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A study on management and functional outcome of tibial plateau fractures in a tertiary care teaching hospital

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Abstract: ***Background:*** The knee is an important weight-bearing joint in the body. Tibial plateau fractures are proximal tibia fractures that involve the articular surface of the knee joint. (1) The patients suffer from morbidity and mortality as a result of these fractures, which range from simple to complicated. They are caused by the combination of axial compression forces and varus or valgus forces. *Objectives:* To study the management, evaluate the functional outcome of tibial plateau fractures treated with various modalities. ***Material & Methods:*** Hospital based prospective cross-sectional study. Department of Orthopaedics, East Point College of Medical Sciences and Research Centre, Bangalore. November 2022 to October 2023. Study consisted a total of 30 subjects. Simple Random technique. For all the patients in the inclusion criteria, demographic data, a thorough history, and clinical examination were made on admission. Then, we evaluated soft tissue injuries even in the closed fractures, followed by a radiological assessment of fracture with Schatzker classification. All our cases underwent initial stabilisation as per the ATLS guidelines. In addition, patients with closed tibial plateau fractures associated with a tense hemarthrosis underwent aspiration of the joint under aseptic precautions. ***Results:*** Our series assessed the clinical outcome with RASSMUSSEN'S KNEE SCORE, which was excellent in 17 patients 56.67%, good in 11 36.66%, fair in 1 3.33 %, poor in 1, i.e., 3.33% patients. Despite all the complications, we can achieve 56.67% excellent results and 36.66% good results, overall 93% acceptable results based on RASSMUSSEN'S KNEE SCORE with our standard surgical care. Besides, we had 3.3% fair & 3.33 % poor results in functional outcomes. ***Conclusion:*** Functional outcome is better with Open Reduction and internal fixation of tibial plateau fractures as it gives excellent anatomical reduction & rigid fixation to prevent post-traumatic arthritis and early motion from preventing the knee stiffness.

Keywords: Tibial plateau, Schatzker's classification, open reduction & internal fixation, Proximal tibial LCP.

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INTRODUCTION

The knee is an important weight-bearing joint in the body. Tibial plateau fractures are proximal tibia fractures that involve the articular surface of the knee joint. (1) The patients suffer from morbidity and mortality as a result of these fractures, which range from simple to complicated. They are caused by the combination of axial compression forces and varus or valgus forces.

Tibial plateau fractures account for 1% of all fractures in adults and 8% of fractures in the elderly due to osteoporosis. (2) These include 55-70% lateral condyle, 10-25% medial condyle, and both in 10-30%. As a result, imaging must be of high quality in order to identify the fracture position, pattern, and displacement.

It is vital to assess soft tissue injuries. Specific fracture patterns are more commonly associated with limb-threatening consequences such as compartment syndrome. Ligament and meniscal injuries must be evaluated since they are more usually linked. (3) Schatzker's classification has been widely used for initial injury assessment, management planning, and prognosis prediction. (4) Treatment has progressed from conservative above-knee slab for uncomplicated

fractures to indirect reduction with C-C screw and traditional rigid plating, which has treated TPFs for years. However, as the number of RTAs grows, so does the severity of the fracture.

It becomes difficult to treat because traditional plates provide insufficient buttressing, resulting in subsequent fracture displacement and interruption of blood flow due to severe soft tissue stripping. This resulted in the creation of a new idea of biological plates, PC-fix 1, PC-fix 2, and LISS. When these two plates are combined, they form an anatomically shaped plate known as the proximal tibial LCP. These fractures benefit from the use of an Ilizarov/hybrid external fixator as well. They offer several options, including a better outcome for a number of patterns in osteoporotic patients for normal knee function, such as maintaining good alignment and preventing subsequent osteoarthritis and deformity.

OBJECTIVES:

1. To study the management, evaluate the functional outcome of tibial plateau fractures treated with various modalities.
2. To study the fracture patterns.
3. To study the complication rates.

MATERIAL AND METHODS:

Study Design: Hospital based prospective cross-sectional study.

Study area: Department of Orthopaedics, East Point College of Medical Sciences and Research Centre, Bangalore.
Study Period: November 2022 to October 2023
Sample size: Study consisted a total of 30 subjects.
Sampling Technique: Simple Random technique.

Inclusion Criteria:

1. Adults aged above 18 years
2. All closed fractures.
3. Type 1 compound fractures.
4. Patients who are willing and fit for surgery.

Exclusion Criteria:

1. Patient aged <18 yrs.
2. Type 2 & 3 compound fractures.
3. Patients who are unfit for surgery
4. Pathological fractures.

Ethical consideration: Institutional Ethical committee permission taken prior to the commencement of the study.

Study tools and Data collection procedure:

For all the patients in the inclusion criteria, demographic data, a thorough history, and clinical examination were made on admission. Then, we evaluated soft tissue injuries even in the closed fractures, followed by a radiological assessment of fracture with Schatzker classification.

All our cases underwent initial stabilisation as per the ATLS guidelines. In addition, patients with closed tibial plateau fractures associated with a tense hemarthrosis underwent aspiration of the joint under aseptic precautions.
They immobilised the limb either in an above-knee slab or through skeletal traction using a distal tibial or calcaneal pin traction on a Bohler Braun splint until definitive fixation was carried out. In cases with excessive swelling and blistering, definitive fixation was delayed until the swelling/ blisters subsided.
The patients were thoroughly evaluated for any co-existing medical conditions, and appropriate treatment was given and prepared for surgery.

Definitive Management: In our study, all 30 patients with proximal tibial fractures underwent definitive fixation, out of which 27 were treated with ORIF or MIPPO technique, two patients with Ilizarov fixation, only 1 with percutaneous C-C screw fixation.
MOBILIZATION: In stable types, the patients were mobilized 48 hrs after the drain removal. Early ROM was started from the fifth day onwards & gradually increased to 90 degrees& full ROM was allowed after suture removal. Partial weight-bearing is delayed until six weeks, and full weight-bearing is allowed after 12-16 weeks, depending on the fracture union.

POP was given in the form of the external splint in cases of doubt and unstable variety for 6-8 weeks. And advised static quadriceps exercises.

Follow up: The first follow-up was usually between 4-6 weeks, and later patients were followed up at regular intervals of 4-6 weeks till complete fracture union.
During the follow-up, we assessed for wound & fracture healing, any reduction loss and any complications. We did regular follow-up from time to time, 16 weeks to 64 weeks.

Analysis of results: The surgical management of complex TPFs has drastically changed over the past decade, wherein minimally invasive procedures have come into vogue. Assessing the results has been difficult because of numerous rating systems, which are currently available. Some of the various systems to assess the functional outcome, which has been used by different authors, include:

- Hohl and Luck knee scoring system, 1956
- Rasmussen scoring system, 1973
- Hospital for special surgery knee score [HSS],1977(57)
- Honkonen, Jarvinen scoring system, 1992
- Knee society clinical rating system, 199
- Lysholm's and Gillguist knee score (58)
- IOWA knee scoring system

Rasmussen 1973 formulated a scoring system for functional assessment of tibial plateau fractures. In his criteria, points were given for subjective complaints, clinical signs, available range of motion, and stability. This scoring system is reasonably good in assessing the functional outcome, and simple to use.
We have followed the RASMUSSEN'S SCORING SYSTEM for our study.
The criteria assessed in this scoring system include subjective complaints and clinical signs

a. The Subjective complaints considered were Pain and Walking capacity.
b. The Clinical signs considered were Extensor Lag, Range of Movement, Stability.

ASSOCIATED INJURIES

1. Anterior cruciate ligament injury in one patient, advised ACL reconstruction after six months of the definitive fracture surgery.
2. Two patients are associated with distal radius fractures, treated conservatively with below elbow cast.
3. One patient with Compound ankle dislocation was treated with an external fixator.
4. Another patient with Compound 2,3 metatarsal shaft fractures was treated with wound debridement & K- Wire fixation.
5. One female patient associated with pubic rami fracture was treated conservatively.

STATISTICAL ANALYSIS:
Pearson's chi-square test also known as the Chi-square test for independence and the Chi-square test of association was used to detect if there was any relationship between two categorical variables. ANOVA was used to compare the two means. A p-value of 0.05 is taken as significant.

RESULTS:

Table 1. Age distribution

Age in years	No. of patients	%
< 20	1	3.3
20 – 50	19	63.3
>50	10	33.3
Total	30	100

In our series, the youngest patient was 19 years old, and the oldest was 70 years. Most patients belong to the 21-50 years who are more prone to RTA.

Table 2: Gender distribution

Gender	No. of patients	%
Males	26	86.67
Females	4	13.33
Total	30	100

In our series, most of our patients are males. Again, it reflects that the outdoor population was more prone to proximal tibial fractures.

Table 3: Mode of injury

Mode of injury	No. of pts	%
RTA	24	80
Self fall	4	13.33
Fall from height	2	6.66

Our study shows that tibial fractures are more prone in RTA.
Present study showed more on left side compared to the right.

Table 4: TYPE OF FRACTURE

Schatzker type	No. of pts	%
Type I	1	3.33
Type II	11	36.67
Type III	3	10
Type IV	1	3.33
Type V	2	6.66
Type VI	12	40
Total	30	100

Most of the fractures 46.67%were type V & VI in our series, usually associated with high-velocity trauma.

Table 5: Method of fixation

Method of fixation	No. of pts	%
Proximal tibial LCP	25	83.33
T-buttress plating	2	6.66
Percutaneous c-c screw fixation	1	3.33
Ilizarov	2	6.66
Total	30	100

In our series, we studied 30 patients, out of which 25 were operated on with Proximal tibial LCP. Two were treated with T-buttress plating, 2 with Ilizarov fixation & only one with Percutaneous C-C screw fixation.
Out of 90 % treated with plating, 40 % of patients required a dual approach as they involve posteromedial quadrants, which need additional plating because of high energy trauma.

Table 6: UNION-DURATION

Duration	No. of pts	%
12-16 weeks	18	60
16-20 weeks	10	33.33
>20 weeks	2	6.66
Total	30	100

In our series, 60% of fractures united between 12-16 weeks.
In our series, most patients have average walking capacity & can walk outdoors for at least 1 hour comfortably.
There was normal extension in the 76.67% of the patients, extensor lag <10 degrees in 6 patients & extensor lag > 10 degrees in 1 patient. In our series, most patients had a range of motion >120. There was normal stability in 29 patients. Only one patient has instability in 20 degrees flexion.

Table 7: RASSMUSSENS KNEE SCORE

Rasmussen's knee score	No. of pts	%
27-30	17	56.67
20-26	11	36.67
10-19	1	3.33
<10	1	3.33
Total	30	100

Our series assessed the clinical outcome with RASSMUSSEN'S KNEE SCORE, which was excellent in 17 patients 56.67%, good in 11 36.66%, fair in 1 3.33 %, poor in 1, i.e., 3.33% patients.

Table 8: CLINICAL RESULTS

Clinical results	No. of pts	%
Excellent	17	56.67
Good	11	36.67
Fair	1	3.33
Poor	1	3.33
Total	30	100

Table 9: COMPLICATIONS

Complications	No. of pts	%
Knee stiffness	**2**	**6.66**
Knee instability	**1**	**3.33**
Varus deformity	**1**	**3.33**
Infection	**1**	**3.33**
Wound dehiscence	**1**	**3.33**
Total	**6**	**20**

DISCUSSION:

Proximal tibial fractures involving the knee joint's articular surface have always been a great challenge to orthopaedic surgeons for being very complex. They are associated with a significant amount of comminution, severe soft tissue & ligament injuries. Any knee joint fracture would result in substantial morbidity and quality of life if not treated properly or adequately.

The treatment includes good mechanical alignment restoration, anatomic reduction, and stable fixation that allows an early ROM that gives a painless, stable & mobile knee. These fractures are being treated conservatively over many years with skeletal traction & above-knee cast but could not achieve satisfactory results in complex types. There arises the need for surgical management.

Percutaneous screw fixation offers its best in isolated undisplaced split type lateral condyle fractures but could not give stability in complex varieties. Open reduction and internal fixation with T-buttress plates or proximal tibial LCP and screws enable direct fracture visualisation that provides stable anatomical fixation. However, this rigid fixation is possible only after extensive soft tissue dissection.

Due to the association of soft tissue injuries with these fractures, additional soft tissue stripping involved in ORIF often render bony fragments avascular and significantly increases the chance of infection. Moore et al. [5], in his series, reported a 23% incidence of infection after ORIF in these complex fractures. ORIF, through compromised soft tissue envelope, has been notably associated with major wound complications and repeated surgical interventions.

Stable internal plate fixation without damaging the soft-tissue envelope is difficult to achieve, and fair results are seen only in 20% to 50% of these fractures. The concept of preservation of the blood supply and atraumatic surgical technique led to the development of biological fixation techniques. This technique reduces soft tissue damage and increases the union rate. A hybrid external fixator avoids soft tissue problems, but there is a risk of malalignment, pin tract infection & poor patient compliance. Our study includes 30 patients with Tibial plateau fractures treated at East Point College of Medical Sciences and Research Centre, Bangalore.

In our study, there is only one person below 20, which is 3.3%, 19 individuals between 20-50 years, i.e., 63.3%, ten individuals more than 50, i.e., 33.3%. So the individuals in the age group of 20-50 are the ones who have a maximum incidence of these high energy fractures. Vasanand et al.[6] studied 54, found 75 % of patients were in the age group 30-50 years. Present study includes 86.67% of males, who work outdoor, travel more often & females are 13.33 %, correlates with the study done by S. Siddharthan.[7]

In the present study, the mode of injury in the majority was the RTA in 24 patients 80 %, Self fall in 4 (13.33%), fall from height in 2 patients (6.66%). As there is an increase in the incidence of usage of motor vehicles, the people who work outdoors are more prone to RTA. Others are falls from height & self-fall in osteoporotic patients & pathological fractures due to other comorbidities. In present study, the laterality of the fracture is more on the left side in 16 individuals out of 30 patients involving 53.33%, whereas on the right side in 14, 46.66%. In our series, 50%, patients fall into type IV, V & VI, i.e., while others are Type I in 3.33%, Type II in 36.67%, Type III in 10% as there is an increase in RTA, high-velocity trauma results in more complex varieties.

In our series, 23 out of 30 patients were operated on within seven days of admission whereas five received treatments between 7-10 days; only two patients were operated on 10th & 11th day respectively because of severe soft tissue injury, ecchymosis & abrasions around the knee. In our series, we treated 83.33% of patients with Proximal tibial LCP; two patients were T -buttress plating, Percutaneous C-C screw fixation in 1 patient with split type unicondylar lateral condyle fracture, two patients with Ilizarov because of excessive swelling.

In our series, we treated 90% of the patients with plating, out of which we used a Single plate with an Antero-lateral approach alone in 51.85%, dual plating with both Antero-lateral & Postero-medial approaches in 40%, Postero-medial alone in 1 patient. This plate allows fixation through the single incision, which avoids wound dehiscence, infection, and prolonged immobilisation associated with extensile approaches. In our study, out of 27 patients, we used dual plating in 12 patients where a single LCP is insufficient to hold the fracture fragments and additional support is needed on the medial aspect. Yoo et al.[8] advocated dual plating in highly complex fractures.

De Boeck and Opdecam[9] used the posterior S-shaped approach of the knee joint to treat 7 cases of posterior split fracture of the tibial plateau. All patients achieved satisfactory clinical outcomes without surgery-related complications. Galla and Lobenhoffer[10] described the posteromedial approach with the patient in the prone position: through a longitudinal incision, located over the medial gastrocnemius, not crossing the popliteal crease, the muscle is retracted laterally to reach the posteromedial aspect of the tibia.

Luo[11] described a posteriorly inverted L-shaped incision to visualise the entire posterior tibia without cutting the gastrocnemius's medial head by lateralizing the gastrocnemius's medial head. Here is the lateral decubitus floating position. It permits changing that to the lateral aspect of the knee whenever necessary. Bhattacharyya et al.[12] also adopted the posterior S-shaped incision for treatment of 13 patients with posterior split fractures of the tibial plateau. The results have shown dehiscence in one case, knee flexion contracture in one case, healing of all fractures, no neurovascular injury, no loss of reduction, and satisfactory results of 88.9%.

In our series, fracture united in 12-16 weeks in 18 patients, 60% out of 100,10 individuals, 33.33% took 16-20 weeks, it took > 20 weeks to unite in 2 patients only because of deep-seated infection. In most patients, union occurred between 12- 16 weeks. The average duration of the union was 15.23 weeks. In our study, early range of motion & static, dynamic quadriceps physiotherapy was advised for all of our patients. Out of which 23 (76.67%) patients gained good ROM > 120 degrees, four persons gained below 120, but more than 90 degrees & only three patients gained less than 900 flexion. We have advised physiotherapy. Lee et al.[13], in their study, concluded that the broad range of knee motion averaged 105 degrees at the last follow-up. In his study, Stannard et al.[14] noted a mean range of 1degree (range 0-10degree) -127 degrees (range 90 -145 degrees) of knee motion. In another study by Egol et al.[15] at the last follow-up, the mean knee extension was 1° (0–15°), and the mean knee flexion was 109.3° (60–135°), In our series, knee stiffness was developed in two patients who were managed with physiotherapy. As a result, they regained > 90 degrees of flexion. Another patient presented with knee joint instability after fracture union. He was given a long knee brace & regained 90 degrees of flexion with physiotherapy. At present, he can manage his day-to-day activities & the patient was not willing for the second surgery.

In our series, one patient developed a deep infection by the 10th postoperative day. He was treated with IV antibiotics, wound debridement & antibiotic cement bead placement, infection was controlled subsequently, and fracture united at

the end of 22 weeks. Shaoj et al.[16] published a study in 2017 with $p < 0.05$: which identified the following risk factors for SSI open fracture, compartment syndrome, operative time, tobacco use, and external fixation.

Another person developed blisters & wound dehiscence & treated with limb elevation & IV antibiotics. Regular dressings were being done & finally wound was closed with secondary suturing. One patient developed varus deformity due to the collapse of medial condyle at ten weeks of the postoperative period due to early weight-bearing; he was advised to wear a knee brace while walking. In these cases, a significant amount of time was provided for soft tissue healing to minimize surgical wound-related problems and better compliance with the postoperative rehabilitation program.

The benefits of early knee motion include - reduced knee stiffness and improved cartilage regeneration. However, these benefits are to be cautiously balanced by risks, including loss of fracture reduction, internal fixation failure, and compromised ligament and soft tissue healing. Schatzker et al.[17] stated that the prognosis is given by the degree of displacement, type of fracture, treatment method, and quality of postoperative care. Despite all the complications, we can achieve 56.67% excellent results and 36.66% good results, overall 93% acceptable results based on RASSMUSSEN'S KNEE SCORE with our standard surgical care. Besides, we had 3.3% fair & 3.33 % poor results in functional outcomes. In our study, the mean pain score was 4.93 with no pain/ occasional pain in 77%, 20% had constant pain after activity, only one individual had significant rest pain. In our evaluation,46.67% have standard walking capacity after surgery, whereas 43.33% can work outdoors >1 hr. Only 6.67% have difficulty walking outdoors and have only short walks outdoors for >15 minutes. Only one person was restricted to Indoors. The average Rassmussen score in our survey was 25.7. Biggi F. et al.[18], the average Rasmussen score was 25 at the end of 6 months, and the results were good to excellent in 41 out of 58 patients (87%).

CONCLUSION:

The conclusions can be drawn from treating tibial plateau fracture with various modalities majority being locking compression plate in this study. As there is increasing incidence in RTA, there is an increase in mortality & morbidity of the tibial plateau fractures. So they need optimum treatment to decrease the burden. Preoperative soft tissue status and repair at the right time significantly change the outcome. Percutaneous C-C screw offers its best in isolated displaced unicondylar fractures. We can treat the tibial plateau with LCP with both the principles of compression and prevent it from collapse by using the concept of bridging.

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