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Comparison Of Complications Between Anterior To Posterior Lag Screws Versus Posterior Buttress Plating For Posterior Malleolus Fixation In Tri-Malleolar Ankle Fracture

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Abstract
Introduction: *Ankle fracture is one of the most common injuries treated by orthopedic surgeons, accounting for 9% of all fractures and 36% of all lower extremity fractures. Percutaneous AP screw and buttress plating through the posterolateral approach are common methods for the fixation of posterior malleolus. This study aimed to compare the complications between Anterior to posterior (AP) lag screws versus posterior buttress plating for posterior malleolus fixation in tri-malleolar ankle fracture.*
Methods: *This quasi-experimental study took place at the Department of Orthopedics & Traumatology, Chittagong Medical College Hospital, Chattogram, Bangladesh, during the period from November 2020 to October 2021. The study involved 28 patients with ankle fractures, divided equally into two groups: Group A received anterior to posterior (AP) lag screw fixation, while Group B underwent posterior buttress plating. Data analysis was conducted using MS Office tools and SPSS version 23.0.*
Result: *In the measurement of dorsiflexion restriction compared to the contralateral side at the final follow-up examination, the higher loss was found in the AP screw group 7.0^0 (5-9) compared to posterior buttress plating group 5.5^0(4-7) though the difference was statistically insignificant (p=0.137). There was no significant difference regarding complications between the two groups.*
Conclusion: *Patients with tri-malleolar ankle fractures in whom the posterior malleolus is treated with posterior buttress plating experience lesser complications at follow-up compared to those treated with AP screws.*
Keywords: *Anterior to Posterior Screw, Posterior Buttress Plating, Ankle, RTA*

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I. INTRODUCTION

Ankle fractures are among the most common injuries managed by orthopedic surgeons, representing 9% of all fractures and 36% of lower extremity fractures in the United States. This rate is on the rise, particularly among young, active individuals and elderly citizens due to an increased risk of fragility fractures associated with aging. Although anatomical and biomechanical studies emphasize the importance of the posterior malleolus in stabilizing the ankle mortise and syndesmosis, the decision to surgically reduce and fix posterior malleolar fractures remains a subject of debate. [1] Approximately 46% of Weber B or C ankle fracture-dislocations involve a fracture of the posterior rim of the distal tibia [2]. Fractures of the posterior malleolus are relatively common, occurring in 7%–44% of rotational ankle fractures [3,4]. These posterior malleolar fractures (PMF) have been a subject of continuous interest for a long time, representing one of the most controversial aspects of treatment. Current indications for their management are varied and evolving, including fractures involving >25% to 33% of the articular surface [5], displacement >2 mm, ankle instability with concomitant syndesmotic injury, and persistent posterior subluxation of the talus [6]. However, this value has been questioned more recently as studies have demonstrated the importance of even small posterior malleolar fragments to ankle stability, and surgical indications have expanded to decrease post-traumatic arthritis [3,7]. Surgical management of displaced posterior malleolar fractures includes two basic techniques: indirect reduction and anteroposterior (AP) fixation or direct

reduction and posteroanterior (PA) fixation. Indirect reduction and AP fixation with lag screws were developed first and still have many proponents among surgeons. Reduction is achieved percutaneously, and fixation is performed with 3.5-mm partially-threaded cancellous lag screws. However, there are some concerns about the routine use of this technique in patients with posterior malleolus fractures, including the precision of the indirect reduction. Moreover, it can sometimes be difficult to achieve interfragmentary compression with AP fixation if the threaded portion of the screw is not completely accommodated within small or medium-sized fragments [1,8]. The treatment of ankle fractures and fracture dislocations involving the posterior malleolus (PM) has evolved significantly over the past decade [9]. With a personalized approach to fracture morphology assessment using preoperative computed tomography (CT) scanning, substantial improvements have been achieved in the historically challenging outcomes of tri-malleolar ankle fractures [10-12]. However, despite the refinement of surgical indications, reduction techniques, and fixation methods, controversy persists regarding individualized approaches, and concerns have been raised about potential complications associated with increased use of posterior approaches [13-15]. Several studies have highlighted that complications can have a detrimental impact on the outcome of ankle fracture treatment. Identifying significant risk factors for complications following PM fracture treatment is crucial for achieving favorable outcomes, emphasizing the importance of an individually tailored treatment regimen that addresses all relevant risk factors [16].

OBJECTIVES

General Objective

- To compare the complications of posterior malleolar fractures treated with posterior buttress plating versus AP lag screw fixation.

Specific Objectives

- To know the age and sex distribution of the study subjects.
- To assess the mechanism of injury of the study population.
- To compare baseline fracture characteristics and complications between two groups.

METHODS

This quasi-experimental study took place at the Department of Orthopedics & Traumatology, Chittagong Medical College Hospital, Chattogram, Bangladesh, from November 2020 to October 2021. The study involved 28 patients with ankle fractures, who were divided into two groups, with each group consisting of 14 cases. Group A received anterior to posterior (AP) lag screw fixation, while Group B underwent posterior buttress plating. All patients provided written informed consent before data collection commenced.

Inclusion criteria:

- Posterior malleolar fracture in tri-malleolar fractures with >2mm displacement, ankle instability, and fractures occurring within 14 days.
- Age 18 or older at surgery.

Exclusion criteria:

- Patients with additional lower extremity injury, pilon-type tri-malleolar fracture.
- Patients with open fractures, bilateral involvement, or multi-trauma cases.
- Patients with ankle arthritis (inflammatory or degenerative) or pathological fractures.
- Patients with comorbidities like diabetes mellitus, CKD, or chronic liver disease.

Patients undergoing surgery lacked specific criteria for fixation method selection. In the AP screw approach, patients were supine, and direct incisions fixated the fibula and medial malleolus. Posterior malleolar reduction was confirmed by fluoroscopy after ligamentotaxis, followed by fixation using 4.0 mm cannulated screws. A posterior lateral approach accessed the posterior malleolus between peroneal tendons and flexor hallucis longus. The posterior malleolus was directly reduced and provisionally fixed with K wires during surgery. Stabilization employed a small fragment T plate or a 1/3 tubular plate in a buttress technique. Fibular fixation was performed through the same incision, and medial malleolus fixation used a separate medial approach. Intraoperative imaging assessed syndesmosis integrity, reinforced with a screw when necessary. Post-surgery, patients wore a plaster cast for three weeks, transitioning to a boot from weeks 2 to 6 for range of motion exercises. Weight-bearing started at 6 weeks, progressing to full weight-bearing at 12 weeks. The final evaluation utilized AOFAS scores, categorizing outcomes as excellent (90-100), good (80-89), fair (70-79), or poor (below 70) in subcategories of pain (out of 40), function (out of 45), and alignment (out of 15). Dorsiflexion restriction status was compared with the unaffected side. Data analysis utilized SPSS version 23.0.

II. RESULTS

In this study, the median age in the AP screw group was 37.5 years, and in the posterior buttress plating group, it was 39.5 years. Males predominated in both groups, accounting for 71.4% in each group. However, both groups were comparable in terms of age and sex distribution. This study revealed that Road Traffic Accidents (RTAs) were the primary cause of fractures in both groups, accounting for 64.3% in the AP screw group and 85.7% in the posterior buttress group, followed by falls from height. Both groups displayed similar distributions in terms of the mechanisms of injuries. According to the Lauge-Hansen classification of injuries, 42.9% of patients in the AP screw group were of the supination-external rotation type, while 57.1% of patients in the posterior buttress group fell into this category, with the remaining patients being of the pronation-external rotation type. It's noteworthy that in the posterior buttress plating group, the size of the posterior malleolar fragment, relative to the length of the tibial articular surface on the lateral radiograph, was larger compared to the AP screw group. Nonetheless, both groups were comparable in terms of their fracture classification and the size of the posterior fragment. In the follow-up radiographic evaluation, only 7.1% of patients in the AP screw group and 14.3% of patients in the posterior buttress group displayed radiographic signs of osteoarthritis. Notably, this difference was not statistically significant (p=0.10). Furthermore, there were no significant differences between the two groups concerning other complications, such as soft tissue infection and bone infection. At the final follow-up examination, when measuring dorsiflexion restriction compared to the contralateral side, the AP screw group exhibited a higher loss, with a median of 7.0^0 (ranging from 5 to 9), in contrast to the posterior buttress plating group, which had a median of 5.5^0 (ranging from 4 to 7). It's worth noting that the observed difference, although notable, was statistically insignificant (p=0.137).

Table 1: Age and sex distribution of the participants (N=28)

Variables	AP lag screw	Posterior buttress plating	P value
	n=14	n=14	
Age (years)			
Median (IQR)	37.5 (29.5-50.0)	39.5 (28.2-56.2)	0.628*
Range	24-55	20-80	
Gender			
Male	10 (71.4%)	10 (71.4%)	1.0†
Female	4 (28.6%)	4 (28.6%)	

IQR: Interquartile range. *Mann-Whitney U test; †Fisher's exact test.

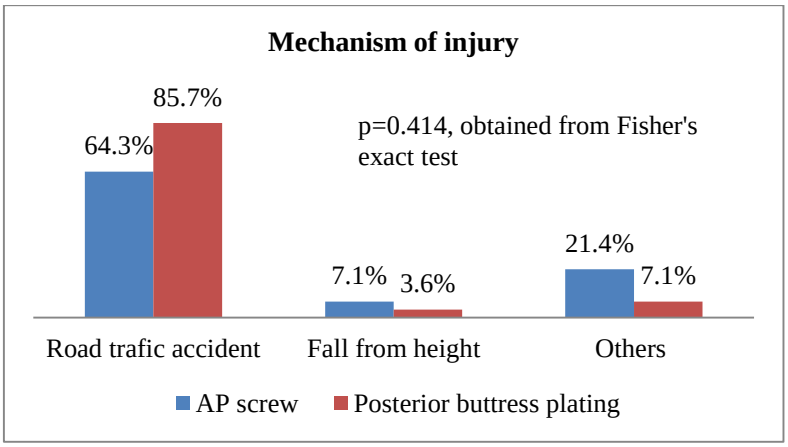


Figure 1: Mechanism of injury

Table 2: Comparison of baseline fracture characteristics

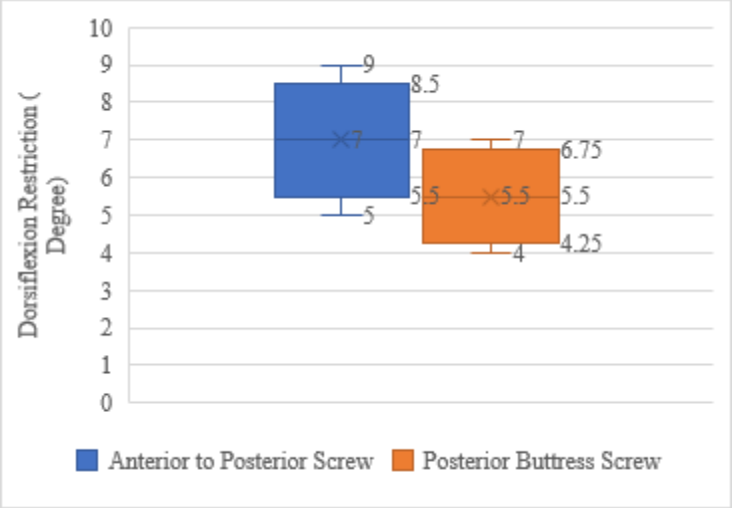
Variables	AP leg screw	Posterior buttress plating	P value
	n=14	n=14	
Classification			
SER	6 (42.9%)	8 (57.1%)	0.705†
PER	8 (57.1%)	6 (42.9%)	
Size of the posterior fragment			
Fragment (%)	26.0 (20.3-36.3)	33.5 (20.8-46.3)	0.311*

***Mann-Whitney U test; †Fisher's exact test. SER: Supination external rotation; PER: Pronation external rotation.**

Table 3: Comparison of complications at final follow-up

Parameters	AP leg screw	Posterior buttress plating	P value
	n (%)	n (%)	
Arthritis (Radiography)	1 (7.1)	2 (14.3)	1.0†
Soft tissue infection	2 (14.3)	4 (28.6)	0.668†
Bone infection	0 (0)	1 (7.1)	1.0†

IQR: Interquartile range; †Fisher's exact test.



P=0.137, obtained from the Man-Whitney U test

Figure 2: Box and Plot diagram showing a comparison of dorsiflexion restriction. (N=28)

III. DISCUSSION

The management of posterior malleolar fractures is marked by several controversies [17]. To determine a more optimal surgical approach with fewer complications, this study compared the complications associated with posterior malleolar fractures treated using posterior buttress plating versus AP lag screw fixation. The findings of the current study revealed that patients experienced significantly fewer complications when treated with posterior buttress plating. The age range in this study was between 20 and 80 years, with a median age of approximately 40 years (37.5 years in the AP screw group and 39.5 years in the posterior buttress plating group). This age distribution was consistent with other studies, such as the one by Kalem et al. (2018), where the mean age was 43.4 years in the AP screw group and 40.8 years in the posterior buttress plating group [18]. In the study conducted by O'Connor et al. (2015), a comparatively higher age range was reported, with mean ages of 45.5 years in the AP screw group and 47.8 years in the posterior buttress plating group [3]. In this current study, the majority of patients were males, accounting for 71.4%. This gender distribution can be attributed to cultural norms, where males often lead more active lifestyles and spend more time outdoors to earn a living, while females tend to stay predominantly indoors. It's important to note that this male majority differed from other studies [18-20], where either female was the majority or the male-female ratio was nearly equal. Road traffic accidents and falls from height emerged as the leading causes of injury in the present study, which aligns with the findings of most other studies [19,20]. In low-income and middle-income countries like Bangladesh, road traffic accidents tend to be particularly severe due to weak enforcement of road safety regulations and the lack of traffic awareness and responsibility among pedestrians and motorists [21]. In the measurement of dorsiflexion restriction compared to the contralateral side at the final follow-up examination, the higher loss was found in the AP screw group (7.0^0) compared to the posterior buttress plating group (5.5^0) though the difference was not statistically significant (p=0.137). Xu et al. (2012) compared dorsiflexion loss in patients applied with fixation and patients not applied with fixation and reported a loss of mean 6.8° ± 9.7° compared with the uninjured side. [22] Verhage et al. (2015) used AP screws for fixation of the large fragment in posterior malleolar fixation in 59 patients with tri-malleolar fracture. [23] The restriction in dorsiflexion compared to the healthy side was reported as a mean of 6.9°. At the final follow-up examinations of the patients in the study of Kamel et al. (2018) a loss of 5° or more dorsiflexion was found in 9 patients (45.0%) in the AP screw group and 8 patients (23.5%) in the plate group and there were not any statistically significant differences between the groups. [18] The clinical improvement observed in this study did not correspond to improved radiographic outcomes, as there was no significant difference in the percentage of patients who developed postoperative arthritis between the two groups, with 1 case in the AP screw

group and 2 cases in the posterior buttress plating group. Given the limited number of patients, a comprehensive statistical evaluation of arthrosis development following posterior malleolar fractures could not be performed. A similar observation was made by O'Connor et al. in 2015, where 11 patients underwent AP screw fixation and 16 patients received posterior buttress fixation [3]. In Kamel et al.'s 2018 study, Grade 1 arthrosis was identified in 2 patients in the AP screw group and 1 patient in the plate group [18]. In the current study, six cases of superficial wound infection were recorded, with two in the AP screw group and four in the posterior buttress group. All of these infections resolved with meticulous wound care and extended antibiotic administration. In the posterior buttress plating group, one patient developed fibular osteomyelitis, which necessitated the removal of the fibular plate four months after surgery. Fortunately, there were no complications in the form of loss of reduction, material failure, or implant migration.

Limitations of The Study

It's important to acknowledge that this study was conducted in a single hospital with a relatively small sample size. As a result, the findings may not be fully generalizable to the broader population. Additionally, the duration of patient follow-up was relatively short. Furthermore, the use of plain radiography, as opposed to computed tomography, for evaluating the reduction could potentially impact the accuracy and comprehensiveness of the results. These limitations should be considered when interpreting the study's findings.

IV. CONCLUSION

Individuals who sustain tri-malleolar ankle fractures and undergo posterior buttress plating for the treatment of the posterior malleolus tend to have fewer complications during their follow-up appointments when compared to patients treated with anterior-posterior (AP) screws. Further research studies incorporating long-term follow-up assessments are needed to provide a more comprehensive understanding of complications, particularly in the context of varying anatomical reductions, and their impact on the development and severity of post-traumatic arthrosis. This investigation should aim to compare the outcomes between posterior buttress plating and anterior-posterior (AP) screw fixation.

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