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Original Research Article

A RETROSPECTIVE STUDY OF FRACTURE HEALING TIME AND FUNCTIONAL OUTCOME OF SURGICALLY TREATED TIBIAL PILON FRACTURES IN ADULTS

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ABSTRACT

Background: Tibial pilon fractures are relatively uncommon, representing 5–7% of all tibial fractures. These injuries occur due to axial loading, where the talus is forced into the plafond, leading to articular impaction of the distal tibia. The timing and nature of the surgical intervention affect soft tissue and bone healing. Research continues to seek improvements in clinical outcomes for this challenging fracture. The aim is to evaluate the fracture healing time and functional outcome of distal tibial pilon fractures in adults treated by different surgical modalities. The objective is to evaluate the radiological fracture healing time. To evaluate the post-operative complications. To evaluate the functional outcome by Olerud and Molander scoring system at 9th post operative month.

Materials and Methods: Study Design: A Retrospective hospital based Observational study. Study area: The study was conducted in the Department of Orthopaedics, KMCH. Study Period: 3 years (May 2021 to April 2024). Study population: Distal tibial fractures with articular involvement in patients more than 18yrs of age who had surgical procedure. Sample size: Total of 26 subjects. Sampling Technique: Convenient sampling.

Results: In the present study of 26 cases, on evaluation of the type of fracture as per AO/OTA classification, most patients were of C type (17 patients, 65.4%) with associated distal fibular fracture (24 pts, 92.3%). Average bone healing time was 16 weeks (21 pts, 75%) with range from 14 to 24 weeks. Ankle stiffness is the most common complication (15 pts, 57.7%) and 1/3rd of patients (9 pts, 34.6%) had no complications. Surgical procedure yields excellent/good functional outcome in majority (21 patients, 80.8%) with Fibular plating and locking medial tibial plating as preferred mode of definite fixation.

Conclusion: In conclusion, tibial pilon fractures remain challenging, with no definitive gold standard treatment. In our present study, surgical approach with immediate temporary external fixator, definitive fixation after around 10 days by open reduction and internal fixation (ORIF) with fibular plate and locking medial tibial plate augmented with articular screws / k wires has yielded excellent/good results in 21 cases (80.8%). Treatment decisions should consider detailed radiographic assessment and surgeon expertise with a two-phase protocol preferred for optimal soft tissue management, which is critical in reducing complications and improving outcomes in high energy pilon fractures.

Keywords: Pilon fracture, Surgical fixation, Fracture healing, Functional outcome.

INTRODUCTION

Tibial pilon fractures are relatively uncommon, representing 5–7% of all tibial fractures.[1] These injuries occur due to axial loading, where the talus is forced into the plafond, leading to articular impaction of the distal tibia. The foot's position during impact, along with the force's direction and strength, creates different fracture patterns and levels of comminution.[2] Intra-articular distal tibia fractures can also arise from a rotational force with little axial load. Such fractures typically result from low-energy

impacts, causing less damage to the soft tissues and less comminution, and should not be regarded as true pilon fractures.[3,4]

The surgical management of pilon fractures involves four steps: restoring the correct length and stabilising the fibula, reconstructing the tibial articular surface, placing cancellous autografts, and stabilising the medial side of the tibia.[5] These principles need adjustment in cases of severe comminution and soft tissue damage.[6] The timing and nature of the surgical intervention affect soft tissue healing. Achieving and maintaining anatomic reduction is technically challenging and sometimes unfeasible.[7] Since internal fixation can lead to localised bone devitalisation, additional harm to the surrounding soft tissue may occur.[8]

In 1990 the Arbeitsgemeinschaft für Osteosynthesefragen / Orthopedic Trauma Association (AO / OTA) developed a more extensive classification system for all fractures of the body based on the Comprehensive Classification of Fractures of the Long Bones (CCF) developed by Müller et al. It uses alphanumeric codes and has been reviewed and updated regularly. True tibial pilon fractures are classified by the code AO 43C, further numbers are added to describe the exact location, comminution and extent of the fracture. While the AO Classification System is generally understood worldwide, it has moderate to poor intra- and interobserver reliability.[9] Nevertheless, this problem does not seem to be problematic in terms of outcome and quality of reduction and it has been suggested that the routine use of 3D-imaging in these complex fractures will further enhance reliability of the classification system.[10]

Research continues to seek improvements in clinical outcomes for this challenging fracture. Despite utilising advanced surgical treatments, satisfactory results are not always achievable in pilon fractures and many studies indicate significant rates of complications. Therefore, in our retrospective study, we had included various surgical treatment modalities for pilon fractures in adults allowing us to evaluate the final functional scores and fracture healing time.

Aim: To evaluate the fracture healing time and functional outcome of distal tibial pilon fractures in adults treated by different surgical modalities.

Objectives

- To evaluate the radiological fracture healing time.
- To evaluate the post-operative complications.
- To evaluate the functional outcome by Olerud and Molander scoring system at 9th post operative month

MATERIALS AND METHODS

Study Design: A Retrospective hospital based Observational study.

Study Area: The study was conducted in the Department of Orthopaedics, KMCH.

Study Period: 3 years (May 2021 to April 2024)

Study Population: Distal tibial fractures with articular involvement in patients more than 18yrs of age who had surgical procedure.

Sample size: The study consisted of a total of 26 subjects.

Sampling Technique: Convenient sampling

Inclusion Criteria

1. Patient aged 18 years and above.
2. All distal tibial pilon fractures with or without fibula fracture.
3. Patients with Gustilo-Anderson classification type 1 and 2.

Exclusion Criteria

1. Patients below the age of 18 years.
2. Pathological fractures.
3. Associated neurovascular injury.
4. Patients with Gustilo-Anderson classification type 3.
5. Polytrauma.
6. Contralateral tibia fractures.
7. Patients medically unfit for surgery.

Ethical Consideration: Institutional Ethical committee permission was taken before the commencement of the study.

Study tools and data collection procedure: Evaluation of all case notes were done and documentation collected for age, sex, mode of injury, smoking, diabetic status, side of injured limb, open/closed fracture, AO/OTA fracture classification, days to surgery from injury, type of surgery, bone healing time and functional outcome by Olerud and Molander scoring system at 9th post operative month.

Table 1: AO/OTA classification : 43

AO / OTA	Severity and Complexity of fracture
A1	Simple extraarticular distal tibial fracture
A2	Distal tibial extraarticular wedge fracture
A3	Multifragmentary extraarticular distal tibia fracture
B1	Pure split fracture
B2	Split depression fracture
B3	Partial articular depression fracture
C1	Simple articular and metaphyseal fracture
C2	Simple articular and multi fragmentary metaphyseal fracture
C3	Multifragmentary articular and metaphyseal fracture

Table 2: Olerud and Molander scoring system for functional outcome

S.No.	Parameter	Degree	Score
1	Pain	None While walking on an uneven surface While walking on an even surface outdoors While walking indoors, constant and severe	25 20 10 5
2	Stiffness	None Stiffness	10 0
3	Swelling	None Only in evenings Constant	10 5 0
4	Stair-climbing	No problems Impaired Impossible	10 5 0
5	Running	Possible Impossible	5 0
6	Jumping	Possible Impossible	5 0
7	Squatting	No problems Impossible	5 0
8	Supports	None Taping, wrapping Stick or crutch	10 5 0
9	Work, activities of daily life	Same as before Loss of Tempo Change to simpler job Severly impaired work capacity	20 15 15 0

Total points -100
- Excellent - 91-100 points
- Good - 61-90 points
- Fair - 31-60 points
- Poor - 0-30 points

Statistical analysis: Collected data was entered in the Microsoft Excel sheet. Data analysis was done by SPSS software Version 20. Continuous variables were categorised as either normal or abnormal, and the patients in either category were reported as proportion. 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

The present study consists of 26 cases of tibial pilon fractures (AO classification B1 to C3 were considered as pilon fractures).

Table 3: Distribution of cases according to Age (yrs)

Age (years)	Number	Percentage (%)			
18-30	8	30.8			
31-40	10	38.5			
41-50	5	19.2			
51-60	2	7.7			
61-70	1	3.8			
TOTAL	26	100			
Descriptive statistics		**Minimum**	**Maximum**	**Mean**	**SD**
Age (in years)		24	67	39.1	10.2

On evaluation of the age distribution in the present study, we found that of the 26 cases, most patients belonged to the age category 31-40 years (10 patients, 38.5%). The mean age was 39.1 years.

Table 4: Distribution of cases according to Sex.

Sex	Number	Percentage (%)
Male	19	73
Female	7	27
Total	26	100

On the evaluation of sex distribution, we found that of the 26 cases in the study, most patients were males (19 patients, 75%) because of travelling and working in fields and factories.

On evaluation of the side of injury in the present study, we found that of the 26 cases, most patients had a right-sided injury (16 patients, 61.5%) and most patients were injured by road traffic accidents (15 patients, 57.6%), 8 were fall from height and 3 were

slip and fall. Of the 26 patients in the current study, 11 patients (42.3%) were smokers and 6 patients (23%) were Type II diabetic.

Table 5: Distribution of cases according to Type of Injury (closed/open)

Closed /open (Gustilo Anderson)	Number	Percentage (%)
Closed	13	50
Open (type 1)	7	27
Open (type 2)	6	23
Total	26	100

On evaluation of the type of injury, we found that of the 26 cases in the study, open and closed injuries were equal (15 patients, 50%).

Table 6: Distribution of cases according to Fracture Classification (AO/OTA)

AO / OTA	Number	Percentage (%)
A1	0	0
A2	0	0
A3	0	0
B1	1	3.8
B2	5	19.2
B3	3	11.5
C1	10	38.5
C2	6	23.1
C3	1	3.8
TOTAL	26	100

On evaluation of the type of fracture as per AO/OTA classification, we found that of the 26 cases in the study, most patients were of C1 type (10 patients, 38.5%) and 24 patients (92%) were associated with a lower third fibula fracture.

Table 7: Distribution of cases according to modality of surgery

Surgical procedure	Number	Percentage (%)
Temporary External fixator	21	80.7
Permanent External fixator	0	0
K wire + Articular screws	22	84.6
Fibular plating	20	76.9
MIPO plating	10	38.5
Anterolateral tibial plating	4	15.4
Medial tibial plating	26	100
Autologous bone grafting	8	30.8

In the present study, most of the patients (20 patients, 76.9%) had K wire/articular screws and 100% (26 patients) had medial tibial plating as a preferred fixation modality. Temporary external fixator were used in 80.7% (21 patients) of cases. Anterolateral and MIPO techniques were used in 15.4% and 38.5% respectively. Autologous bone grafting were performed in one third of cases (8 cases, 30.8%).

Table 8: Distribution of cases according to time of definitive surgery

Days to definitive surgery	Number	Percentage (%)
0	1	3.8
1-5	3	11.5
5-10	8	30.8
10-15	11	42.3
15-20	2	7.8
20-30	1	3.8

In the present study, most of cases had definitive surgical intervention before 15 days (23 pts, 88.5%), of which, they were almost equally split before and after 10 days. Immediate definite fixation was performed in one case (3.8%) only. One case had definitive fixation at 23rd day due to late presentation.

Table 9: Distribution of cases according to Complications

Complications	Number	Percentage (%)
Nil	9	34.6
Superficial wound infection	4	15.4
Deep wound infection	2	7.8
Non-union	1	3.8
Ankle stiffness	15	57.7

Oon evaluation of complications following surgery in the present study, four patients had superficial wound infections (15.4%) treated by dressings and antibiotics; two patients with diabetes had deep wound infections (7.8%) treated by debridement and antibiotics according to culture and sensitivity reports, one patient had non-union (3.8%) and was treated by re-plating with cancellous bone grafting from iliac crest, fifteen patients had Ankle stiffness (57.7%) treated by physiotherapy & range of motion exercises and 9 patients had no complications (34.6%).

Table 10: Distribution of cases according to Fracture Union in Weeks

Fracture union in weeks		**Number**		**Percentage**
6 weeks		0		0
10 - 18 weeks		15		57.7
18 - 24 weeks		11		42.3
Total		26		100
Descriptive statistics	**Min.**	**Max.**	**Mean**	**SD**
Fracture union (in weeks)	14	22	16.0	5.3

In the present study, on evaluation of the duration taken for the fracture union, most patients had fracture union in 10-18 weeks (15 patients, 57.7%), The mean duration for fracture union was 16 weeks.

Table 11: Distribution of cases according to Functional Outcome

Functional outcome	**Number**	**Percentage**
Excellent	6	23.1
Good	15	57.7
Fair	4	15.4
Poor	1	3.8
Total	26	100

In the present study, on the evaluation of the functional outcome of the fracture, most patients had Good results (15 patients, 57.7%). One diabetic patient with non union had poor result (3.8%).

DISCUSSION

Fractures of the distal tibia rank among the most challenging fractures to manage effectively. The condition of the soft tissues and the extent of comminution at the time of injury significantly influence long-term clinical outcomes. The objective of surgical intervention is to achieve proper alignment of the joint surface while providing sufficient stability to facilitate early movement. This should be done using methods that reduce damage to both bone and soft tissue blood supply to minimise complications associated with treatment.

The present study revealed the average age of patients with such injuries to be 39.1 years (Range 24-67 yrs). The average age of patients in the present study is comparable with the studies of Chandra Sekaram Naidu et al,[11] and Vallier HA et al.[12] As in the present study, the male preponderance has also been reported by Collinge C,[13] Grose A,[14] and Vallier HA.[12]

Cory Collinge et al,[13] observed 100% high-velocity fractures in their study and Rakesh K. Gupta et al,[15] observed 66% high-velocity fractures, which correlates with our present study, at 57.6%. In the present study, type C1 and C2 fracture patterns were most commonly seen, which are comparable with other studies. The possible reason for this type of fracture pattern was that most of the patients sustained injuries due to RTA, where type C fracture patterns are more common. Type B fracture patterns were seen in patients who sustained injuries due to axial loading (fall from height).

Millington et al published that fibular fractures are present in upto 90% of all tibial pilon fractures. Similarly, in our series 21 patients (92%) had associated distal fibular fracture, comparable with the above study.[15]

Zou J et al,[16] observed postoperative complications of distal tibia plating who had 2.12% infection, 5.31% malunion, 5.31% non-union, and 7.44% delayed union. They found a significantly different distribution between open-reduction and closed-reduction groups. There were 5 (9.6%) patients in the closed group who had mal-reduction, including two who had rotation deformities and three who had posterior angular deformities. No patients in the closed group had mal reduction. Infection and non-union were high in the open group and malunion was high in the closed group.

Dillin L et al,[17] reported disastrous results when inadequate and unstable internal fixation was used to treat pilon fractures, including a 36% wound dehiscence and 55% infection rate. Helfet DL et al,[18] reported a 20% malunion rate in minimally invasive plate osteosynthesis of distal fractures of the tibia. No. No patient had evidence of delayed wound healing, wound dehiscence, or deep infection.

In the present study, there was superficial infection (15.4%), wound dehiscence (7.8%) and delayed union (7.8%) all in the same patient. One patient had a bent implant (3.8%) after weight bearing prematurely. Ankle stiffness in 15 (57.7%) patients, which was independent to method of fixation. In a study that established open reduction with plate and screw fixation as the standard, Ruedi and Allgower

achieved 74% acceptable results in 84 patients. These results did not deteriorate for 9 years.

Mast et al,[18] reported 78% satisfactory results in 37 patients with a minimum follow-up interval of 6 months. Less dramatic results were reported by a variety of authors when the plafond fractures studied included larger numbers of high-energy injuries. Bourne and colleagues,[19] studied 42 patients with tibial plafond fractures, 62% of whom were victims of high-energy trauma. Of the 16 Ruedi type III fractures treated by open reduction and internal fixation, only 44% had a satisfactory result. The majority of these fractures were complicated by nonunion (25%), infection (13%), and Arthrodesis (32%).

Ovadia and Beals,[20] reviewed 34 fractures equivalent to Ruedi Type III treated with traditional open reduction and plate fixation. Good to excellent results were achieved in only 47%. Complications were numerous and, although not sub-classified according to fracture type, superficial infections or skin loss developed in 9 patients (11%), osteomyelitis developed in 5 patients (6%), 17 patients (12%) required either ankle Arthrodesis or Arthroplasty.

Im GI et al,[21] In a study of 30 patients using anatomic plates and screws, open reduction and internal fixation was done with 88.2% excellent to good results according to Oleurd and Mollander function ankle score and with a better alignment of fracture fragments. Hazarika et al,[22] in a series of 20 patients with distal tibial fracture treated using locking compression plates through the MIPPO technique. This approach aims to pressure bone biology and minimise surgical soft tissue trauma. This provided 87.5% of good to excellent results. Fractures were classified according to the AO system and performed as staged surgery after stabilisation with external fixators primarily.

Gao et al,[23] studied 32 adult patients with very short metaphyseal fragments in fractures of distal treated with a polyaxial locking system. The polyaxial locking system has shown results of 87.3% functional outcome with the American Orthopaedic Foot and Ankle Society score, which offers more fixation versatility and may be a reasonable treatment option for distal tibia fracture with very short metaphyseal segments.

Gupta RK et al,[15] a series of 79 patients of distal metaphyseal tibial fractures fixed with locking plate and they reported 31.2% excellent result,47.5% good result,11.2% fair result and 10.1% poor result. Chandra Sekharam Naidu M et al,[11] reported 58.3% excellent outcome, 20.8% good outcome, 16.7% fair outcome and 4.2% poor outcome.

The average time for fracture union in various studies conducted using various methods was 14-28 weeks. The present study had an average fracture union time of 16 weeks, which was comparable with studies conducted using the LCP. In the present study, 21 (80.8%) patients had excellent/good results and 5 (19.2%) patients had fair/poor results, which are comparable with other studies. Four patients (15.2%) had fair results, which is because of multiple interventions in the form of wound debridement and hardware removal (fibula plate) followed by skin grafting, one patient had poor results because of non union and implant (plate) failure.

CONCLUSION

In conclusion, tibial pilon fractures remain challenging, with no definitive gold standard treatment. In our present study, surgical approach with immediate temporary external fixator, definitive fixation after around 10 days by open reduction and internal fixation (ORIF) with fibular plate and locking medial tibial plate augmented with articular screws / k wires has yielded excellent/good results in 21 cases (80.8%). Treatment decisions should consider detailed radiographic assessment and surgeon expertise with a two-phase protocol preferred for optimal soft tissue management, which is critical in reducing complications and improving outcomes in high energy pilon fractures.

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