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Functional outcome of external fixator in Pilon fracture

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Abstract: Background: Pilon fractures are complex fractures of the lower limb in adults that can be managed by various modalities, including open reduction and internal fixation (ORIF), external fixation, and conservative management.
Materials and Methodology: In this study, 30 patients with pilon fractures were treated with external fixation at a tertiary care center. The patients were followed up for 12 months, and their functional outcomes were evaluated using the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle and Hindfoot Score.
Results: The results showed that the use of external fixation led to a significant improvement in functional outcome in patients with pilon fractures, including range of motion, pain, and anatomical reduction.
Conclusion: External fixation is a less invasive and less time-consuming surgical modality for the treatment of pilon fractures. This technique has a favourable functional outcome and can be considered as an effective option for managing this complex fracture in adults.

Keywords: Pilon fracture; External fixator; AOFAS.

1. Introduction

Pilon fractures, which are fractures of the tibial plafond, result from low- to high-energy axial-loading injuries [1]. The term "pilon" is derived from the French word for a pestle, and was first used by Etienne Destot, a French Radiologist, in 1911 to describe the fracture. High-energy tibial pilon fractures are caused by axial loading, with the talus being driven into the distal tibia, resulting in comminution of the metaphyseal bone and occasional proximal diaphyseal extensions [2,3].

Although relatively uncommon, pilon fractures account for only 1% of all fractures of the lower limb and 5% to 7% of those of the tibia [4–6]. Due to frequent comminution and the thin soft-tissue envelope in the area, treatment of these fractures is challenging. The tibial pilon is characterized by a total absence of muscle coverage and marginal vascularity, therefore, even moderate trauma often results in extensive soft-tissue damage. Two mechanisms are believed to be responsible for most tibial pilon fractures: low-stress trauma (sports injuries), which is less common and secondary to rotational forces, and high-stress trauma (motor vehicle accidents, falls from height, workplace accidents), which is more common and produces axial transmission of the load with the talus pushed onto the distal tibia, resulting in a multifragmentary implosion of bones and cartilage structures. CT imaging has shown that high-energy tibial plafond fractures typically involve three relatively consistent main fragments: posterolateral (Volkmann), anterolateral (Chaput), and medial fragments, which are associated with soft tissue attachments of the posterior inferior tibiofibular ligament, anterior inferior tibiofibular ligament, and deltoid ligament, respectively [7,8].

The principles of treatment for pilon fractures include respecting the soft tissues, restoring the congruity of the articular surface, and reducing the anatomic alignment of the lower limb to enable early movement of the ankle joint [9,10].

Nonoperative management of pilon fractures is typically reserved for patients with nondisplaced articular fractures, surgical contraindications due to medical comorbidities, or low demand such as non-ambulatory patients [11]. Surgical treatment options for pilon fractures include open reduction and internal fixation, external fixation, and minimally invasive plate osteosynthesis (MIPO) [12].

While open reduction and internal fixation can lead to positive outcomes in treating low-energy pilon injuries, a high incidence of complications such as skin necrosis, wound slough, deep wound infection, nonunion, malunion, and amputation have been reported for high-energy compression injuries with bony comminution and severe damage to the thin soft-tissue envelope around the ankle. Minimally invasive plating osteosynthesis (MIPO) is an alternative that allows for indirect reduction and stable fixation with minimal soft tissue complications, but it is mainly limited to the treatment of extra-articular fractures (43A), a few undisplaced articular fractures (43B1-C1), or cases of soft tissue lesions [13,14].

The use of external fixation, without articular reduction or fixation, has been considered definitive treatment in highly comminuted or open pilon fractures to maintain length, alignment, and rotation. Several studies have reported that external fixation reduces the number of iatrogenic complications and is a safe, reproducible, and effective treatment modality in fractures of the distal tibia [15].

Therefore, in the present study, we aim to evaluate the results of treating pilon fractures with an external fixator, which we consider to be the best option for managing these fractures.

2. Material and Methods

2.1. Source of Data

The study was conducted at the Departments of Orthopaedics (Out Patient Department, Emergency Service, and Indoor Patient Department) at Government Medical College and Hospital.

2.2. Study Population

The study included patients with Pilon fracture attending the Departments of Orthopaedics (Out Patient Department, Emergency Service, and Indoor Patient Department) at Government Medical College and Hospital.

2.3. Study Period

The study was conducted over a period of 24 months from September 2020 to September 2022.

2.4. Sample Size

The sample size for the study was 30.

2.5. Screening Procedure and Format

The screening procedure and format involved the following steps:

1. Obtaining informed consent from the patients.
2. Obtaining the patient's medical history.
3. Conducting an orthopedic evaluation.
4. Recording vital signs.
5. Conducting relevant investigations.

2.6. Inclusion Criteria

The following inclusion criteria were applied:

1. Patients aged 18 years and above.
2. Patients diagnosed radiologically with distal end tibial fracture.
3. Patients who were willing to participate in the study.

2.7. Exclusion Criteria

The following exclusion criteria were applied:

1. Patients aged less than 18 years.
2. Patients with significant comorbidities.
3. Patients who were not willing to participate in the study or refused to give consent.

2.8. Detailed Procedure of Study

After applying the inclusion and exclusion criteria and obtaining valid informed consent from the patients, the study was conducted.

2.9. Postoperative Regimen

1. Active mobilization of the ankle, knee, and non-weight bearing walking using a standard walking frame was initiated from the second postoperative day under the supervision of a physiotherapist. Intravenous antibiotic regimen was continued for 5-7 days (12-14 days in compound fractures) after the surgery. Another 5 days of oral antibiotics were prescribed. Regular cleansing of the pin exit points was performed.
2. Patients were encouraged to do non-weight bearing exercises.

Patients were assessed using the following scoring system during follow-up.

2.10. AOFAS Ankle and Hindfoot Score for Follow-up

2.10.1. Follow-up Schedule

Follow-up was scheduled at the following time points:

- 15th day
- After 1 month
- After 3 months
- After 6 months
- After 9 months
- After 1 year

2.11. Withdrawal/Discontinuation Criteria

Patients who refused to participate in the study, death of the patient, and patients who were not willing to follow-up were excluded from the study.

2.12. Statistical Analysis

Data was entered in a Microsoft Excel format. Frequency tables and measures of central tendency (mean) and measures of dispersion (standard deviation) were obtained using the statistical package SPSS software. Outcome variables with a p-value less than 0.05 were selected, and cross-tabulation was performed to determine the strength and direction of the association between variables. The chi-square test was used to check statistical associations between variables and covariates.

2.13. Ethical Clearance

This study was conducted after obtaining proper permission from the ethical committee. A 30-year-old male patient came to the casualty with a history of RTA with blunt trauma to the left ankle, see Figures 1-10.

Figure 1. placement of proximal tibia pins

Figure 2. frame assembly

Figure 3. final framework of external fixator

Figure 4. AO C1 type of pilon fracture

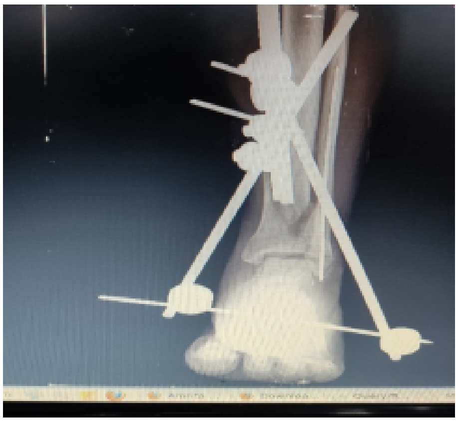

Figure 5. immediate post op x ray AP view

Figure 6. immediate post op x ray Lateral view

Figure 7. removal of external fixator after 4 month-AP view

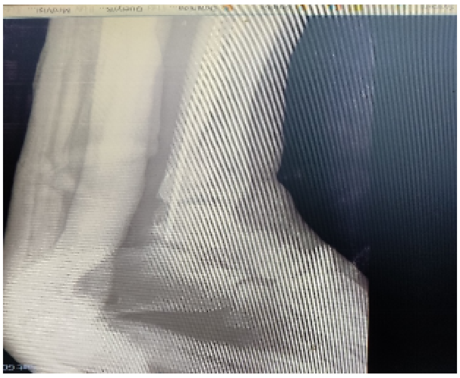

Figure 8. removal of external fixator after 4 month-Lateral view

Figure 9. PLANTAR FLEXION AT ANKLE AFTER 6 MONTH

Figure 10. DORSIFLEXION AT ANKLE AFTER 6 MONTH

3. Results

Our study included a sample of 30 patients with Pilon fractures who were receiving treatment at the Department of Orthopedics.

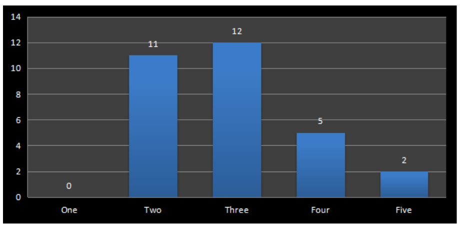

Figure 11. Distribution of study subjects according toclinical union time (months)

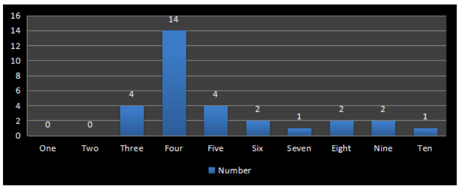

Figure 12. Distribution of study subjects according to radiological union time (months)

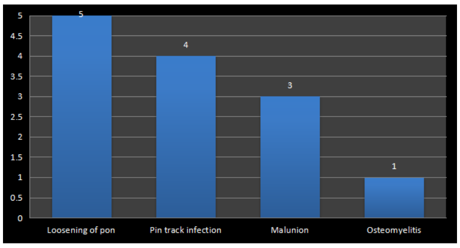

Figure 13. Distribution of study subjects according to complication

4. Discussion

In our study (Table 1), we observed that Pilon fractures were classified as 4 (13%) type C1, 11 (37%) type C2, 7 (23%) type C3, 6 (20%) type B2, and 2 (7%) type A3 fractures. We noted 4 (19%) open fractures in our study, which is comparable to findings reported in other studies by Guadinez *et al.*, (20%) and Barbieri *et al.*, (30%). In the study by Tornetta *et al.*, [16], they found that there were 12 (57%) type C1 fractures, 6 (29%) type C2 fractures, and 3 (14%) type C3 fractures. Ranjeet *et al.*, [15] reported that their study included 9 (32.14%) open fractures, and the fracture pattern and type were as follows: A2 (7.14%), A3 (21.42%), C1 (21.42%), C2 (35.70%), and C3 (14.28%). Ramos *et al.*, [17] reported that of the 18 patients with C-type fractures, five had type A1 fractures, eleven had A2, five had A3, twelve had C1, three had C2, and three had C3 fractures.

Table 1. Distribution of study subjects according to AO classification, Ruedi-Allgower classification, and wound classification

Parameters		Number	Percentage (%)
AO Type	**C1**	4	13
	C2	11	37
	C3	7	23
	B2	6	20
	A3	2	7
Type of wound	**Open**	13	43
	Closed	17	57

In our study (Table 2), 6 (20%) patients had axial injuries, while 24 (80%) patients had rotational injuries. The clinical union time was 2 months in 11 (37%) cases, 3 months in 12 (40%) cases, 4 months in 5 (17%) cases, and 5 months in 2 (7%) cases. The mean time to union was 5.033 ± 1.956 months. The radiological union time was 3 months in 4 (13%) cases, 4 months in 14 (47%) cases, 5 months in 4 (13%) cases, 6 months in 2 (7%) cases, 7 months in 1 (3%) case, 8 months in 2 (7%) cases, 9 months in 2 (7%) cases, and 10 months in 1 (3%) case. The mean time to radiological union was 2.933 ± 0.9072 months. In [18], the mean time to union was 4.8 months (range, 3-16 months). Galante *et al.*, [19] reported that union was obtained in 159 fractures at an average of 125 days. Lemsanni *et al.*, [10] reported that the study patients showed radiologic union within an average time of 14 weeks (9-19).

Table 2. Distribution of study subjects according to mechanism of injury, associate injury and injury to operation time

Parameters		**Number**	**Percentage (%)**
Mechanism of injury	**Axial**	6	20
	Rotational	24	80
Injury to operation time (Days)	**One**	9	30
	Two	12	40
	Three	6	20
	Four	3	10

In this study (Tale 3), we observed the degree of dorsiflexion and plantarflexion in patients with ankle fractures. We found that 63% of cases had 1 to 10 degrees of dorsiflexion, 33% had 11 to 20 degrees of dorsiflexion, and 3% had 21 to 30 degrees of dorsiflexion. In terms of plantarflexion, 20% had 1 to 11 degrees, 47% had 11 to 20 degrees, 27% had 21 to 30 degrees, and 7% had 31 to 40 degrees. Other studies cited in the paper found similar ranges of motion, with one reporting an average range of motion of 10 degrees of dorsiflexion and 13 degrees of plantarflexion.

Table 3. Distribution of study subjects according to clinical union time (months)

Union Time (Months)	**Number**	**Percentage (%)**
One	0	0
Two	11	37
Three	12	40
Four	5	17
Five	2	7
Total	30	100

The paper also reported (Table 4) on complications that occurred in the patients. These included loosening of pins in 17% of cases, pin track infection in 13% of cases, malunion in 10% of cases, and osteomyelitis in 3% of cases. Other studies mentioned in the paper reported on complications such as deep and superficial infection, traumatic arthritis, and nonunion, but these occurred at lower rates.

Table 4. Distribution of study subjects according to range of motion (Degree)

Range of motion (Degree)		Number	Percentage (%)
Dorsiflexion	1 to 10	19	63
	11 to 20	10	33
	21 to 30	1	3
Plantar flexion	1 to 10	6	20
	11 to 20	14	47
	21 to 30	8	27
	31 to 40	2	7

We also used the AOFAS ankle and hindfoot score to assess the functional outcomes of the patients. They found that the mean score was 75.8+10.86, and that 30% of patients had an excellent result, 46% had a good result, 16.6% had a fair result, and 6.6% had a poor result. Another study mentioned in the paper found a higher mean AOFAS score of 86.622 in their patients.

Overall, the study provides information on the range of motion and complications that can occur in patients with ankle fractures, as well as their functional outcomes as assessed by the AOFAS score.

5. Conclusion

Pilon fractures pose several challenges, including gross comminution, small fragments, intra-articular communition, bad skin, and subcutaneous anteromedial surface, which can compromise the precarious blood supply of the lower third to lower fourth tibia. As a result, the outcome of Pilon fracture treatment is typically unfavorable despite any treatment modality. Even with ORIF using various plate types or the MIPPO technique, significant skin problems can occur due to the subcutaneous anteromedial surface and precarious blood supply, which can further compromise communited fracture fragments after open reduction.

The success of surgical treatment for Pilon fractures depends on several factors, including the associated soft tissue injury, fracture communition, and the accuracy of the articular reduction. Respecting the soft tissue envelope is the first step in minimizing complications. External fixation, combined with limited open reduction and internal fixation in a staged protocol, is a reliable and safe treatment even for AO type C Pilon fractures, with minimal severe soft tissue complications, a relatively good functional result, and no local soft tissue irritation or implant removal.

In adults with Pilon fractures, external fixation is an easy, reliable, safe, and reproducible treatment modality.

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Conflicts of Interest: "Authors declare that they do not have any competing interests."

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