

Original Research Article

Comparison between malleolar locking plate and metaphyseal locking plate for the management of the distal tibial fracture

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ABSTRACT

Background: A pilon fracture is a distal tibial metaphyseal fracture that involves the ankle joint. Distal tibia fractures include extra-articular fractures of the metaphysis and the more severe intraarticular tibial plafond or pilon fractures. Several treatment methods have been recommended for the treatment of these injuries, with a recent emphasis on minimally invasive techniques. This research studies the outcome of a malleolar locking plate (M) versus a metaphyseal locking plate (P) in the management of distal tibial (Pilon) fracture.

Methods: Distal tibial M and P were used to treat 80 cases of tibial pilon fracture. The study examined the use of anterior/ anteromedial approach for tibia and posterolateral/ lateral fibular fixation.

Results: The male to female gender ratio was 2.63 in M and 1.35 in P. Mean age was 57.03±15.93 (M) and 52.1±12.788 (P). Surgeries were mostly done within 1 day to 1 week. Mean hospital stay was 6.43±4.545 (M) and 4.93±4.676 (P). The mean lower extremity functional score (LEFS) was 66.55 (M) and 67.15 (P) with 83.56% maximal function. 3 P cases had infections. No infections were seen in M group at the end of the 12th week follow-up.

Conclusions: The results of the study indicate that there is no significant difference in terms of LEFS criteria, union, fracture alignment, range of motion (knee and ankle), infection, and other outcome measures between M fixation and P in the treatment of distal tibia fracture in adults.

Keywords: Distal tibia fracture, Pilon, Locking plates, LEFS, Fracture alignment

INTRODUCTION

Orthopaedic surgeons refer to distal tibia fractures as “pilon” fractures, due to the French word “pestle”.¹ Étienne Destot, an anatomist and radiologist, used this term when he compared the anatomy of the ankle joint to a mortar and pestle.² In this analogy, the trochlea is the pestle, and the distal ends of the tibia and fibula are the mortar. When a hit is directed axially, such as during a fall from a height, it can cause a fracture in the distal tibia. Overall, the outcome after treating pilon fractures is still not satisfactory. Common complications include problems with healing of the skin and soft tissues, delayed union,

nonunion, or infection. This is mainly due to the poor blood supply and thin soft tissue coverage in the affected area. Pilon fractures are often caused by high-energy injuries, and they are frequently open and involve massive contusion of the skin, muscles, and blood vessels. Furthermore, after surgical treatment of pilon fractures, arthritis can develop in up to two-thirds of cases. To address these issues, it is now recommended that surgical treatment be carried out in stages according to the principles of damage control orthopaedics. The development of implants with angular stability and less invasive stabilization techniques also offers hope for achieving better mid- and long-term results.³⁻⁵ Distal tibia

fractures are classified into two types: extra-articular and intra-articular fractures, also known as Pilon's or plafond fractures. The incidence of these fractures ranges from 3 per 10,000 per year among 30 to 34-year-old women to 28 per 10,000 per year among 15 to 19-year-old boys. These fractures make up 3% to 10% of all tibia fractures and less than 1% of lower extremity fractures.⁶⁻⁹ These fractures are usually caused by high-energy injuries such as falls from heights or motor vehicle accidents and are often open fractures. They are frequently associated with other trauma in other areas of the body and severe soft tissue compromise.^{7,8} The limited soft tissue, subcutaneous location, and poor vascularity make treatment more challenging. Several treatment methods have been recommended, including various external fixation techniques, intramedullary nailing, and plate fixation, with a recent emphasis on minimally invasive techniques.¹⁰⁻¹⁵ However, each treatment option has its own benefits and complications, including wound infections, which are the most common complication of distal tibial fracture management.¹⁴⁻¹⁶ Deep infection is considered a significant problem among patients who undergo external fixation or plating, with an infection rate ranging from 0 to 15%. The development of infection may result from compromised soft tissue, an immune system's inability to ward off potential infection, or colonization of virulent microorganisms.^{17,18} Several studies regarding the treatment of distal tibial fractures are available. This study aims to research the Comparison between the M and the P for the management of the distal tibial (Pilon) fracture. Ethical clearance and informed consent were taken from the respective authority.

Objectives

General objective was to study the outcome of pilon fracture treatment by using locking plates.

Specific objective was to compare the management of pilon fracture by using the M and P.

METHODS

This prospective cross-sectional study has been designed to assess and compare the effect of plates used in pilon fracture management among patients who came to visit department of orthopaedics, President Abdul Hamid medical college hospital, Kishoregonj, from June 2020 to May 2023. Within this period, 80 patients aged 18 years or more came to this hospital with pilon fractures.

Inclusion criteria

Patients who are over 18 years of age and have sustained closed/Gustilo and Anderson grade I traumatic extra-articular/intra-articular distal tibia fractures, and are seeking medical attention at the emergency/OPD in the department of orthopaedics within 15 days post-injury are eligible to participate in the trial if they provide written informed consent and have understood details of the study.

Exclusion criteria

Exclusion criteria were patients not eligible for surgery include those with compartment syndrome, general bone or joint disease, pathological fracture, comorbidities like uncontrolled diabetes and peripheral vascular disease, associated major injuries or polytrauma, and previous surgery.

Patients who were admitted to the orthopaedic ward due to injuries were given analgesics and their limbs were splinted. For open fractures, the wound was cleaned and stitched, and intravenous or oral antibiotics were given in all cases of Gustilo Grade I fractures. If a patient had poor skin condition and/or a haemorrhagic blister, the blister was aspirated and the limb was elevated with two pillows underneath until a wrinkle sign was observed. The patient underwent a full pre-anaesthetic check-up and, if deemed fit for anesthesia, was taken up for elective surgery. The research team used the consecutive sampling technique to collect data, which was then entered into Microsoft excel 2012. To analyze the data, they used SPSS 21.0 for Windows (SPSS Inc., Chicago, Illinois) software and applied the independent samples T test and Mann-Whitney U test to compare outcome measures with parametric means. To compare non-parametric means, the Chi-square test and Fisher's test were used. The level of significance was set at $p \leq 0.05$. The ethical review committee of President Abdul Hamid medical college hospital has approved the study. A well-informed written consent paper was signed by the patients.

RESULTS

Over 3 years, 80 patients with distal tibia fractures visited President Abdul Hamid medical college hospital. 65% were male, 35% female. Mean age for was 57.03 ± 15.93 and 52.1 ± 12.78 years. Road traffic accidents caused 45% of injuries, falls from height caused 40% (Table 1). In Table 2, M group had longer hospital stays (6.43 days) compared to P group (4.93 days). Most surgeries were performed within a week. P group had slightly more blood loss. Second post-operative day infection was 5 % in each group. In 12th week follow-up, no patient of M group had infections, while 3 patients in P group had infection (Table 3). On AP X-ray view, $>5^\circ$ malalignment was observed in 9 out of 80 patients. At the 12-week follow-up, the mean coronal plane angulation was 2.55° for M and 3.30° for P. On the lateral X-Ray view, $>10^\circ$ malalignment was seen in 6 patients. The mean post-op sagittal plane angulation was 4.05° for M and 4.63° for P (Table 4). The M group had a clinic-radiological union rate of 82.5% at 12 weeks, while the P group had a rate of 90%. Both groups had a similar range of motion of knee and ankle, expressed as a percentage (Table 5). The LEFS criteria for evaluation of the outcome as well as the percentage of maximal function (POMF) was found similar in both groups (Table 6). Figure 1 shows X-ray of P fixation (tibia) and Figure 2 shows X-ray of M fixation (tibia).

Table 1: Socio-demographic and clinical characteristics of patients.

Characteristics		Group		P value
		M	P	
Mean age±SD		57.03±15.93	52.1±12.78	0.13
Sex	Male	49	43	0.16
	Female	31	37	
Nature of fracture	Closed	49	50	0.79
	Open	31	30	
Mode of injury	RTA	36	32	0.944
	Fall from height	20	24	
	Others	14	14	
Injury and hospital arrival interval	<12 hrs	21	24	0.767
	12 hr-1 day	8	7	
	>1 day-1 week	6	6	

Table 2: Injury-surgery interval, hospital stay, and haemoglobin levels in two group.

Characteristics		Group		P value
		M	P	
Injury and surgery interval	Upto 1 day	7	7	0.06
	1 day-1 week	17	26	
	>1 week	16	7	
Mean hospital stay ± SD (days)		6.43±4.545	4.93±4.676	0.146
Hb (gm. %)	Preop	11.07±1.48	11.51±2.07	0.273
	Postop	10.19±1.36	10.57±2.04	0.329
	Difference	0.88±0.46	0.94±0.46	0.584

Table 3: Follow up of infection in different stages.

Duration	Infection	Group		P value
		M	P	
2nd postop day	Present	22	22	1.00
	Absent	58	58	
2nd weeks	Present	24	27	0.518
	Absent	56	53	
6 weeks	Present	0	23	0.241
	Absent	80	57	
12 weeks	Present	0	3	0.241
	12 hr-1 day	8	7	

Table 4: Comparison of alignment in AP and lateral view at different stages of follow up.

Duration	Infection	Group		P value
		M	P	
Postop day	Present	54	55	1.00
	Absent	26	25	
6 weeks	Present	55	56	1.00
	Absent	25	24	
12 weeks	Present	55	56	1.00
	Absent	25	24	
Postop day	Present	53	56	0.518
	Absent	27	24	
6 weeks	Present	53	56	1.00
	Absent	27	24	
12 weeks	Present	57	57	1.00
	Absent	23	23	

Table 5: ROM knee and ankle between the two groups at different stages of follow-up.

Variables	M	P	P value
ROM knee (Mean±SD)			
2 weeks	83.15±6.784	84.05±5.257	0.509
6 weeks	83.43±6.957	84.68±4.833	0.354
12 weeks	83.28±7.111	85.43±4.888	0.119
ROM ankle (Mean±SD)			
2 weeks	87.38±6.758	89.68±4.817	0.84
6 weeks	88.08±6.639	89.75±4.640	0.195
12 weeks	88.73±5.444	89.63±4.595	0.427

Table 6: LEFS and percentage of maximum function (POMF) between two groups.

Groups	LEFS (Mean ± SD)	P value
M	66.55± 3.07	0.387
P	67.55± 2.60	
POMF (Mean ± SD)		
M	83.18±3.83	0.349
P	83.93±3.26	

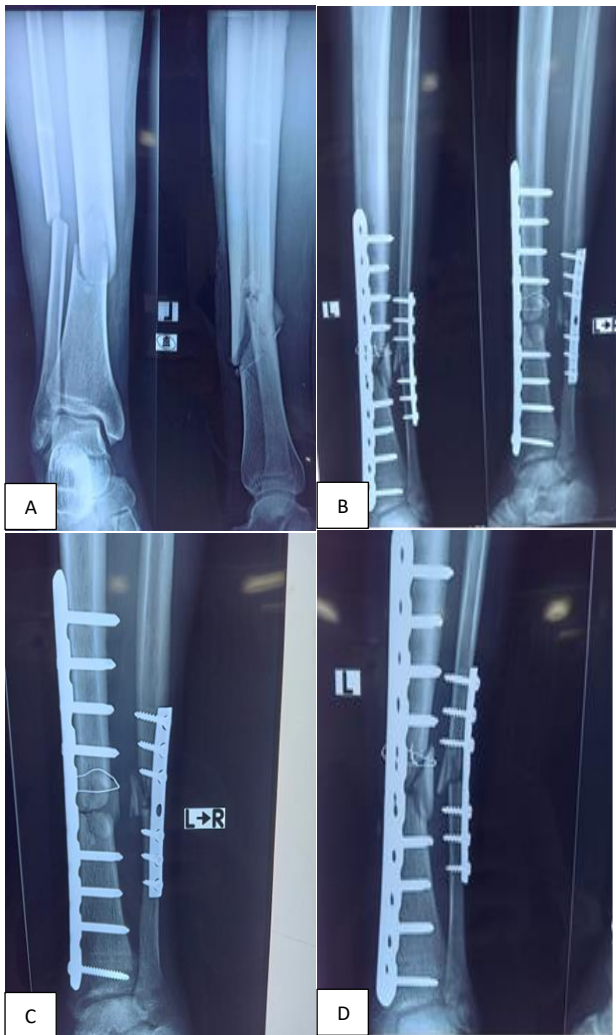


Figure 1 (A-D): X-ray showing Fracture distal tibia and fibula A/P and lateral view and X-ray of 2nd, 6th and 12th week follow-up after P fixation.



Figure 2 (A-D): X-ray of distal tibial plafond, X-ray of 2nd week fixation with M and X-ray of 12th week outcome with M fixation.

DISCUSSION

Distal tibial fractures are a major challenge for orthopaedic traumatologists. One of the main difficulties is the soft tissue injury that often accompanies such fractures. These types of fractures, which involve the weight-bearing distal

tibial articular surface and were first described by the French radiologist Destot in 1911, are known as pilon fractures.¹⁹

Metallosis refers to the penetration of tiny metal particles into tissues, such as soft tissues and bones around an internal fixator.^{29,30} This occurs due to abnormal contact with the metal surface, which causes the release of metal particles.³¹ These metal particles are then surrounded by histiocytes, which induce the release of a fracture around the joint.²¹ There are several complications that can arise from the surgical treatment of lateral malleolar fractures, including loose screws, malunion, nonunion, delayed union, deep infection, loss of fixation, skin defects, peroneal tendinitis, and skin irritation.^{20,22-27} But in the current study infection in pre-operation stage, during the process and post operation stage were found almost similar in both of the groups.

Ps are designed to prevent osteoporosis induced by stress shielding, minimal movement, and toggle and screw back-out induced by sedimentation-all of which can be observed with standard plates.^{32,34} In biomechanical experiments, Kim et al found that the two locking screws used for the distal unilateral cortical bones have the same stability as the three distal screws used in the standard plate.³³ Unlike standard plates, the fixation strength of locking metal plates is independent of the bone mineral density.³³ Additionally, locking metal plates have shown superior performance in comminuted fractures.³³

External fixators used for the distal tibia can be bulky and uncomfortable for the patient, and many patients find them visually unappealing. However, using an anatomically shaped metaphyseal plate for external fixation can provide a much lower profile. The study team was the first to use this method, and others have reported similar experiences more recently.³⁵⁻³⁸ With this technique, the external fixator plate can be easily concealed under regular clothing, and there's less chance of it hitting the opposite lower leg during ambulation. From the surgeon's perspective, the multiple 3.5-mm locking holes distally offer many options for distal fixation, in contrast to the more commonly used two large external fixator pins. Despite its low profile, the metaphyseal external fixation method is strong enough to handle the forces acting on the distal tibia. However, the cost of this method tends to be higher than standard half-pin external fixators, although ring fixators or hybrid fixators can also be expensive.

Limitations

This was a single-centered study with limited population for a longer period of time. These may cause data loss and not provide the overall scenario of the country.

CONCLUSION

In the current study, infection rate was found slightly higher in P group, union rate was higher in P group,

malunion was slightly higher in M group, but the results were not statistically significant. More study including more study places is required to establish a proper option.

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