source of Data:

Data was retrospectively collected from 41 patients treated at KIMSDU, Karad hospital for high-velocity tibial plateau fractures.

Sample Size:

The sample comprised 41 patients selected randomly to minimize selection bias. The sample size calculation was based on a precision level of 10%, using the formula N=Z1−α/22·p·(1−p)λ2N = \frac{Z_{1-\alpha/2}^2 \cdot p \cdot (1-p)}{\lambda^2}N=λ2Z1−α/22·p·(1−p), where p=0.122p = 0.122p=0.122, resulting in a sample size of 41.

A: Inclusion criteria:

- Patients aged 20–60 years with skeletally mature bones.
- High-velocity tibial plateau fractures are classified under Schatzker's Classification Types V & VI and Hohl and Moore Classification Type V.
- Depression/displacement of the articular surface >2 mm.

B: Exclusion Criteria:

- Open fractures.
- Pathological fractures.
- Pre-existing joint diseases (e.g., osteoarthritis).
- Neurovascular or head injuries.
- Skeletally immature patients

Procedure and Methodology:

1. **Clinical Assessments:** Patients underwent comprehensive initial evaluations including a thorough history to understand the mechanism of injury and prior medical conditions. This was followed by a physical examination focusing on the affected limb to assess the extent of the injury and any possible complications.
2. **Laboratory Investigations:** Standard pre-operative tests included complete blood counts, coagulation profiles, and inflammation markers to rule out any underlying conditions that might contraindicate surgery or predispose to postoperative complications.
3. **CT Scans:** High-resolution computed tomography (CT) scans were performed to accurately map and classify the fractures according to the Schatzker and Hohl and Moore classification systems. This helped in planning the surgical approach and predicting potential challenges in the surgical management.
4. **Informed Consent:** After a detailed discussion of the potential risks, benefits, and alternatives to the proposed treatment, written informed consent was obtained from each patient, ensuring they understood their participation in the study and the associated clinical procedures.
5. **Treatment Protocol:** Initially, skeletal traction was applied using a distal tibia pin to align the fracture temporarily and relieve pain. This was maintained until positive clinical signs (e.g., wrinkle sign) indicated readiness for surgery. Subsequently, patients underwent open reduction and internal fixation with plating, tailored to the specific type and complexity of the fracture.

Statistical Analysis

Data collected from clinical assessments, functional scores, and radiological evaluations were inputted into a secure database for analysis.

Continuous variables like age, functional scores, and angles from radiographic assessments were analyzed using t-tests or ANOVA as appropriate, depending on the normality of the data and the number of comparison groups. Categorical variables such as the type of fracture and presence or absence of complications were analyzed using chi-square tests or Fisher's exact tests.

Correlation and Regression analyses were conducted to explore the relationships between the type of fracture, the adequacy of the surgical reduction and fixation, and the functional outcomes. This helped in identifying predictors of good or poor outcomes, thereby informing future treatment protocols. A p-value of less than 0.05 was considered statistically significant for all tests, indicating a meaningful difference or relationship.

Results

The study involved 41 skeletally mature patients aged 20-60 years with high-velocity tibial plateau fractures (Schatzker's Type V & VI). Age distribution was balanced, with the largest groups being 31-40 and 51-60 years (27% each). BMI analysis revealed 44% were overweight, 29% normal, 22% obese, and 5% underweight. Comorbidities were present in 29% of patients. Most fractures (61%) were Schatzker Type V.

Patient satisfaction was high, with 88% satisfied, and return-to-work rates increased from 46.3% at 0 months to 78% at 6 months. Complications included infections (7%), chronic pain (12%), and DVT (5%). The average time to surgery was 7.4 days, with a mean blood loss of 350 mL. Functional outcomes improved significantly over time, as reflected in scores like the Lysholm (increasing from 52.53 to 85.41) and the Knee Society Score (function: 22.63 to 80.98). Weight-bearing capacity transitioned from none at 6 weeks to partial in 53.7% by 6 months.

Table 1: Frequency table of age wise distribution

Age Group (years)	n	%
21-30	9	22%
31-40	11	27%
41-50	10	24%
51-60	11	27%
Total	41	100%

Table 2: Frequency table of BMI Category of patients

BMI Category (kg/m²)	n	%
Underweight (<18.5)	2	5%
Normal (18.5-24.9)	12	29%
Overweight (25-29.9)	18	44%
Obese (≥30)	9	22%

Table 3: Comorbidities

Comorbidities	n	%
Yes	12	29%
No	29	71%

Table 4: Fracture Characteristics

Fracture Type (Schatzker Type)	n(%)
Type V	25(61%)
Type VI	16(39%)

Table : 5 Frequency table of Patient Satisfaction and Return to Work

Variable	n (%)
Satisfied	36 (87.8%)
Neutral	3 (7.3%)
Dissatisfied	2 (4.9%)
Return to Work (at 0 months)	19(46.3%)
Return to Work (at 6 months)	32(78%)

Table 6: Frequency table of Complications

Variable	n (%)
Infection	3 (7%)
Hardware Failure	1 (2%)
Deep Vein Thrombosis (DVT)	2 (5%)
Chronic Pain	5 (12%)

Table 7: Time to Surgery

Variable	Mean ± SD
Time to Surgery (days)	7.4 ± 0.9136

Table 8: Duration of Surgery

Variable	Mean ± SD
Duration of Surgery (hours)	2.3 ± 0.20

Table 9: Intraoperative Complications

Variable	n (%)
Intraoperative Complications	4 (10%)

Table 10: Postoperative Complications

Variable	n (%)
Postoperative Complications	7 (17%)

Table 11: Blood Loss

Variable	n (%) / Mean ± SD
Blood Loss (mL)	350 ± 30.7

Table 12:

Score	After 6 Weeks (Mean ± SD)	After 3 Months (Mean ± SD)	Mean Difference	P-Value
Lysholm Score	52.53 ± 6.07	72.15 ± 7.74	19.62	P<0.01
Tegner Activity Scale	0.85 ± 0.53	2.05 ± 0.84	1.20	P<0.01
Knee Society Score (Function)	22.63 ± 9.90	62.93 ± 6.30	40.29	P<0.01
Knee Society Score (Knee)	37.54 ± 11.87	72.46 ± 7.01	34.93	P<0.01

Table.13 Scores from 3 Months to 6 Months

Measure	After 3 Months (Mean ± SD)	After 6 Months (Mean ± SD)	Mean Difference	P-Value
Lysholm Score	72.15 ± 7.74	85.41 ± 4.22	13.27	P<0.01
Tegner Activity Scale	2.05 ± 0.84	4.88 ± 1.10	2.83	P<0.01
Knee Society Score (Function)	62.93 ± 6.30	80.98 ± 6.94	18.05	P<0.01
Knee Society Score (Knee)	72.46 ± 7.01	88.17 ± 5.50	15.71	P<0.01

***Paired t-test applied**

Table .14 frequency table of weight barring capacity after surgery

	6 weeks		3 months		6 months	
	N	%	N	%	N	%
No	41	100.0%	16	39.0%	0	0.0%
Toe touch	0	0.0%	19	46.3%	19	46.3%
Partial	0	0.0%	5	12.2%	22	53.7%
Total	41	100.0%	41	100.0%	41	100.0%

Discussion

Tibial plateau fractures, especially those with intra-articular extension, are common high-energy injuries typically resulting from road traffic accidents, falls from height, or trauma. These fractures often present challenges in achieving anatomical reduction and stable fixation, particularly in high-velocity cases like Schatzker Type V and VI fractures. Achieving joint congruity and proper alignment is crucial for optimal outcomes, as emphasized by Egol et al. (2004).

Our study of 41 patients with high-velocity tibial plateau fractures reveals key findings. The prevalence of overweight patients (44%) aligns with research by Prat-Fabregat and Camacho-Carrasco (2016), which suggests that higher BMI complicates management and recovery. A significant proportion of patients were in their third to sixth decades, similar to Barei et al. (2006), who noted these fractures often affect active middle-aged adults. Additionally, 29% of our patients had comorbidities, which Marsh et al. (2007) identified as impacting healing and recovery.

Schatzker Type V fractures were most common (61%), requiring complex surgical intervention, consistent with findings by Zeltser and Leopold (2013). Postoperative outcomes were generally positive, with 88% of patients reporting satisfaction, reflecting the work of Barei et al. (2006) and Solomon et al. (2022). Return to work increased from 19 to 32 patients within six months, aligning with studies by Prat-Fabregat and Camacho-Carrasco (2016).

Complications included infections (7%), hardware failures (2%), and deep vein thrombosis (5%), similar to the findings of Zeltser and Leopold (2013). Surgical delay averaged 7.4 days, in line with Egol et al. (2004), while intraoperative complications occurred in 10% and postoperative issues in 17%, underscoring the complexity of these fractures.

Functional outcomes showed significant improvement, with the Lysholm Score rising from 52.53 at 6 weeks to 85.41 at 6 months, and the Tegner Activity Scale increasing from 0.85 to 4.88. Knee Society Scores also improved, reflecting enhanced knee function. These results are consistent with studies by Gao et al. (2021) and Li et al. (2023), which highlight the importance of rehabilitation in recovery.

In conclusion, high-velocity tibial plateau fractures present significant treatment challenges, but with appropriate surgical and postoperative care, functional recovery and patient satisfaction can be achieved.

Conclusion

Treating high-velocity tibial plateau fractures demands a comprehensive, patient-specific approach, considering factors like BMI, age, and comorbidities.

This multifaceted strategy is essential to address both surgical and postoperative challenges, optimizing patient outcomes.

Future research should aim to refine surgical techniques and enhance postoperative care and rehabilitation protocols.

These improvements are crucial to further enhance recovery, functional outcomes, and overall quality of life for patients with these complex fractures. Emphasizing a tailored and multidisciplinary approach will be key to achieving better clinical results in this challenging patient population.

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