MEDICAL SCIENCE

Does a two-stage approach to treat tibia pilon fractures have a favorable consequence?

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ABSTRACT

Background: Tibial pilon fractures are generally challenging to manage. The pattern of trauma and skin status all contribute to greater management outcomes. Despite the existence of numerous treatment techniques, no one has yet evolved the perfect method. Due to extended immobility, casts are frequently increasing the probability of non-union, malunion and joint stiffness. *Aim:* The study intended to assess the function and quality outcomes as well as the prevalence of sequelae in those who underwent the two-staged procedure in adults. *Methodology:* The research employed 21 patients with pilon fractures consecutively. The whole patients who were included in the study were older than 18 years and were given two staged processes of treatments for their fracture through the period between April 2019 and March 2022 at King Saud Medical City. The AO-OTA Classification is used to categorize fractured sides. The patients were followed up at predetermined intervals of 1,2,3,4,12,18,24 and 36 months and functional outcomes were reviewed utilizing AOFAS. *Results:* With a mean follow-up of 24.7 months (range, 12-36), a total of 21 pilon fractures (2 type 43-A, 10 type 43-B and 9 type 43-C) were studied. The average AOFAS score was 86.91. Thirteen individuals (61.9%) showed early, late, temporary or permanent concerns. *Conclusion:* All varieties of Pilon fractures are best treated with a two-stage orthopedic surgery owing to the high perceived functional result and briefer length of hospitalization.

Keywords: Pilon, distal tibia, fracture, staged surgery, soft tissue, ankle, complication

1. INTRODUCTION

Approximately 1% of the fractures of the lower extremities are pilon fractures, which constitute about 3 to 10% of all tibia fractures (Andalib et al., 2021). The ideal management of pilon fractures involves anatomic reduction along with timely functional training. Unfortunately, a variety of factors can disrupt this ideal, including infection, as well as bone loss, which may lead to

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inadequate or failure of treatment (Chen et al., 2019; Alshammari, 2022). Even though the management of these fractures has advanced greatly in past few years, the optimal management of these fractures has remained complex and demanding, mostly because of robustly damaged soft tissue, a high-energy fracture modality and accompanying ankle's intense swelling (Çeçen et al., 2014; Sajjadi et al., 2018). Therefore, in this context, choosing a convenient treatment remains a contentious issue (Chan et al., 2015; Tang et al., 2012). There are many treatment approaches for Pilon fractures, each with its own merits and drawbacks, including close reduction and casts, external fixation, open reduction and internal fixation and a two-stage approach (Paluvadi et al., 2014; Abd-Almageed et al., 2015; Gupta et al., 2015; Yoon et al., 2015). Adding to debates over the best approach, there is controversy concerning the timing of when Pilon fractures should be treated (Tang et al., 2014; Sajjadi et al., 2018). The two-stage technique, which includes first stabilization via external fixation proceeded by definitive internal fixation after soft recovery, has been indicated by several authors as being the most often utilized approach for such fractures, particularly for pilon type 43-C. The prolonged hospital admission, higher infection hazard and paucity of anatomic reduction as a result of the deferred procedures are some of this method's significant disadvantages (Sajjadi et al., 2018). The usefulness of two-stage techniques in dealing with Pilon fractures has not been addressed locally. Therefore, the goal of the present randomized research was to assess the clinical, functional and radiologic outcomes as a predictor of the usefulness of the two-stage method in the treatment of Pilon fractures.

2. MATERIALS AND METHODS

Study layout and inhabitants

Patients with pilon fractures who met the research's eligibility requirements were prospectively enrolled in the study at King Saud Medical City (April 2019 to March 2022).

Enclosure criteria

An individual who meets the merit requirements:

- Presenters $\geq$ 18 years of age during the chosen period at our department
- Those who had a two-stage surgical procedure to address tibia pilon fractures
- Those who had at least two years of postoperative follow-up
- Those who consented to take part in the present study

Exclusion criteria

Exclusion criteria are diabetic patients, who had undergone foot or ankle surgical procedures in the past, who had a relevant neural or vascular accident, those whose fracture was pathological, those with serious orthopedic malformations and anyone who discontinued follow-up.

The technique

Patients initially had skin and neurovascular system examinations. The damaged ankle was then subjected to standard roentgen, including lateral and anteroposterior views (also taken from the intact side for comparison), as well as a Computed tomography. Utilizing the AO classification pilon fractures were categorized into three distinct classes: Extra-articular, Partial and Complete Articular Fractures (43-A, 43-B and 43-C respectively) (Tomás-Hernández, 2016). Relying on the Gustilo-Anderson categorization scheme, soft tissue damages were classified into various groups (Elniel and Giannoudis, 2018). The Tscherne Oestern method was used to assess the soft tissue status in closed fractures (Halvachizadeh et al., 2022). Patients received prophylaxis IV antibiotics and anti-tetanus (Toxoid/Immunization). Open fractures were swabbed, irrigated thoroughly and debrided, then povidone-iodine-saturated gauze was applied (Gardezi et al., 2021). All fractures were managed by a two-staged procedure; immobilization via posterior slabs for closed/type I fractures and external fixators for both types II and III, preceded by ORIF in a later step.

Postoperative treatment

In a prophylactic measure, 2 grams of cefazolin were administered intravenously. The antibiotics were then changed based on the results of the culture and sensitivity tests if the wound becomes infected. A gradual weight-bearing program begins at the end of the sixth week.

Impact metrics

In a predetermined fashion, patients were followed up clinically and radiologically at 1, 2, 3, 4, 6, 12, 18, 24 and 36 months or till bone fusion and maximum function were accomplished. Malunion was considered if the bone healed with angulation/medial rotation > 10 degrees/lateral rotation > 15 degrees or tibial shortening of ≥ 2 cm. Union is deemed by the presence of a bridging callus in three cortices in absence of ache and tenderness on the fracture side, whereas nonunion is the bone that do not heal within six months. Utilizing Burwell-Charnley roentgen indicators, the reduction was categorized as poor, fair and anatomical (Wang et al., 2020). The AOFAS score (American Orthopedic Foot and Ankle Society) had been applied and calculated at the last follow-up visit to quantify the functional outcome after the complete union, which collectively categorizes the function into excellent, fair and poor as > 90, between 80 to 90 and between 70 to 79 points respectively (Wang et al., 2022).

Data collection

The information was gleaned through a predefined questionnaire.

Data analysis

Software from the Statistical Package for Social Sciences (SPSS) edition 23.0 was utilized to manipulate and interpret the raw data. Statistics were judged significant at $p \leq 0.05$ at a CI of 95%. The Chi-square test was employed to look at how closely points and variables were related. Whereas to determine how the physical factors varied, the ANOVA test was utilized.

3. RESULTS

In the research, 21 patients had completed clinical and radiological follow-ups, thus their information was obtainable for the eventual assessment. Their average follow-up period was 24.7±3.4 with a range of 19 to 36 months. There had been 18 males and 3 women among the sufferers (M:F ratio, 6:1), having a mean age of 35.29±11.15 years (range extent, 21–60). Amongst the high-energy injuries, 14 (66.7%) had occurred as a result of road automobile incidents and the remaining 7 (33.3%) were due to falls (Table 1).

Table 1 Patients' characteristics (n=21)

Characteristics	
Gender	
Male	18 (85.7)
Female	03 (14.3)
M:F ratio	6:1
Age	
Mean age	35.29±11.15 (range, 21 to 60)
Young ≤ 40 years	15 (71.4)
Fracture's side	
Right	12 (57.1)
Left	09 (42.9)
Fracture's category	
Open (Compound)	5 (23.8)
Closed	16 (76.2)
Mechanism of injury	
RTA	14 (66.7)
Fall	07 (33.3)
Follow-up, months	24.7±3.4 months (range, 19 to 36)
Associated fibula fracture	5 (23.8)

Following the Gustilo grading method, there had been five open fractures, 1 (4.8%) of which were grade I, 1 (4.8%) being grade III and the other 3 (14.3%) were of grade II. Tscherne's approach categorized 16 (76.2%) closed fractures into grade C1 and grade C2 fractures in 11 (52.4%) and 5 (23.8%) patients respectively. Following AO categorization, the fractures were classified into types 43-

A, 43-B and 43-C in 2 (9.5%), 10 (47,6%) and 9 (42.9%) respectively (Table 2). An additional fracture was present in 14 individuals (66.7%) it included 5 fractures to the fibula (23.8%).

Table 2 Pilon fractures classifications (n=21)

Classification	Frequency (%)
AO classification	
43-A	02 (9.50)
43-B	10 (47.6)
43-C	09 (42.9)
Gustilo-Anderson classification of open fractures	
Type I	01 (4.80)
Type II	03 (14.3)
Type III	01 (4.80)
Tscherne Oestern's classification of closed fractures	
C1	11 (52.4)
C2	05 (23.8)

Within six hours of the incident, immobilization with the posterior slab or else an external fixator was undertaken. The restitution of the posterior and lateral columns occurred on an average of 11.7±4.6 (range, 9–16) days following the primary intervention. The average intervening period from the first to the second stage of the operation was 12.3 days (within a range of 10–17 days).

Following the second stage of management, the mean recovery interval was 3.7 (range, 2.0–6) months and the clinical and radiographical results showed that the entirety of victims had reached fracture union. Using Burwell and Charnley's radiographic appraisal technique, anatomical and fair reduction were visible in 20 (95.2%) of patients' postoperative radiographs. There were 21 (100%) individuals eligible for the AOFAS Ankle-Hind foot standard measures, 17 (81.0%) of them had excellent, good or satisfactory postoperative ankle function. The mean AOFAS score was 86.91±11.52 (range, 60-100 points). In the current study, 19 (90.5%) postoperative complications have arisen (Table 3).

Table 3 Radiographical and clinical outcomes of pilon fractures (n=21)

Outcome measure	Frequency (%)	P value
AOFAS score		0.021*
Excellent (80-100 points)	8 (38.1)	
Good (80-90 points)	5 (23.8)	
Fair (70-79 points)	4 (19.05)	
Poor (< 70 points)	4 (19.05)	
Mean AOFAS score	86.91±11.52, (range, 60-100 points)	
Burwell and Charnley's radiological quality of reduction		0.007*
Anatomical	15 (71.4)	
Fair	5 (23.8)	
Poor	1 (4.8)	

Post-procedural complications were encountered in 5 (23.8%) victims (infection, skin necrosis, delayed union and osteoarthritis). Of them, 4 individuals (19.1%) experienced superficial surgical site infections; however, with daily dressing, their wounds recovered. Regional skin necrosis occurred in 1 (4.8%) individual, who received treatment with vacuumed- draining and later flap transference. Following the second stage procedure, the delayed union occurred in 2 (9.5%) individuals. Post-traumatic osteoarthritis of varying degrees (only discomfort with minimal radiological evidence to moderate form with radiological evidence

present with pain but not interfering with daily activity) was encountered in 3 individuals (14.3%). Patients did not have nonunion or need for arthrodesis (Figure 1).

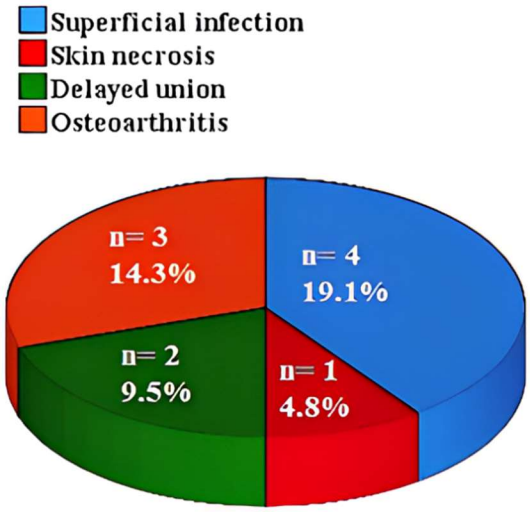

Figure 1 Complications after two staged procedures (n=21)

4. DISCUSSION

Pilon fracture treatments are exceedingly difficult and frequently have worse-than-ideal outcomes. Many patients do not experience the desired results from these fractures since they are frequently brought on by severe trauma and engage the articular surface and a lot of sufferers will struggle with aches and pains from this issue for the rest of their lives (Sajjadi et al., 2018). The best way to treat pilon fracture is unclear, as well as the best time to do so. It is believed that the injured and enlarged soft tissue in these fractures is responsible for the increased rates of suppuration and wound healing issues associated with surgery in such fractures (He et al., 2013).

To our knowledge, there are no distinct clinical indicators that may be used to choose the best timing for the next surgery. In the current study, 5 (23.8%) patients experienced mild to moderate post-procedural sequelae while in the study by Sajjadi et al., (2018), post-procedural complications were seen in 6 (30%) of the group of 20 patients treated by the two-stage method.

Studies showed that infection as a consequence of complications from traumatic wounds might have devastating effects. The incidence of wound complications may be decreased by postponing the surgical procedure for 5–14 days till posttraumatic edema substantially subsided (Mair et al., 2021; Utomo et al., 2022). In the current study, the mean interval between the 2 stages was 12.3 days. Hasani, (2020) in his study, the mean period lapsed since the insult to the definitive procedure was 11 days. Whereas in a study by Chen et al., (2019), the period from the first to the second stage ranged between 10 to 14 days with a mean of 12 days. In the study conducted by Talwar, among the group managed by the two-stage method, postoperative complications were superficial infection in 16.7%, deep infection in 8.3% and arthritis in 25% and arthrosis in 66.8% of patients which is higher than the findings reported in the present study.

In the research by Yaradilmis et al., (2020), patients received excellent, good, fair and poor scores, in 40%, 37.7%, 17.7% and 4.4% respectively. While, in a research paper by De-Moura et al., (2018), the patients had experienced excellent, good, satisfactory and poor scores in 31.25%, 31.25%, 25% and 12.5% respectively. Furthermore, Rubio-Suarez et al., (2018) acknowledged that the patients had excellent, good, fair and poor scores as experienced in 30.5%, 46.7%, 13.1% and 9.7% of patients respectively. Hasani, (2020) in his study, the average AOFAS functional score was 86.54 points whereas it was 81 points (Chen et al., 2019).

The average AOFAS score of 86.91 in the current study indicates that functional movement had been regained in the majority of patients. In certainty, the results were excellent for 38.1% of the patients, good for 23.8%, fair for 19.05% and poor for 19.05%. About 95.2% of the patients had an anatomical and fair reduction.

Study limitations

No study is without limitations and the current study is no exception. Initially, no comparison group with identical injuries that received other treatments modality was employed in this study. This is because pilon fractures are uncommon injuries, making it challenging to conduct controlled studies to compare different treatment modalities. Furthermore, the follow-up period was

somewhat short; extended observation durations may enable disorders like traumatic arthritis to manifest. The clinical outcome was exclusively assessed using the AOFAS assessment method; therefore, some results may have been biased in that regard. For future research, we intend to employ additional assessment methods to lessen this bias.

5. CONCLUSION

Anatomic reduction, restitution of vertical orientation, preservation of joint integrity, a union of bone fragments, mobility without discomfort and absence of surgical site complications are the targets of management for pilon fractures. The grade of the fracture, and soft tissue destruction, all influence the treatment approach for tibia pilon fractures. Before choosing the appropriate immobilization method in the first stage, it is crucial to take into account the fracture pattern and soft tissue situation. The current study demonstrates a two-staged approach is a successful treatment strategy for maintaining the biological environment by conserving soft tissue, yielding improved outcomes in terms of union interval and complication frequencies that are consistent with other studies. Despite propitious preliminary results, studies including a larger number of patients are needed to confirm the leverage of such treatment methods.

Authors' contribution

Sager HA: Participants and major contributors to data collection, introduction, results and discussion.
Fares A: Participated in the study design and introduction section and decisively evaluated axial material components.
Mohammed SA: Worked with the team to organize the data, revise papers for inclusion, organize the results and outline the project.
Mohammed A: Collaborated with colleagues to gather data, identify publications for inclusion and construct materials and methods.
Ahmed OA: Assisted in data collection, identified relevant literature for inclusion and drafted the results section.
Saadeldin AI: Reviewed papers for inclusion, contributed to the study design and wrote part of the discussion.
Moaath AA: In addition to overseeing the project, he also reviewed the research data and rewrote the manuscript in a pivotal intellectual aspect.
The article was written, edited and evaluated by all authors in a variety of ways.

Ethical consideration

The institutional review board (IRB), of King Saud Medical city, granted ethical approval for this study (Reference No.: H1RI-19-Aug19-01). In addition, signed informed consent from the patients for participation was obtained before inclusion in the current study.

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Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

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