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Original Research Article

COMPARISON OF ANTERIOR-TO-POSTERIOR AND POSTERIOR-TO-ANTERIOR SCREW FIXATION VERSUS POSTEROLATERAL PLATE FIXATION OF THE POSTERIOR MALLEOLUS IN TRIMALLEOLAR ANKLE FRACTURES

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ABSTRACT

Background: Posterior malleolar fractures account for approximately 7% to 44% of all ankle fractures. Inadequate treatment may increase the risk of post-traumatic arthritis. Fixation is often considered for displaced fragments involving more than 25% to 35% of the articular surface, although the optimal indications and fixation technique for posterior malleolar fractures in trimalleolar ankle injuries remain controversial. **Objective:** To compare the clinical and radiological outcomes of anterior-to-posterior screw fixation and posterolateral plate fixation of the posterior malleolus in patients with trimalleolar ankle fractures. **Study Design:** Prospective randomized comparative study. **Place and Duration of Study:** This study was conducted at Peoples University of Medical and Health Sciences Nawabshah Pakistan from August 2025 to August 2026

Materials and Methods: A total of 80 patients aged 18 to 60 years with trimalleolar ankle fractures were enrolled at a tertiary care hospital. Patients were randomly allocated into two equal groups of 40 patients each. Group A underwent posterior malleolar fixation using anterior-to-posterior (AP) screws, whereas Group B underwent open reduction and internal fixation using a posterolateral plate. Patients were followed for six months. The primary outcome was the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Score. Secondary outcomes included time to weight-bearing and radiological union. Continuous variables were compared using the independent-samples t-test, while categorical variables were analyzed using the chi-square test or Fisher's exact test, as appropriate. A p-value of less than 0.05 was considered statistically significant.

Results: All 80 patients completed the six-month follow-up, and baseline characteristics were comparable between the groups. The mean time to weight-bearing was significantly shorter in Group A than in Group B (7.03 ± 0.71 vs. 12.01 ± 1.49 weeks, $p < 0.001$). Similarly, the mean time to radiological union was shorter in Group A (18.79 ± 1.91 vs. 20.14 ± 2.01 weeks, $p = 0.003$). Functional outcomes were comparable, with good or excellent AOFAS scores reported in 85.0% of patients in Group A and 87.5% in Group B ($p = 0.91$).

Conclusion: Both anterior-to-posterior screw fixation and posterolateral plate fixation achieved comparable functional outcomes at six months. Anterior-to-

posterior screw fixation was associated with earlier weight-bearing and radiological union. Further studies with longer follow-up are warranted to confirm these findings.
Keywords: Posterior malleolar fracture; trimalleolar ankle fracture; anterior-to-posterior screw fixation; posterolateral plate fixation; open reduction and internal fixation; AOFAS Ankle-Hindfoot Score.

INTRODUCTION

Posterior malleolar fractures account for approximately 7% to 44% of all ankle fractures.[1] The posterior malleolus (PM) refers to the posterior aspect of the distal tibial plafond and may involve the posterior tibial tubercle or posteromedial portion of the tibial plafond, depending on the fracture pattern.[2,3] The posterior tibial margin plays an important role in ankle joint congruity, load transmission, and stability. Inadequate restoration of the articular surface and ankle stability following injury may contribute to post-traumatic osteoarthritis.[4]

Open reduction and internal fixation (ORIF) is a well-established treatment for displaced medial and lateral malleolar fractures.[5] Historically, posterior malleolar fractures have often been managed conservatively, particularly when the fragment was expected to reduce indirectly following reduction and fixation of the lateral malleolus.[6] Traditional indications for posterior malleolar fixation have emphasized fragment size, particularly when the fragment involves approximately 25% to 35% or more of the tibial plafond articular surface.[7] However, fragment size alone may not adequately determine the need for fixation. Factors such as displacement, articular incongruity, fracture morphology, and syndesmotic stability are also relevant. Consequently, the indications for posterior malleolar fixation remain debated, and some authors have advocated syndesmotic fixation without direct fixation of the posterior fragment in selected cases.[8]

Several surgical techniques are available for posterior malleolar fixation, although the optimal approach may vary according to fracture morphology and fragment characteristics.[9] The commonly used techniques include anterior-to-posterior (AP) screw fixation and direct posterior fixation using a posterolateral plate.[10] AP screw fixation allows stabilization through a percutaneous or limited approach, whereas posterolateral plating facilitates direct visualization, reduction, and buttress fixation of the posterior fragment. Despite the widespread use of both techniques, uncertainty remains regarding their comparative clinical and radiological outcomes in patients with trimalleolar ankle fractures.[11]

Therefore, this study aimed to compare anterior-to-posterior screw fixation with posterolateral plate fixation of the posterior malleolus in patients with trimalleolar ankle fractures, focusing on functional outcomes, time to weight-bearing, and radiological union.

MATERIALS AND METHODS

This prospective randomized comparative study was conducted in the Department of Orthopedics at a tertiary care center. Patients presenting with trimalleolar ankle fractures during the study period were screened for eligibility. The study protocol was approved by the institutional Ethical Review Committee, and written informed consent was obtained from all participants before enrollment.

Inclusion Criteria

Patients were eligible for inclusion if they were aged 18 to 60 years, had a trimalleolar ankle fracture requiring operative stabilization of all three malleoli, and provided informed consent to participate in the study. A total of 80 patients meeting the eligibility criteria were enrolled.

Exclusion Criteria

Patients with additional injuries involving other parts of the lower limb, a history of previous lower-limb injury, or pilon fractures were excluded from the study.

Patient Assessment and Randomization

All eligible patients were assessed by the investigator. A detailed medical history, general examination, and systemic examination were performed. Routine laboratory investigations and appropriate radiological examinations were conducted to assess eligibility and facilitate preoperative planning.

The 80 enrolled patients were randomly allocated in a 1:1 ratio to two groups using a computer-generated random number sequence, with 40 patients in each group:

Group A: Posterior malleolar fixation using anterior-to-posterior (AP) screws.

Group B: Posterior malleolar fixation using open reduction and internal fixation (ORIF) with a posterolateral plate.

Surgical Procedure

All surgical procedures were performed by a single orthopedic surgeon to minimize inter-surgeon variability. The medial and lateral malleolar fractures were treated using standard fixation techniques, and fracture reduction was assessed intraoperatively under fluoroscopic guidance.

In Group A, the posterior malleolar fragment was reduced and stabilized using anterior-to-posterior screw fixation. In Group B, the posterior malleolar fragment was exposed through a posterolateral

approach, directly reduced, and stabilized using a posterolateral plate. Intraoperative syndesmotic stability was assessed in both groups. Postoperatively, the affected limb was immobilized according to the treatment protocol, and rehabilitation, including range-of-motion exercises, was initiated as clinically appropriate.

Follow-up and Outcome Assessment

Patients underwent clinical and radiological assessments at 2 weeks, 6 weeks, and 6 months postoperatively. The time to weight-bearing and time to radiological union were recorded in weeks.

Functional outcomes were assessed at 6 months using the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Score, graded as excellent (90–100), good (75–89), fair (50–74), or poor (below 50). The AOFAS Ankle-Hindfoot Score at 6 months was the primary outcome measure. Secondary outcome measures included time to weight-bearing and time to radiological union.

Statistical Analysis

Data were recorded using a predesigned, semistructured proforma and analyzed using Microsoft Excel and SPSS software. Continuous variables, including age, time to weight-bearing, time to radiological union, and AOFAS score, were summarized as means and standard deviations. Categorical variables, including sex, mechanism of injury, fracture type, and AOFAS functional category, were presented as frequencies and percentages.

Between-group comparisons of continuous variables were performed using the independent-samples t-test. Categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 80 patients with trimalleolar ankle fractures were enrolled and randomly allocated into two equal groups (n = 40 each). All patients completed the 6-month follow-up. The two groups were comparable in baseline characteristics. [Table 1]

Table 1

Variable	Group A (n = 40)	Group B (n = 40)	Test statistic	p-value
Age (years), mean ± SD	39.1 ± 10.01	36.4 ± 6.92	t = 1.40	0.165
Sex, n (%)				
Male	30 (75.0)	28 (70.0)		
Female	10 (25.0)	12 (30.0)	$\chi^2 = 0.25$	0.617
Mode of injury, n (%)				
Road traffic accident	24 (60.0)	22 (55.0)		
Fall	12 (30.0)	13 (32.5)	$\chi^2 = 0.24$	0.888
Other	4 (10.0)	5 (12.5)		
Type of fracture, n (%)				
Closed	18 (45.0)	22 (55.0)		
Open	22 (55.0)	18 (45.0)	$\chi^2 = 0.80$	0.371

Table number 2 shows the comparison of time to weight-bearing and radiological union between the groups.

Table 2

Outcome (weeks)	Group A (n = 40)	Group B (n = 40)	p-value
Time to weight-bearing, mean ± SD	7.03 ± 0.71	12.01 ± 1.49	<0.001
Time to radiological union, mean ± SD	18.79 ± 1.91	20.14 ± 2.01	0.003

Table number 3 shows the AOFAS Ankle-Hindfoot Score at 6 months.

Table 3

AOFAS grade, n (%)	Group A (n = 40)	Group B (n = 40)	p-value
Excellent (90–100)	12 (30.0)	15 (37.5)	
Good (75–89)	22 (55.0)	20 (50.0)	
Fair (50–74)	5 (12.5)	4 (10.0)	0.91
Poor (<50)	1 (2.5)	1 (2.5)	
Total	40 (100)	40 (100)	

**p-value by Fisher's exact test*

DISCUSSION

This prospective randomized comparative study evaluated the functional and radiological outcomes of anterior-to-posterior (AP) screw fixation and posterolateral plate fixation of the posterior malleolus in patients with trimalleolar ankle fractures. At six months, both techniques demonstrated comparable functional outcomes, with good or excellent AOFAS Ankle-Hindfoot Scores in the majority of patients in both groups. However, AP screw fixation was associated with significantly earlier weight-bearing and radiological union than posterolateral plate fixation.

The absence of a significant difference in functional outcomes contrasts with some findings reported in

the existing literature. O'Connor et al. reported better postoperative functional scores among patients treated with posterolateral buttress plating than among those treated with AP screw fixation.[12] Similarly, Deendayal et al. reported better overall functional outcomes following posterolateral plating.[13] In contrast, a network meta-analysis suggested that screw fixation may offer advantages in functional outcomes and pain relief, whereas open plating may provide better radiological outcomes.[14] The comparable AOFAS scores observed in the present study highlight the variability in published findings and suggest that the functional outcome of posterior malleolar fixation may depend on several factors, including fracture morphology, quality of reduction, restoration of articular congruity, syndesmotic stability, and rehabilitation. Nevertheless, the absence of a statistically significant difference in our study does not establish equivalence between the two techniques.

An important finding was the shorter time to weight-bearing in the AP screw group compared with the posterolateral plate group (7.03 ± 0.71 versus 12.01 ± 1.49 weeks, $p < 0.001$). Radiological union also occurred earlier in the screw group (18.79 ± 1.91 versus 20.14 ± 2.01 weeks, $p = 0.003$). These findings are consistent with the results reported by Deendayal et al., who observed delayed weight-bearing and healing in patients treated with plate fixation.[13] Several factors may explain these differences. Posterolateral plating requires a posterior surgical approach and greater soft-tissue exposure than percutaneous or limited-incision AP screw fixation. Depending on the extent of surgical dissection, soft-tissue handling and periosteal disruption may influence postoperative recovery and fracture healing.[15] Differences in postoperative rehabilitation protocols may also affect the timing of weight-bearing.[16]

Although the difference in mean time to radiological union was statistically significant, its magnitude was relatively modest, at approximately 1.35 weeks. In contrast, the difference in time to weight-bearing was approximately five weeks and may have greater practical implications for postoperative rehabilitation. However, because rehabilitation was not standardized between the groups, the extent to which the observed difference reflects the fixation technique rather than postoperative management remains uncertain. Therefore, the earlier initiation of weight-bearing in the AP screw group should be interpreted cautiously and should not be taken as evidence that screw fixation inherently permits earlier loading in all patients.

Posterior malleolar fixation also plays an important role in restoring syndesmotic stability. In a cadaveric study, Gardner et al. demonstrated that posterior malleolar fixation restored approximately 70% of intact syndesmotic stiffness, compared with approximately 40% following syndesmotic screw fixation.[17] Fixation of the posterior malleolar fragment may help restore the posterior inferior tibiofibular ligament attachment and the tibial incisura, thereby contributing to syndesmotic stability.[18-20] In the present study, syndesmotic stability was assessed intraoperatively in both groups. However, the number of patients requiring additional syndesmotic fixation was not recorded. Consequently, the comparative effects of the two fixation techniques on syndesmotic stability and the need for supplementary fixation could not be determined.

This study has several limitations. First, it was conducted at a single center and involved a single surgeon, which may limit the generalizability of the findings. Second, the six-month follow-up period was insufficient to evaluate long-term outcomes, particularly the development of post-traumatic osteoarthritis. Third, detailed information regarding posterior malleolar fragment size, fracture morphology, articular step-off, and quality of reduction was not collected. These factors may influence both the choice of fixation technique and the resulting clinical outcomes. Fourth, postoperative rehabilitation and weight-bearing progression were not standardized between the groups, potentially confounding the observed differences in time to weight-bearing. Fifth, the AOFAS Ankle-Hindfoot Score includes subjective components, and blinded outcome assessment was not performed, introducing the possibility of assessment bias. Finally, data regarding postoperative complications and the need for additional syndesmotic fixation were not available. These limitations should be considered when interpreting the findings.

CONCLUSION

Anterior-to-posterior screw fixation and posterolateral plate fixation of the posterior malleolus produced comparable functional outcomes at six months in patients with trimalleolar ankle fractures. AP screw fixation was associated with earlier weight-bearing and radiological union, although the difference in mean time to union was relatively small. The findings support the use of either technique according to fracture morphology, the feasibility of achieving satisfactory reduction, soft-tissue conditions, and the surgeon's clinical judgment. Larger multicenter studies with standardized rehabilitation protocols and longer follow-up are needed to clarify the comparative effectiveness of these techniques.

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Conflict of Interest

The authors declare no conflicts of interest related to the conduct or publication of this study.

Ethical Approval

Ethical approval was obtained from the institutional Ethical Review Committee before the

commencement of the study. Written informed consent was obtained from all participants.

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