Comparison of Percutaneous Screw Fixation and Conservative Treatment of Posterior Malleolar Fractures: A Radiological and Functional Outcomes Analysis

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Abstract

Aim: The aim of this study was to compare the clinical and radiological results in patients with trimalleolar fractures with a small posterior malleolar fragment of the ankle joint with and without percutaneous screw fixation.

Methods: The study involved patients (18-65 years) with (Group 1) or without (Group 2) percutaneous screw fixation of posterior malleolus fractures between January 2017 and December 2023. Clinical and radiological evaluation was conducted at various time points up to the last follow-up. Functional evaluation was conducted using American Orthopedic Foot and Ankle Scores (AOFAS), Visual Analogue Scores (VAS), and dorsiflexion restriction. Radiological evaluation included the measurement of the gap and step between at the fracture site and presence of ankle osteoarthritis.

Results: In this study, sixty-five patients (Group 1: 33, Group 2: 32) who met the inclusion criteria were followed up for a mean of 31.65±6.4 (24–44) months. There were no significant differences in the clinical results between the groups ($p > 0.05$). At the final radiograph, the mean gap and step distances in Group 1 were lower than in Group 2 ($p < 0.001$). There was no significant difference between the groups regarding the presence of ankle osteoarthrosis ($p = 0.658$).

Conclusion: This study indicates that while percutaneous screw fixation of small posterior malleolus fragments does not significantly improve clinical outcomes compared to non-fixation, it does result in better radiological alignment. The findings suggest that maintaining joint congruity may be more crucial than fixation in preventing posttraumatic ankle osteoarthritis. Further research is needed to explore these findings.

Keywords: *Posterior malleolus; Fracture; Screw fixation; Conservative*

1. Introduction

The posterior malleolus is crucial for the ankle joint, providing tibiotalar load transfer, rotational stability, and posterior talar support because it covers the load-bearing portion of the tibial plafond and the ankle syndesmosis. Posterior malleolus (PM) fractures account for approximately 7-44% of all ankle fractures and are usually associated with other malleolus fractures and syndesmosis injury leading to instability[1,2]. The Haraguchi classification is one of the most widely used classifications of posterior malleolus fractures[3]. Haraguchi Type 1 is a triangular fragment type involving the posterolateral corner of the tibial plafond and accounts for approximately 67% of all PM fractures[4,5]. If these fractures involve more than 25% of the articular surface, they should be fixed to provide greater syndesmotic stability[6]. Percutaneous screws are a safe and minimally invasive method frequently used for PM fragment fixation. Although surgical treatment is recommended for large posterior malleolus fractures, there is no consensus in the literature regarding the fixation of PM fragments less than 25% of the ankle joint and there are studies showing that conservative treatment is also effective [7,8].

In our study, we aimed to compare the clinical and radiological outcomes of patients with trimalleolar fractures involving less than 25% of the ankle joint in Haraguchi Type 1 PM fractures, with and without percutaneous screw fixation.

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2. Materials and Methods

After ethics committee approval, patients who underwent trimalleolar fracture surgery in our hospital were retrospectively analyzed (Health Research Institutional Review Board IRB Number: 0066, Date: 18/07/2024). All patients signed informed consent form. In this study, patients whose posterior malleolus fractures were fixed with percutaneous screws (Group 1) or not (Group 2) between January 2017 and December 2023 were evaluated. This study included patients diagnosed with trimalleolar fractures between the ages of 18 and 65 who had PM fractures (<25% of tibia plafond) treated with screws or conservative management. The included patients also had preoperative and postoperative computer tomography (CT), underwent medial and lateral malleolar fracture fixation, and had at least 2 years of follow-up.

The present study excluded patients with open fractures, pathologic fractures, isolated posterior malleolus fracture, PM fragments fixed with plate screws, prior ankle complaints or surgical procedures, ipsilateral injury, fracture history in the same ankle, perioperative syndesmotic instability (positive cotton test) or performing syndesmotic stabilization, inappropriate x-rays, and follow-up for less than 2 years.

2.1. Surgical Technique

Surgical procedures were performed by the same specialized surgical team. All patients were operated under anesthesia in the supine position using a tourniquet. The affected ankle was sterilized and draped for surgery. First, the fibula fracture was fixed with plates and screws through a posterolateral incision. Then, through a separate incision, the medial malleolus fracture was fixed with cannulated screws. Treatment of the PM fragment was determined according to the surgeon's preference.

After fixation of the fibula and medial malleolus fractures, reduction of the posterior malleolus was achieved with ligamentotaxis in Group 1. After the reduction was controlled under fluoroscopy, fixation was performed using one or two cannulated screws through a percutaneous mini-incision over the anterior ankle joint. In Group 2, no fixation method was applied for the posterior malleolus fracture (Figure 1).

Following fracture fixation and skin closure, a plaster cast was applied to all patients postoperatively and an active range of motion exercises were started one month after surgery. Full weight bearing was allowed 3 months after surgery.

2.2. Clinical and Radiological Evaluations

Patients were followed up clinically and radiologically at regular intervals for a minimum of 2 years. The demographic data (age, gender, affected side, etc.) of all patients were recorded (Table 1).

Clinical assessment was performed using American Orthopedic Foot and Ankle Scores (AOFAS), Visual Analogue Scores (VAS), and dorsiflexion restriction (more than 10%) at the last follow-up. Clinical results were then compared between the groups.

Radiological evaluation was performed by a senior radiologist and orthopedic surgeon. A consensus was reached to make a final assessment if there was a disagreement between the surgeon and the radiologist. The classification of PM fracture was classified according to the Haraguchi system by examining ankle views and computed tomography [3]. The length of the PM fracture and tibia plafond measurements were conducted from preoperative lateral x-rays. The gap or step between the PM fragment and tibia plafond was evaluated and measured in millimeters using PACS software at the last follow-up. The presence of ankle osteoarthritis was also assessed on radiographs according to the previous study [9]. Radiological results were then compared between the groups.

2.3. Statistical analysis

Statistical analysis was performed using IBM SPSS version 25.0. The relationship between non-parametric categorical data of the patients was analyzed using Pearson's chi-square test. The relationship between parametric numerical variables was analyzed using Student's t-test. Significance level was defined as $P < 0.05$.

3. Results

Sixty-five patients (Group 1:33, Group 2:32) were followed up for a mean of 31.65±6.4 (24–44) months. The mean age of the patients was 41.1±13.6 (21–63) years. There were 31 (47.7%) male and 34 (52.3%) female patients. In 18 cases (27.7%) traffic accidents, in 19 cases (29.2%) ankle sprain injuries and in 28 cases (43.1%) falls were recorded. The affected extremities were 30 (46.1%) right-sided and 35 (53.9%) left-sided. The mean time from injury to surgery was 3.3±1.1 (2–5) days. No significant difference was found between the two groups in terms of these demographic parameters ($p > 0.05$) (**Table 1**).

Figure 1

Radiographic images of patients with (bottom row) and without (top row) fixation of posterior malleolus fracture: preoperative anteroposterior (a,f) and lateral (b,g) ankle x-rays, computed tomography views (c,h), and postoperative anteroposterior (d,i) and lateral (e,i) ankle x-rays.

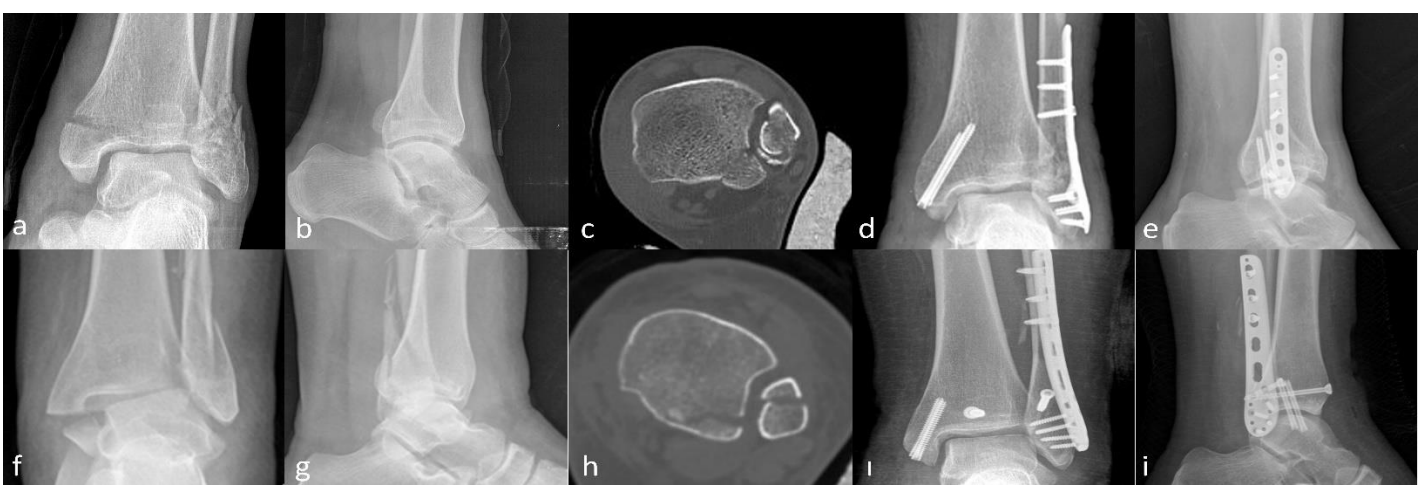

Table 1

Characteristics of the study population.

Variable	Group 1 Posterior malleol fixation (n=33)	Group 2 Posterior malleol without fixation (n=32)	p
Age (years)	41.5±14.6	40.6±12.6	0.787 +
Sex (male: female, n)	17:16	14:18	0.531 *
Affected side (right: left, n)	16:17	14:18	0.692 *
Mechanism of injury (fall: road accident: sprain, n)	11:7:15	9:9:14	0.791 *
Injury to surgery time (days)	3.4±1.1	3.3±0.9	0.839 +
Follow-up (month)	30.8±5.3	32.4±7.3	0.331 +

*+: Student t-test, *: Pearson Chi Square and Fisher's Exact test*

Table 2

Clinical results of two groups

Variable	Group 1 Posterior malleol fixation (n=33)	Group 2 Posterior malleol without fixation (n=32)	p
AOFAS Score (0: poor, 100: excellent)	91.2±5.8 (84-100)	93.3±4.9 (85-100)	0.130 +
VAS Score (0: no pain, 10: maximum pain)	1.27±1.1 (0-3)	1.13±0.9 (0-3)	0.537 +
>10% Dorsiflexion restriction	3 (9.1%)	2 (6.3%)	0.667 *

*AOFAS: The American Orthopedic Foot and Ankle Society, VAS: The Visual Analogue Scale, +: Student t-test, *: Pearson Chi Square and Fisher's Exact test*

Table 3

Radiological results of two groups.

Variable	Group 1 Posterior malleol fixation (n=33)	Group 2 Posterior malleol without fixation (n=32)	p
Gap (mm)	0.36±0.5 (0-2)	1.81±0.6 (1-3)	<0.001 +
Step (mm)	0.79±0.9 (0-3)	1.91±0.6 (1-3)	<0.001 +
Ankle osteoarthritis (n) (%)	3 (9.1%)	4 (12.5%)	0.658 *

*SD: Standard deviation, mm: millimeter, +: Student t-test, *: Pearson Chi Square and Fisher's Exact test*

At the last follow-up, the mean AOFAS and VAS scores were 92.2±5.5 (84-100) points and 1.2±0.9 (0-3) points for two groups. A loss of 10% or more dorsiflexion was found in 3 patients (9.1%) in Group 1, in 2 patients (6.3%) in Group 2. There were no significant differences in the clinical results between the groups ($p > 0.05$) (**Table 2**).

The mean gap distance between the posterior malleolus and tibia plafond was 1.1±0.9 (0-3) mm for all patients, and there was a significant difference among the groups. At the last x-rays, the mean gap distance in Group 1 [0.36±0.5 (0-2) mm] was lower than in Group 2 [1.81±0.6 (1-3) mm] ($p < 0.001$) (**Table 3**).

The mean step measurement between the posterior malleolus and tibia plafond was 1.3±0.9 (0-3) mm for all patients, and there was a significant difference among the groups. At the last x-rays, the mean step measurement in Group 1 [0.79±0.9 (0-3) mm] was lower than in Group 2 [1.91±0.6 (1-3) mm] ($p < 0.001$) (**Table 3**).

Ankle osteoarthritis was observed in only 7 (10%) of all patients. Early-stage arthritis was observed in 3 (9.1%) patients in Group 1 and 4 (12.5%) patients in Group 2. No significant difference was found between the groups in terms of ankle osteoarthritis ($p = 0.658$) (**Table 3**). All patients with ankle osteoarthritis presented a gap or step of more than 2 mm at the posterior malleolus fracture line. Any patients suffered from severe osteoarthritic changes.

4. Discussion

In the present study, we found that in patients with Haraguchi type 1 posterior malleolus fractures involving less than 25% of the ankle joint, there was less gap and step between the fractures when

the PM fragment was fixed with cannulated screws percutaneously. Although PM fixation resulted in better radiological alignment, clinical outcomes remained comparable to conservative treatment.

Fixation of the posterior malleol in trimalleolar fractures is determined according to the ratio of the posterior fragment to the ankle joint. There is a consensus in the literature about posterior fragment fixation for PM fragment size greater than 25% [4,10]. However, there are different studies suggesting operative or conservative treatment for PM fractures less than 25% of the ankle joint. Gardner et al. [6] recommended fixation to maintain syndesmotic stability even if the posterior malleolus fracture was less than 25%. However, Van Hooff et al. [7] showed that joint biomechanics did not change and functional results were similar with conservative treatment of small posterior malleolus fractures. Also, McDaniel and Wilson [11] concluded that failure of fixation of a posterior malleolus fragment measuring ≤25% would not affect the overall outcome. In our study, although better reduction quality was achieved in patients with PM fractures less than size of 25% of the distal tibial articular surface fixed with percutaneous screws compared to conservative treatment, no significant differences were found between the groups in terms of clinical outcomes, similar to previous studies [7,11].

Posterior malleolus fixation can be performed using screw or plate osteosynthesis via a posterolateral approach or an anteroposterior percutaneous screw technique. Anteroposterior or posteroanterior screw methods are frequently used because they are minimally invasive, less soft tissue dissection and lower risk of infection. Batar and Sisman [12] reported better clinical and radiological results with the posteroanterior screw technique compared to anteroposterior screw fixation due to direct reduction. On the other hand, Xu et al. [13] reported in a retrospective study that anatomical reduction was achieved similarly in patients with both posteroanterior and anteroposterior screw fixation. Although different fixation methods for posterior malleolus fixation were not compared in our study, we have shown that anteroposterior screw fixation provides less gap and step distance between fragments, is a reliable method to maintain reduction and results in good functional scores.

Posttraumatic ankle osteoarthritis is a progressive, degenerative articular cartilage disease that can occur after primary or neglected ankle fractures [14,15]. Ankle fractures involving the PM are associated with an increased incidence of posttraumatic osteoarthritis [16]. Especially the presence of fracture dislocation, joint surface incongruity and residual talar subluxation are risk factors for the development of posttraumatic ankle osteoarthritis, regardless of the size of the posterior malleolus fragment [4]. Therefore, some authors suggest that all posterior malleolus fractures should be fixed to decrease the incidence of ankle arthritis [1]. On the other hand, there are also studies showing that osteoarthritis develops more when the posterior malleolus fracture is surgically treated [4]. In the present study, it was observed that all patients with ankle osteoarthritis had a gap or step of more than 2 mm in the posterior malleolus. In our opinion, in order to prevent ankle arthritis, reduction and joint congruity should be maintained rather than fixation of the posterior malleolus fracture.

We are acknowledged that our study has some limitations. These limitations are the small sample size, the retrospective and single-centre nature of the study, the fact that the decision of posterior malleolus fixation was left to the surgeon, and the relatively short follow-up period to evaluate long-term results. Although trimalleol fractures were diagnosed in all patients in our study, the types, fixation and quality of reduction of medial and lateral malleolus fractures were not evaluated. Furthermore, the development of posttraumatic arthritis may be associated not only with posterior malleolus fractures but also with other malleolus fractures and this uncertainty should be taken into consideration. Multicentre prospective randomized controlled studies with greater sample size and duration of follow-up should be performed to provide further evidence for these findings.

5. Conclusion

In conclusion, our study indicates that while fixation of Haraguchi type 1 posterior malleolus fractures less than 25% of the ankle joint improves radiological outcomes, clinical results remain comparable to conservative treatment. No differences between groups in terms of the development of arthrosis suggest that preservation of joint congruity may be more important than fixation in preventing posttraumatic ankle osteoarthritis. Further research with larger samples is necessary to validate these findings.

Conflict of Interest:
The authors declare that they have no conflict of interest.

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Ethics Approval: All methods were carried out in accordance with relevant guidelines and regulations. This study was performed in line with the principles of the Declaration of Helsinki. Ethics approval was obtained by the Izmir Katip Celebi University Atatürk Training and Research Hospital Health Research Institutional Review Board (No:0066).

Consent to Participate: Consent to participate was obtained from all patients for being included in this study.

Consent for Publication: Not applicable.

Informed Consent:
Informed consent was obtained from all individual participants included in the study. Patients signed informed consent regarding publishing their data and photographs.

Competing Interest:
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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All the authors contributed to the study's conception and design. Material preparation, data collection, and quality assessment were performed by M.M. and T.B. Statistical analysis and literature review were performed by M.M., O.D.A and I.A. The first draft of the manuscript was written by M.M. and C.O., and all the authors commented on previous versions of the manuscript. All the authors read and approved the final manuscript.

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No artificial intelligence was used for the writing of the submitted work.

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