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Comparative study between percutaneus and open reduction with internal fixation of medial malleolar fracture by lag screw in adults

M.A.Abd El Ghany[1], M.A.Mashhour[1], M.E.Al-Ashhab[1] and H.E.Farag[2]
[1]Orthopedic Surgery, Dept., Faculty of Medicine, Benha Univ., Benha, Egypt
[2]Orthopedic Surgery, Dept., Faculty of Medicine, Ain Shams Univ., Cairo, Egypt
Email:

Abstract

Background: Aim of the Work: to compare results of treatment with percutaneous method and ORIF by lag compression screw method in medial malleolar fracture in adults. Patients and Methods: This prospective comparative study included 20 patients with medial malleolar fracture, they were divided into two groups; group A was reduced by closed method and group B was treated by ORIF by lag compression screw. They were recruited and assessed for eligibility from orthopaedic surgery department at El-Salam hospital and Benha University hospital. Results: Regarding the demographic data in all patients, the mean age of the recruited patients was 33.30 years old and that 65% of patients were males and 35% were females. Regarding the side and associated fractures in all patients, our results indicated equal distribution of fractures (50% right and 50% left side). The majority of patients (45%) have isolated medial malleolar fractures, however, 35% of patients have associated lateral malleolus fracture, 15% have associated trimalleolar fracture and 5% have associated femur fracture. Conclusion: Both closed reduction percutaneous fixation and open reduction internal fixation resulted in acceptable radiographic outcomes and low complication rates for the treatment of medial malleolar fractures. The advantages of the percutaneous fixation are the avoidance of potentially excessive soft tissue dissection associated with the open approach; however, it is associated with higher rates of delayed union due to the limited visualization. The advantages of ORIF method include being highly satisfactory in most patients and good functional outcome, however, it is associated with skin necrosis, infections, and wound healing disorders.

Keywords: Percutaneus, internal fixation, medial malleolar fracture, lag screw adults.

1 .Introduction

Ankle fractures are the second most common orthopaedic trauma presentation, accounting for approximately 10% of all fractures presenting at hospitals. The annual incidence of ankle fractures is approximately 122–184/100,000 person years (1:800) all over the world. Ankle fracture are usually caused by a rotational injury, where the ankle becomes twisted, turned or rolled while walking or running, such as during sports activity. But they can also be caused by a high-force impact, such as fall from height or automobile collision **[15]; [5]; [17]; [21].**

Lauge-Hansen describes the position of the foot at the time of injury (i.e. supination or pronation) and described the deforming force direction (i.e. abduction, adduction, or external rotation) to reavel the princepales of redication such fracture. The goal of the treatment is to restore the normal anatomy and function the ankle joint throw anatomical reduction and functional to avoid the posttraumatic complications in a weight bearing ankle joint **[23]**.

Several fixation techniques for medial mallellous fractures have been described, including unicortical partially threaded compression screws, bicortical fully threaded screws, buttress or neutralization plating, and tension band fixation. Important considerations when deciding on a particular fixation technique include fracture geometry and the extent of comminution. These fixation techniques typically involve a traditional open approach to fracture reduction and fixation. Although a variety exists regarding fixation options, a percutaneous approach to medial mallellous fixation has not been included in recommendations put forth by the AO group. Percutaneous and minimally invasive approaches to medial mallelous fracture fixation have been previously described. In comparison to an open technique, a percutaneous approach offers the potential advantage of decreased surgical morbidity, decreased postoperative pain, and decreased risk of wound complications. However, without direct fracture visualization and fracture site débridement, it is possible that acceptable reduction could be hindered, leading to higher rates of nonunion and malunion **[3].**

2. Aim of the Work

To compare results of treatment with percutaneous method and ORIF by lag compression screw method in medial malleolar fracture in adults.

3 .Patients And Methods

Study Design: Description: A prospective comparative study, **Duration of the study:** This study was conducted during a period of six months starting from January 2021 till September 2021, **Number of subjects:** Totally twenty patients with medial malleolar fracture were included in this study and **Study setting**: This study was conducted at the El-Salam specialized hospital in El-Salam City, Cairo, Egypt and in Benha University hospital in Benha City, Qalyubiyya Governorate, Egypt.

Study subjects: The present study included 10 cases treated by ORIF method and 10 cases treated by closed reduction with percutaneous fixation method. Thirteen males and 7 females were included. Ten cases were right side while 10 cases left side. Regarding the associated fractures, 10 cases have isolated fracture, 7 cases have associated lateral malleolus fracture and 3 cases have associated trimalleolar fracture. Follow up

period ranged between 3 to 9 months from januray till September 2021. Associated fracures included lateral mallellous, ankle dislocation and trimalleolar fracture.Time elapsed between onset of trauma and surgical interference from the first 24 hour or after one week to prevent wound dehescience. The mean age of the included cases was 33.30±9.61 with age range 19-55 years old.

Subjects of this study were recruited according to the inclusion and exclusion criteria as following:

Inclusion criteria

Age group (18-60) years. Cases less than 18 years old were not included to avoid physeal injury , 2) Unstable fracture of ankle with or without dislocation of the ankle joint requiring operative intervention, 3) Closed injury, 4) Weber B and Weber C fractures and 5) Surgery date within 2 weeks of date of fracture.

Exclusion criteria

Additional lower limb injury which may impact on patient rehabilitation, 2) Open fracture, 3) Confirmed severe associated neurovascular injuries, 4) Distal tibial intra-articular fractures (Pilon-type injuries) and 5) Patients medically unfit for surgery.

Table (1) Demographic data in all patients

		No	%
Sex	**Female**	7	35.0%
	Male	13	65.0%
Age	**Mean± SD**	33.30 ± 9.61	
	Range	19 -55	

Table (2) Side and Associated Fractures in all patients

		No	%
Side	**Left**	10	50.0%
	Right	10	50.0%
Associated Fractures	**Isolated**	10	50.0%
	Lateral mallellous	7	35.0%
	Trimallellar	3	15.0%

Table (3) Type of fixation in all patients

		No	%
Type of fixation	Orif by lag screw	10	50.0%
	Percuteneus	10	50.0%

Assessment: Patients fulfilling the inclusion criteria were divided into two groups; the first group was reduced by percutaneous method and the second group was treated with open reduction with internal fixation (ORIF) by lag compression screw. Patients were subjected to the following:

Preoperative Evaluation:

a) Clinical evaluation: Detailed sheets were taken for all patients including: Personal history including age, sex, and occupation, special habits of medical importance, pre-injury function and hand dominance, history of present illness, mechanism of injury, side affected, time since injury, previous treatment, sensory and motor power affection in the injured limb, perceived ability to participate in a structured rehabilitation program, associated injury, past history and medical comorbidities and local and brief neurovascular assessment of the affected limb.

b) Radiological evaluation: All patients were examined radiologically by: Standard antero-posterior (AP) view and lateral view and mortise view.

The aim of the radiological evaluation was to identify the fracture pattern. The same views were also used in the follow-up clinics 12 weeks after surgery, to evaluate

bone healing as part of hospital ankle fracture protocol. The decisions made for radiographic evaluation were based on radiological union, disappearance of the fracture line, and appearance of a bridging callus.

c) Intervention: A single dose of a prophylactic broad spectrum antibiotic treatment, a third generation cephalosporin, was given one hour before surgery. The operation was done under spinal anesthesia. Pneumatic tourniquet to the upper thigh was applied. The patient was positioned supine with a bloster underneath the buttock of the affected side.

Fixation

a) Open reduction and internal fixation (ORIF)

Draping and surgical approach: The skin over lower leg, ankle and entire foot were prepared with aqueous povidone-iodine solution. The skin incision plane was drawn using a skin marker. Tape around toes was applied to minimize the risk of infection. Standard draping around lower leg in calf region was applied.

Surgical technique: For patients assigned for open reduction and internal fixation (ORIF), an incision was made slightly posterior to the medial malleolus, in line with the tibia, and curves it anteriorly distally to form a "J" incision, The skin with the subcutaneous tissue was retracted to preserve the blood supply to the area. The flaps of skin were separated to expose the fracture positions, followed by clearance of hematoma and soft tissues at the ends of the fracture and Using a periosteal elevator, the interposed periosteum was removed from the fracture site. The medial malleolus fracture was debrided and reduced by reduction clamp under direct visualization (Figure 1).

Fixation was then performed with two 4mm partially threaded cancellous lag screw (35–45 mm length) inserted at 90° to the fracture. Good reduction of the fractures was confirmed by a C-arm device.

Closure: The wound was thoroughly irregarted and achieved haemostasis. The fascia was left open. The subcutaneous fascia was closed using 2.0 PDS/ Vicryl. Skin closure was achieved using 3/0 subcuticular monofilament suture (Figure 2).

Fig.(1) A 'J' incision curved anteriorly is performed slightly posterior to the medial malleolus, exposing the fragment.

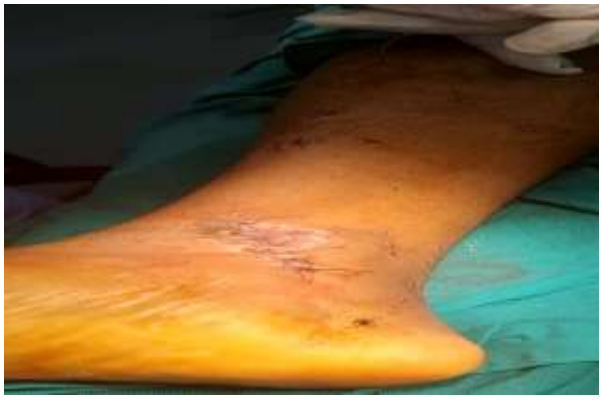

Fig.(2) Skin closure.

Post-operative treatment: A short leg posterior plaster splint with foot at 90° was applied. The neurovascular status of the extremity was assessed. Post-operative AP and lateral radiographs were obtained. Early active movement of toes at 24-48 hours after the surgery was examined. All patients received antibiotics anti oedematous for 10 days post-operatively. Analgesics and anti-coagulant medications were delivered.

b) Closed reduction and percutaneous fixation (CRPF)

Draping and surgical approach: The skin over lower leg, ankle and entire foot were prepared with aqueous povidone-iodine solution. Tape around toes was applied to minimize the risk of infection. Standard draping around lower leg in calf region was applied.

Technique: For patients assigned for closed reduction and percutaneous fixation (CRPF), no incision was made for fracture reduction. Closed reduction of the fracture was done according to the nature of the fracture classification type then reduction is maintained by a pointed reduction clamp was applied percutaneously from the tip of the malleolus to the distal tibia to reduce the fracture so that the fracture sites were close to or in full compliance with the conditions of anatomical reduction, the reduction was checked by the image intensifier in the lateral and antero-posterior views. The medial malleolus was divided into three zones on the base of anatomic landmarks. Zone 1 is the anterior colliculus; Zone 2 the intercollicular groove; and Zone 3 the posterior colliculus. The screws were introduced in zone 1 and 2 to avoid injury of posterior tibial tendon and guidewires were inserted to enable passage of cannulated screws through stab incisions and that was fluoroscopically guided. Good reduction of the fractures was confirmed by a C-arm device (Figure 3).

Fig.(3) Closed reduction through percutaneous technique and imaging to check adequate reduction intra-operatively.

Fig.(4) Percutaneous approach in the treatment of medial malleolar fracture.

In transverse fractures, two 1.8 mm K-wires were introduced from the malleolus tip in an antero-inferior to postero-superior direction and perpendicular to the fracture line. In the longitudinal fracture, the two wires were inserted parallel to the ankle and perpendicular to the fracture**.**

A 2.7 mm drill bit was introduced through a 3 mm skin incision in the direction of previously introduced k-wire. A suitable length of a 45 mm partially threaded cancellous screw was introduced into the previously drilled hole. Another screw was then inserted using the same technique. The two small set 4 mm cancellous screws were advanced and tightened till achieving adequate compression at the fracture site (Figure 4).

Post-operative treatment: A short leg posterior plaster splint with ankle elevation was applied to diminish postoperative edema. The neurovascular status of the extremity was assessed. Post procedure AP and lateral radiographs were obtained. Ankle movement was allowed employing an ankle brace. All patients received antibiotics, anti oedematous for 10 days post-operatively. Analgesics and anti-coagulant medications were delivered.

Rehabilitation: Partial weight-bearing then fully weight-bearing.

d) Post-operative evaluation: The injury was dressed every day other day using betadine and saline and slab below knee was applied. All patients received antibiotics, anti oedematous from 7 to 14 days post-operatively. Analgesics and anti-coagulant medications were delivered, stitch removal occured after 2 weeks. The patients were followed up for at least 12 weeks and evaluated clinically and radiologically. All patients were placed in a splint at the time of surgery for 2 weeks. At 2 weeks, sutures were removed and patients were placed in a short leg cast and kept non weight-bearing for another 4 weeks, at 6 weeks postoperatively, the general protocol enabled patients to remove the cast and begin weight-bearing as tolerated in a controlled ankle motion boot. If there was concern for fracture healing, the non–weight bearing period was extended by 2 to 6 weeks and patients were examined with special attention paid to wound inspection, neurovascular examination, palpation for tenderness, and active and passive range of motion. Radiographs were taken at each follow-up visit at 2 weeks, 4 weeks, 6 weeks, 8 weeks, 10 weeks and 12 weeks post-operatively and included AP, lateral, and mortise views of the ankle. Radiographs were evaluated for maintenance of reduction, failure of fixation, and evidence of fracture line.

Study Evaluations: Demographic characteristics of the studied cases, intraoperative Complications and Limitation of movement in all patients, functional assessment post-operatively and pain during movement,

incidence of infection and hardware removal in all patients.

Ethical Consideration: Written consent was taken from patient before including them in the study, aims of the study and any possible risk were discussed with patient and privacy of the collected data was assured.

Data Management: Data were collected, coded, revised and entered to the Statistical Package for Social Science (IBM SPSS) version 20. The data were presented as number and percentages for the qualitative data, mean, standard deviations and ranges for the quantitative data with parametric distribution and median with inter quartile range (IQR) for the quantitative data with non-parametric distribution.

Chi-square test was used in the comparison between two groups with qualitative data and **Fisher exact test** was used instead of the Chi-square test when the expected count in any cell found less than 5

Independent t-test was used in the comparison between two groups with quantitative data and parametric distribution and **Mann-Whitney test** was used in the comparison between two groups with quantitative data and non-parametric distribution.

The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following: $P > 0.05$: Non significant (NS), $P < 0.05$: Significant (S) and $P < 0.01$: Highly significant (HS)

4. Results

At the end of the study all patients were evulated radiolgically and fuctionally to evualte the degree of success and satisfaction. Result of surgical of interference evaluated through two method:

1- Radiological by x-ray and special viwes like oblique Mortise view. Reduction evaluated by x-ray to assess the step off joint according to:

1-Excellent: no step off or anatomical reduction

2-Good: 1-2mm step off

3- Poor: >2mm step off

Group a: 3 cases are excellent,4 are good and 3 cases are poor.

70% satificatiory and 30% unsatificatiory results.

Group b :4 cases are excellent,4are good and 2 cases are poor.

80% satificatiory and 20% unsatificatiory results.

2-Functional :we use the american orthopedic of ankle and foot society score (AOFAS Score) include the ankle and hind foot,we use the ankle score divided into two groups

- **Group A :** the large score is 88 and the least is 68 and the mean 77.
- **Group B:** the large score is 90,the least is 66 and the mean is 74.

Over all the results of 20 cases as 15 patients in our study were satisfied and 5 were unsatisfied.

- **Group a:** 3 cases are excellent,4 are good and 3 cases are poor.
- 70% satificatiory and 30% unsatificatiory results.
- **Group b:** 4 cases are excellent,4are good and 2 cases are poor.
- 80% satificatiory and 20% unsatificatiory results.

Table (4) Demographic data among type of fixation

		Type of fixation				Chi square test\	
		Group (B) orif by lag screw (open reduction) (No.=10)		Group (A) Percuteneus (No.=10)		Independent t test	
		No	%	No	%	x^2\t*	p value
Sex	Female	4	40.0%	3	30.0%	0.22	0.639
	Male	6	60.0%	7	70.0%		
Age	Mean± SD	33.00 ± 11.19		33.60 ± 8.34		-0.136*	0.893

This table showed that there was no statistically significant difference between type of fixation among demographic data

Table (5) Side and associated Fractures among type of fixation.

		Type of fixation				Chi square test	
		Group (B) orif by lag screw (open reduction) (No.=10)		Group (A) Percuteneus (No.=10)			
		No	%	No	%	x^2	p value
Side	Left	6	60.0%	4	40.0%	0.8	0.371
	Right	4	40.0%	6	60.0%		
Associated Fractures	Isolated	٦	٦0.0%	4	40.0%		
	Lateral mallellous	3	30.0%	٥	٥0.0%	4.254	0.513
	Trimallellar	1	10.0%	1	10.0%		

This table showed that there was no statistically significant difference between type of fixation among Side and associated Fractures.

Table (6) Intraoperative Complications and Limitation of movement among type of fixation.

		Type of fixation Group (B) orif by lag screw (open reduction) (No.=10)		Group (A) Percuteneus (No.=10)		Chi square test	
		No	%	No	%	x^2	p value
Intraoperative Complications	**Long time**	2	20.0%	0	0.0%	2.222	0.136
	No	8	80.0%	10	100.0%		
Limitation of movement	**Limited dorsiflexion**	3	30.0%	3	30.0%	0.000	1.000
	No	7	70.0%	7	70.0%		

This table showed that there was no statistically significant difference between type of fixation among intraoperative Complications and Limitation of movement.

Table (7) Loss of reduction and Delayed or non-union among type of fixation

		Type of fixation Group (B) orif by lag screw (open reduction) (No.=10)		Group (A) Percuteneus (No.=10)		Chi square test	
		No	%	No	%	x^2	p value
Loss of reduction	**No**	10	100.0%	10	100.0%	NA	NA
Delayed or non-union	**Delayed**	2	20.0%	4	40.0%	0.952	0.329
	United	8	80.0%	6	60.0%		

Table (8) Pain during movement and Hardware removal among type of fixation

		Type of fixation Group (B) orif by lag screw (open reduction) (No.=10)		Group (A) Percuteneus (No.=10)		Chi square test	
		No	%	No	%	x2	p value
Pain during movement	**No pain**	8	80.0%	6	60.0%	0.952	0.329
	Painful	2	20.0%	4	40.0%		
Hardware removal	**No**	10	100.0%	10	100.0%	NA	NA

This table showed that there was no statistically significant difference between type of fixation among Pain during movement and Hardware removal

Table (9) Infection and Constant - Murley score among type of fixation.

		Type of fixation Group (B) orif by lag screw (open reduction) (No.=10)		Group (A) Percuteneus (No.=10)		Chi square test\ independent t test	
		No	%	No	%	x^2\t*	p value
Infection	**Mild infection**	2	20.0%	4	40.0%	0.952	0.329
	No	8	80.0%	6	60.0%		
Constant - Murley score	**Mean± SD**	3.80	3.01	1.40	0.70	2.455*	0.024

This table showed that there was statistically significant increase Constant - Murley score in orif by lag screw in comparison to percuteneus

Table (10) Ankle fracture score among type of fixation.

Aofas ankle-hindfoot score
1-pain(40 points)
-none =+40
-mild,occasional =+30
-moderate,daily =+20
-severe,almost always present =+0
2-function(50 points)
a-activity limitation,support requirement
-no limitation,nosupport =+10
-no limitation of daily activities,limitation of recreational activities,no support =+7
-limited dailyand recreational activities,cane =+4
- nolimitation of daily activities,limitation of recreational activities,walker,crutches,wheelchair,brace =+0
b-maximum walking distance ,blocks
-greater than six =+5
-four- six =+4
-one-three=+2
-less than one =+0
c-walking surfaces
-no difficulty on any surface =+5
-some difficulty on un even terrain ,stairs ,inclines ,ladders =+3
-severe difficulty on un even terrain ,stairs .inclines,ladders =+0
d-gait abnormalities
-none,slight =+8
-obvious =+4
-marked =+0
e-sagittal motion (flexion plus extension)
-normal or mild restriction (30or more)=+8
-moderate restriction (15-29)=+4
Severe restriction (less than 15)=+0
f-hindfoot motion (inversion plus eversion _
-normal or mild restriction (75-100 normal)=+6
-moderate restriction (25-74)=+3
-marked restriction (less than 25)=+0
g- ankle –hindfoot stability (anteroposterior,varus-valgus)
-stable =+8
-definitely unstable =+0
3-aligment (10)
-good,plantigrade foot ,ankle hind foot well aligned =+10
-fair ,plantigrade foot ,some degree of ankle hind foot mal alignement =+5
-poor ,non plantigrade foot ,severe malalignement symptoms =+0
4- total score (100)
- -------pain points+
- ----function points +
- - --------alignement=
- Total points /100

		Type of fixation					
		Group (B) orif by lag screw (opern reduction) (No.=10)		**Group (A) Percuteneus (No.=10)**		**Chi square test\ independent t test**	
		No	**%**	**No**	**%**	**x^2\t***	**p value**
Ankle fracture score	**Good**	9	90%	6	60%	7.544	.027
	Fair	1	10%	4	40%		
	Mean ±SD	68.7	5.14	73.8	4.66	2.323	0.032

This table showed that there was statistically significant increase good ankle fracture score in orif by lag screw (open reduction) in comparison to percuteneus.

5.Case Presentation

Case 1

A.History:

Male patient 34 years old and Mode of trauma: ankle twisting injury

B.Preoperative evaluation:

Fracture type: medial malleolus fracture, Side affected: The left side, concomitant diseases: no history of medical illness, no associated injuries, time Elapsed between trauma and surgery after 1 day and follow up for three Monthes Fig (5-6-7)

Fig. (5)Preoperative X.ray (anteroposterior and lateral view)

Fig. (6) Immediate postoperative X.ray (anteroposterior & lateral views)

Fig. (7)3months follow up

Group B

Case 1

a.History: Male patient 33 years old and mode of trauma: ankle twisting injury

b.Preoperative evaluation: fracture type: medial malleolus fracture and lateral mallellous, side affected: The left side, concomitant diseases: no history of medical illness, no associated injuries, time Elapsed between trauma and surgery after 1 day and follow up for three months Fig (8-9)

Fig (8) Preoperative x.ray (anteroposterior &lateral)

Fig. (9)3months follow up.

6. Discussion

Medial malleolar fractures can be treated with either ORIF or by percutaneous approach. However, both methods are associated with a considerable number of complications. The aim of the present study is to compare results of percutaneous and open reduction with internal fixation by lag compression screw in medial malleolar fracture in adults**.**

This prospective comparative study included 20 patients with medial malleolar fracture, they were divided into two groups; group A was reduced by closed method and group B was treated by ORIF by lag compression screw. They were recruited and assessed for eligibility from Orthopaedic Surgery Department at El-Salam specialized hospital in El-Salam City, Cairo, Egypt and in Benha University hospital in Benha City, Qalyubiyya Governorate, Egypt. Regarding the demographic data in all patients, our results indicated that the mean age of the recruited patients was 33.30 years old and that 65% of patients were males and 35% were females. Such findings were in agreement with **Toth et al. [24]** that indicated that the incidence of ankle fractures is similar between males and females with a bimodal distribution: there is a peak between 20 and 40 years of age (predominant males following high-energy trauma) and a second peak between 50–70 years of age (females, linked to low-energy trauma). Additionally, a previous study by **Juto et al. [11]** indicated that females have an increased incidence of ankle fractures during their life, mainly between the ages of 30 and 60 while men have more of an even incidence of ankle fractures throughout their life. Regarding the side and associated fractures in all patients, our results indicated equal distribution of fractures (50% right and 50% left side). Our results indicated the majority of patients (45%) have isolated medial malleolar fractures, however, 35% of patients have associated lateral malleolus fracture, 15% have associated trimalleolar fracture and 5% have associated femur fracture. Such findings were in agreement with **Hu et al. [9]** that indicated that medial malleolar fracture-related characteristics included 37.3% of patients had associated lateral malleolus fracture and 35.5% of patients had associated trimalleolar fracture. Contrarily, **Agarawal et al. [1]** study that indicated that right side medial malleolar fractures is more prevalent in comparison with the left side. Similarly, **Jain et al. [10]** indicated that 60% of medial malleolar fractures are in the right side and 40% in the left side. Regarding the intraoperative complications and limitation of movement in all patients, our results indicated that 10% of patients' intraoperative complications were long operative time and that 30% of patients' limitation of movement was limited dorsiflexion. Such finding was in agreement with **Gaurav et al. [7]** that compared the functional outcome of ankle joint after medial malleolar fractures treated with ORIF with tension band wiring and lag screws and found that patients treated with ORIF lag screw had significant limited dorsiflextion.

Additionally, a previous study by **Mohammed et al. [14]** indicated that limitation of movements and swelling of the ankle are usually the result of neglect in treatment of soft tissue. Our results indicated that all patients had no loss of reduction, and 30% of patients had delayed union. Such findings were in agreement with **Hu et al. [9]** that indicated that the incidence of delayed union, and malunion among patients with medial malleolar fracture were 20.3% and 4.4%, respectively and that the high-energy injury, vertical fractures or comminuted fractures, bi- or trimalleolar fractures, fair or poor reduction, and interposed soft tissue are factors that resulted in delayed union. Additionally, **Matson et al. (2017a)** reported that patients who underwent operative fixation of closed ankle fractures demonstrated a high incidence of delayed union (61.6%). Regarding the pain during movement and hardware removal in all patients, our results indicated that 30% of patients expressed pain during movement and all patients had no hardware removal. In explanation of such pain, a previous study by **Hu et al. [9]** indicated that chronic pain and limited range of motion post-operatively could be caused by the nonunion and delayed union that lead to inferior functional score of the treated ankle. Additionally, **Hanhisuanto et al. [8]** indicated that several risk factors for inferior function following medial malleolar fracture treatment including age >60 years, smoking history and female gender. Moreover, a previous study by **Reith et al. [18]** indicated that there are no specific guidelines regarding whether hardware should be removed or not and that hardware removal from the ankle is the most common site of removal due to the small amount of overlying subcutaneous tissue resulting in palpable hardware that can be symptomatic with foot wear and activity. Contrarily, **Egol et al. [5]** indicated significant increases in the proportion of individuals with no pain between the 3- and 6-month following ankle fracture surgery evaluations and between the 6- and 12-month evaluations. Regarding the demographic data among type of fixation, our results indicated no statistically significant difference regarding patients' gender and age (P value>0.05). Such findings were in agreement with **Matson et al. (2017)** study that compared ORIF versus percutaneous fixation for medial malleolus fractures and found no statistically significant difference between both groups regarding the demographic characteristics. Similarly, **Hu et al. [9]** indicated no statistically significant difference between the ORIF group and percutaneous fixation group regarding age, sex, mean BMI, alcohol use, tobacco use, diabetes mellitus, and fracture-related characteristics. Our results indicated no statistically significant difference between type of fixation among side and associated fractures (P value>0.05). Such findings were in agreement with **Weinraub et al. [25]** study on the management of medial malleolar fractures that indicated no statistically significant differences between the ORIF group and subcutaneous group regarding the involved fractures side. Our results indicated no statistically significant difference between type of fixation regarding intraoperative complications and limitation of movement (P value>0.05). Such findings were in disagreement with **Gamal and Shams, [6]** that indicated that the operative time was significantly shorter with percutaneous fixation when compared to the time needed for the traditional ORIF technique. Our results indicated no statistically significant difference between type of fixation regarding loss of reduction and delayed or non-union (P value>0.05). Such findings were in agreement with **Matson et al. [12]** that indicated that there was no statistically significant difference observed between the closed reduction percutaneous fixation method and ORIF groups regarding outcomes, including nonunion, mal union, time to union, rate of hardware removal, and wound complications. However, such findings were in disagreement with **Weinraub et al. [25]** that indicated the fixation of medial malleolar fractures using ORIF was superior to fixation using percutaneous fixation method and that ORIF should remain the treatment of choice for healthy patients free of bone and wound healing risk factors. Our results indicated no statistically significant difference between type of fixation regarding incidence of infection (P value>0.05). Such findings were in agreement with **Matson et al. [12]** that indicated that in the treatment of medial malleolar fractures there was no significant difference between using the ORIF method and closed percutaneous method regarding the incidence of infection. Contrarily, a review study by **Zaghloul et al. [26]** indicated the increased incidence of infection among ORIF group especially surgical site infection, particularly in elderly patients who have contributing risk factors such as diabetes, immunosuppression and peripheral vascular disease. Additionally, a previous study by **Ovaska et al. [16]** indicated that the open reduction method has 6.8% incidence of deep infection and that diabetes, alcohol abuse, fracture-dislocation and soft-tissue injury (Tscherne grade of ≥1) are significant patient-related risk factors for infection**.**

The advantages of percutaneous approach include less invasive approach, less soft tissue dissection and decrease the risk of the wound healing complications in comparison with ORIF. So it is more suitable in patients with comorbidities such as osteoporosis, diabetes, peripheral vascular disease, and tobacco smoking. Reduction is achieved using reduction clamp under C arm control. The time of operation is shorter in comparison with the ORIF method. On the other hand, delayed union and non-union are more common in the percutaneous approach due to the periosteal flap and soft tissue interposition that lead to healing retardation**.**

ORIF is better than closed reduction method, ORIF by ankle sore range from 66 -90 while closed reduction score ranged from 65 -80.

In treating medial malleolar fractures, restoration of anatomical alignment is highly essential. This is because only a slight variation from normal is incompatible with good joint function. ORIF method include direct visualization of the fracture and better reduction of the

fractured bones and efficient removal of periosteal flap and soft tissue that lead to better union, therefore, ORIF method is superior over closed treatment. However, the incidence of infection is more common among the ORIF patients in comparison with the closed method**.**

First cases treated with either ORIF or closed method needed longer operation time in comparison with the last cases, so, more experience is gained that is reflected by the shorter operation time among the last cases**.**

Study limitations: The limitations of our study include the short follow up as the radiographic follow-up in our study was limited to 12 weeks and thus could not capture the long-term outcomes of fracture healing**.**

Future prospective: ORIF method is superior over percutaneous treatment due to the direct visualization of the fracture that lead to proper reduction and proper removal of periosteal flap and soft tissue that lead to efficient union.

7. Conclusion

Both closed reduction percutaneous fixation and open reduction internal fixation resulted in acceptable radiographic outcomes and low complication rates for the treatment of medial malleolar fractures. The advantages of the percutaneous fixation are the avoidance of potentially excessive soft tissue dissection associated with the open approach; however, it is associated with higher rates of delayed union due to the limited visualization. The advantages of ORIF method include being highly satisfactory in most patients and good functional outcome, however, it is associated with skin necrosis, infections, and wound healing disorders.

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