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A Comparative Study in Management of Vertical Medial Malleolus Fractures by Cannulated Screw versus Plating Fixation

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ABSTRACT

Background: Fractures of the medial malleolus (MM) are involved in approximately 50% of all ankle fractures and can occur alone or as part of a bimalleolar or trimalleolar injury of the ankle. Medial-malleolar-fracture pattern consists of 57% transverse fractures, 26% oblique fractures, and 6% vertical fractures.

Aim of the study: To evaluate and compare consequence of vertical medial malleolar fracture managed with cannulated-screw fixation versus plating.

Patients and Methods: In this prospective cohort study including 20 patients were collected from the outpatient clinic of orthopedic Surgery departments Al-Azhar University Hospital & Assiut Police Hospital from April 2021 to May 2022 classified into two groups, Group (A): patients managed by cannulated screws and Group (B): patients managed by internal fixation by plates.

Result: Our results revealed that no significant difference between both groups (p-value > 0.05) regarding demographic data, mode of trauma and Lauge-Hansen classification highest frequency for SA II type (11 (55%) cases). Mean operative time was 30 minutes for group A and 45 minutes for group B, incidence of wound complications with high incidence for group B and functional outcomes Group B had a significant result in AOFAS and VAS with a significant difference between both groups (p-value < 0.05).

Conclusion: Plating Fixation strategy has showed that it is possible to produce good functional results with high rates of union and a low proportion of reported postoperative complications. However, in our trial plating fixation showed better functional results and low incidence of malunion.

Keywords: Medial Malleolar fracture; Cannulated screw fixation; Buttress plating.

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Authorship: All authors have a substantial contribution to the article.

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INTRODUCTION

According to the description performed by Shivaram and Pankovich in 1979 through cadaveric studies; observed that anatomical surgical of medial malleolus associated with complex ligamentous.¹

Medial Malleolus emerged from distal tibia that disconnected in pyramidal operation with smooth medial convex surface subcutaneous and vitreous lined cartilage concave articularily.²

Fractures of the medial-malleolus are common, with annual incidences ranging from 101 to 187 per 100,000.³ Several fixation techniques have been described for MM fractures, including partial thread unicortical screw, full thread bicortical screws, buttress or neutralization plates, and anchored

fixation.⁴ Important considerations when choosing a particular fixation technique are the geometry of the fracture and the degree of reduction.⁵

There are four classes of resulting injuries applied by Lauge-Hansen classification: supine external rotation (SER), pronated external rotation (PER), supinated adduction (SAD), and pronated abduction (PAB). The most common lesion pattern is HAIR (60%) followed by SAD (20%).⁶

Vertical osteotomy of the medial malleolus fracture were performed on distal tibia; with different fixation technique including two parallel porous unicortical bone screws, two divergent unicortical porous bone screws, two bicortical porous bone screws or parallel bicortical porous bone screw and Buttress plating fracture fixation.⁷

Traditionally, two-parallel partially threaded porous microspheres (4.0 mm diameter) are most often used for these two-fractures due to their minimal invasion of surrounding tissue.^{7&8} However, its use has been questioned due to instability, with a non-union rate of 20%, bone destruction and metal prominence.⁸ The non-slip plate construction provides the most rigid initial fixation and supports a higher fracture load. fracture of the medial malleolus in relation to fixation with monocortical and bicortical screws.⁹

This study aimed to assess and compare the consequence of vertical-medial-malleolus-fracture managed with cannulated-screw fixation versus plating through stability, rate of union and postoperative infection.

PATIENTS AND METHODS

In this prospective cohort study including 20 patients were collected from the outpatient clinic of orthopedic Surgery departments Al-Azhar University Hospital & Assuit Police Hospital from April 2021 to May 2022.

They were classified into two groups, each group included 10 patients; Group (A): patients managed by cannulated screws and Group (B): patients managed by internal fixation by plates.

The study group was under the following criteria; Age were 20 – 60, both sex, Right & Left leg and open Vertical Medial malleolar fractures patients were included; while Immuno-compromised patients, HCV & HBV, Cerebral disorders, fractures with vascular or nerve injury and comorbid diseases were excluded.

All patients included in this study were subjected to; Complete history, complete clinical examination, biological tests: complete blood count, random blood sugar, liver function test, renal function test, hepatitis marker and pro-thrombin time, concentration and INR. Also; Digital X-ray, Ankle Scan and MRI were performed.

Statistical analysis data were coded and entered using the Social Science Statistical Package (SPSS) version 26 (IBM Corp., Armonk, NY, USA). Data were pooled using mean and standard deviation for quantitative variables, frequencies (number of cases), and relative frequencies (percentages) for categorical variables. Comparisons between groups were made using an unpaired t-test. To compare categorical data, the chi-square test (2) was performed. Instead, the exact test was used when the predicted speed was less than 5. P values less than 0.05 were considered statistically significant.

Approval of the study protocol by the Ethical Scientific Committee of Al-Azhar and police hospitals was obtained from the patients which fully informed about all study procedures before enrollment.

RESULTS

20 patients the mean age was 50.27 for group A and 51.39 for Group B, with male: female ratio 3:2 for group A and 1:1 for group B. there was no significant difference between both groups (p-value > 0.05) regarding the demographic data. Mode of trauma Of the included 20 patients there was no significant difference between both groups (p-value > 0.05) regarding mode of trauma with high incidence of twisting (50% of all cases). Clinical Examination Of the included 20 patients there was no significant difference between both groups (p-value > 0.05) regarding mode of trauma with high incidence of twisting (50% of all cases). According to Lauge-Hansen classification there was no significant difference between both groups (p-value > 0.05) with highest frequency for SA type (11 (55%) cases from all 20 cases).

	Group A (Cannulated Screw) (10 cases)	Group B (Plating) (10 cases)	P-value
Age	50.27	51.39	0.851*
Gender	Male	6 (60%)	0.548#
	Female	4 (40%)	
BMI	33.25	34.78	0.082*
Smoking	3 (30%)	4 (40%)	0.078#
Twisting	5	5	0.064#
Fall from height	2	1	0.064#
Road traffic accident	3	4	0.064#
Side/Lauge-Hansen (Right)	5	6	0.054#
Side/Lauge-Hansen (Left)	5	4	0.054#
Side/Lauge-Hansen (SA II)	6	5	0.072#
Side/Lauge-Hansen (SA III)	2	3	0.072#
Side/Lauge-Hansen (SA IV)	2	2	0.072#

Table 1: Demographic data, Mode of Trauma and Clinical Examination

Operative time of the included patients the mean operative time was 30 min for group A and 45 min for group B with a significant difference between both groups (p-value < 0.05). Follow-up data Of the included patients the mean time for follow up was 21.84 months for group A and 23.37 months for group B with no significant difference between both groups (p-value > 0.05). Moreover, it took 2.5 months for complete union of group A and 2.1 months for group B with no significant difference between both groups (p-value > 0.05). The total incidence of union complications was 30% for Group A and 10 % for group B with a significant difference (p-value < 0.05) between both groups. Finally, there

was a significant difference (p-value < 0.05) between both groups regarding incidence of wound complications with high incidence for group B (plating Group). Causes of complication may be either 1) surgical factors like bad reduction of fracture, 2) patient factors like smoking, vascular disorders & malnutrition. Functional outcome regarding the functional outcomes Group, B (plating) had a significant better result in both AOFAS and VAS. Table 5 shows the detailed functional outcomes.

	Group A (Cannulated Screw) (10 cases)	Group B (Plating) (10 cases)	P-value
Duration for follow up(months)	21.84	23.37	0.062 *
Time to union (Months)	2.5	2.1	0.059 *
Operative time (min)	30	45	0.041 *
Union complications			
Delayed union	3	1	0.024 #
Non-union	0	0	
Superficial Wound Infection	0	1	0.042 #
AOFAS	92.45	96.84	0.025 *
VAS	3.76	0.15	0.01 *

Table 2: Operative time, Follow-up data and functional outcome.

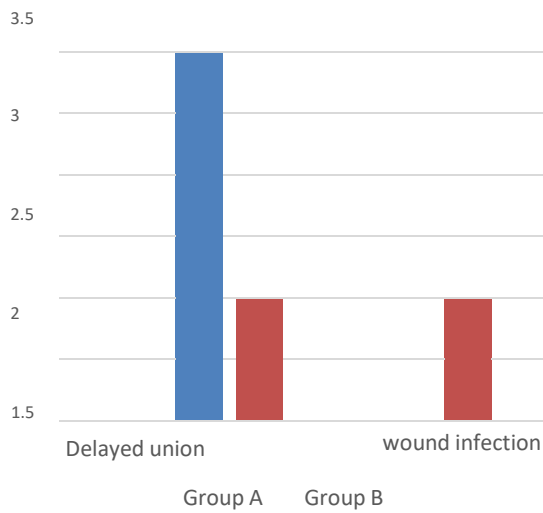


Fig. 1: Postoperative complications.

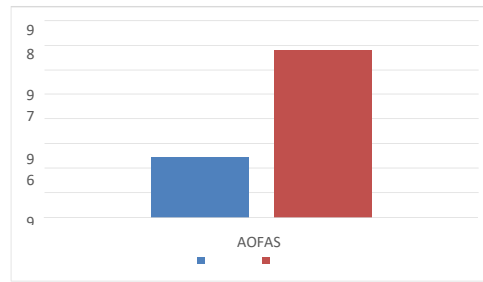


Fig. 2: AOFAS score.

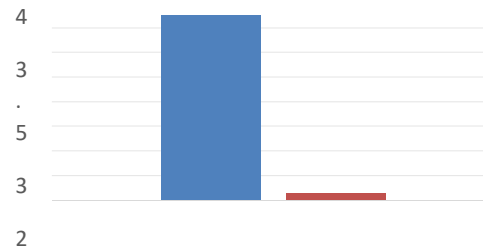


Fig. 3: VAS score

Case Presentation

Preoperative data: Male patient, 45 years old, smoker, worker, Co-morbidities: -ve Mode of Trauma: Falls to ground and Fracture side: closed right fracture.



Fig. 4: Preoperative assessment.



Fig. 5: Preoperative x-ray.

Anesthesia: Spinal and Operation: ORIF (plating).
and Operative time: 60 min.



Fig. 6: Postoperative Images.

Postoperative: Immediate postoperative X-rays were performed, Intact neurovascular status was verified and Intravenous broad-spectrum antibiotics were

prescribed for two days. Oral antibiotics were continued for one week.



Fig. 7: Follow-up X-rays.

Follow-up: Follow-up period 6 months. At 2 weeks: Stitches were removed. Patient could weight bear on the normal side with crutches. At 6 weeks: Infection and DVT were excluded clinically. Follow-up X-rays showed stable fixation. Touch weight-bearing with crutches was started. Patient was encouraged to do range of motion exercises.



Fig. 8: Post-operative x-ray.

At 12 weeks: Follow-up X-rays showed complete union. Full weight bearing was allowed. After 6 months: AOFAS was excellent.

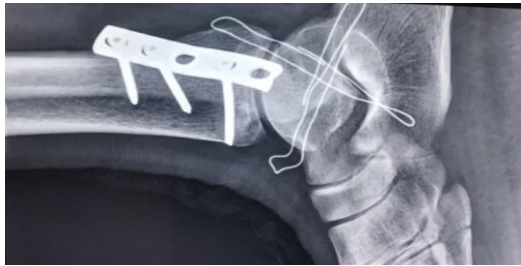


Fig. 9: 12 weeks follow up x-rays.

Preoperative data: Male patient, 24 years old, manual worker, non-smoker, Co-morbidities: -ve, Mode of Trauma: RTA and Fracture side: open left fracture.



Fig. 10: Preoperative x-ray.

Anesthesia: Spinal. Operation: Open reduction and Cannulated screws were used to fix the fracture. Postoperative: Intact neurovascular status was verified. Intravenous broad-spectrum antibiotics were prescribed for two days. Oral antibiotics were continued for one week. Follow-up: Follow-up period 6 months. At 2 weeks: Stitches were removed and Patient could weight bear on the normal side with crutches. At 6 weeks: Infection and DVT were excluded clinically. Follow-up X-rays showed stable fixation. Touch weight-bearing with crutches was started. Patient was encouraged to do range of motion exercises.



Fig. 11: Follow-up images.

At 12 weeks: Follow-up X-rays showed complete union (). Full weight bearing was allowed. After 6 months: AOFAS was excellent.



Fig. 12: 12 weeks follow up x-rays.

DISCUSSION

Isolated medial malleolus fractures are commonly treated surgically in order to reduce the risk of articular incongruity, instability, nonunion, and posttraumatic arthritis. The clinical and radiologic outcomes of surgically treated medial malleolus fractures have been documented in several publications. However, some research suggests that fractures of the medial malleolus can be treated conservatively¹⁰

The objective of therapy for vertical medial malleolus fractures is to get the patient's ankle function back to where it was before the accident. Stable reduction and reasonably early weight bearing and motion are the most prominent ways for reaching this aim. Although the ankle joint is a tiny articular surface, it absorbs a considerable load during walking, hence it is critical to reduce it. This study was aim to assess and compare the consequence of vertical-medial-malleolus-fracture managed with cannulated-screw fixation versus plating through stability, rate of union and postoperative infection.

Small patient groups have been used in this study of medial malleolus fractures. There is still no agreement on the rationale for operational intervention, the categorization of these fractures, the functional outcomes of treatment, the operating method, or the treatment plan.

The mean age was 50.27 for group A and 51.39 for Group B, with male: female ratio 3:2 for group A and 1:1 for group B. there was no significant difference between both groups (p-value > 0.05) regarding the demographic data.

According to Herskovic et al.,¹¹ conservative treatment of isolated median sulcus fractures leads to a high degree of healing and satisfactory functional results.⁷ Therefore, surgical treatment of open fractures should be reserved for bipolar or tripolar fractures.

There was no significant difference between both groups (p-value > 0.05) regarding mode of trauma with high incidence of twisting (50% of all cases).

Hoelsbraken et al.¹² used noninvasive follow-up monitoring for medial malleolus fractures occurring in bimalleolar and trimalleolar fractures. They found that surgical fixation of the lateral malleolus gave good results for medial fissure fractures with a displacement of less than 2 mm. However, due to the high incidence of posttraumatic and posttraumatic arthritis, these patients required long-term follow-up.

Internal fixation of the medial malleolus has been documented using various methods. However, the most common mounting techniques are foam mounting screws and bare wire.^{9&10}

Previous research has demonstrated the biomechanical advantages of both fixation systems. However, there is no clear evidence for the best clinical approach. This results in less irritation of the deltoid-ligament and subcutaneous tissue than other fixators, leading to fewer implant-related issues.¹³

The goal of treatment of a medial malleolus fracture is to restore the patient's pre-injury ankle function. Constant lowering, weight bearing and early shifting are the primary means of achieving this. Although the ankle is a small joint surface, it requires a lot of stress when walking, so it needs to be reduced.¹⁴

Patients there was no significant difference between both groups (p-value > 0.05) regarding mode of trauma with high incidence of twisting (50% of all cases). According to Lauge-Hansen classification there was no significant difference between both groups (p-value > 0.05) with highest frequency for SA II type (11 (55%) cases from all 20 cases)

According to several studies, complete fixation with a conical cortical screw is superior to simple, narrow cortical procedures in terms of holding strength.¹⁵

The mean operative time was 30 min months for group A and 45 min for group B with a significant difference between both groups (p-value < 0.05).

Lareau et al.,¹⁶ of 490 patients enrolled, compared the association rate of 32 patients who had only percutaneous medial fixation with 458 patients who

underwent open reduction and internal fixation. The degree of association in the open reduction group was 92.4% at eight weeks versus 71.9% in the skin group (p. 0.001). The implanted periosteal flap remains closed during the rotational aspect of the injury and, according to the authors, is certainly not repairable after percutaneous fixation.

The mean time for follow up was 21.84 months for group A and 23.37 months for group B with no significant difference between both groups (p-value > 0.05).

Compared to our annotated study for included patients, the median time to continuation was 21.84 months for group A and 23.37 months for group B, with no significant difference between the two groups (p value > 0.05).

Maniar et al.¹⁷ recommend the use of 40-45 mm screws. On the other hand, screws that are too short may not work very fast and cause distraction instead of the expected voltage. In a study of 116 cadaveric rods, Labronky and colleagues found that the mean distance from the medial fork tip to the distal tibial canal was 55 mm and there was no need to increase screw length beyond 45 mm.¹⁸

King et al.¹⁸ investigated four sets of fixations in an artificial bone model for the treatment of simulated lateral head fractures. Fastening with parallel, single-layer, parallel, or double-point bolting was more rigid and withstood higher shear stresses than non-slip coatings.

Finally, there was a significant difference (p-value < 0.05) between both groups regarding incidence of wound complications with high incidence for group B (plating Group) and this occurred due to either tobacco smoking, peripheral vascular disease, malnutrition.

To the best of our knowledge, no studies on the efficacy of employing headless compression screws to fix medial malleolar fractures have been published.

These screws have lately been utilized to treat olecranon, midfoot, and talar neck fractures and fusions. Traditional procedures have drawbacks, such as post-operative soft tissue irritation and significant non-union rates, as previously mentioned. The goal of this study was to evaluate clinical outcomes in patients in order to identify the efficacy of employing cannulated screws to minimize the rate of non-union and pain in comparison to open reduction and internal fixation by plating (ORIF).

Overall, we discovered a considerable reduction in non-union rates, since all fractures in our trial healed without the need for extra treatment.¹⁹

CONCLUSION

Despite its flaws, the results of this study show that the cannulated screws and plating may be used to treat medial malleolus fractures. Plating fixation has showed that it is possible to produce good

functional results with high rates of union and low proportion of reported postoperative complications. Our study observed that plating fixation showed better functional results, high stability, no postoperative skin infection and low incidence of malunion.

Conflict of interest : none

Limitations

First; small scale of included patients, second; different initiative strategies available nowadays and third; many different factors were not examined. Further studies were needed for the identification of high-risk age patients for cannulated screw and plating fixation.

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