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Evaluation of The Results of Antiglide (small T) Plating of Vertical Medial Malleolus Fractures

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Abstract:

Objective: *To assess the radiological and functional outcomes of open reduction and internal fixation with T-shaped plate (antiglide plate) of vertical shear medial malleolus fracture.****Subjects and Methods****: This clinical trial study included 22 participants underwent open reduction and internal fixation with T-shaped plate (antiglide plate) for treating vertical shear fractures of the medial malleolus at orthopedic department, Zagazig University Hospitals in the period from January 2019 to February 2020.****Results****: Concerning union duration, the complicated group had longer union duration (100.0%) of non-complicated cases had union duration less than (20) weeks while (50.0%) of the complicated cases had union duration more than (20) weeks this may be explained by the fact that prolonged stay may cause superficial infection. No complications and only two patients (9.1%) had superficial infection with no other complications, regarding age where complication were among the older age group (50 to 65) years.* ***Conclusions****:Osteosynthesis using the small T-plate in the vertical shear of medial malleolus fracture gives a good choice of rigid fixation.*

Keywords:*Medial malleolus , Fracture fixation, Fractures, T-shaped.*

I. INTRODUCTION

Ankle fractures are among the most common types of fractures treated by orthopedic surgeons. The incidence of ankle fractures is reported to be 187 fractures per 100,000 people each year. Sixty to 70% of these injuries are unimalleolar fractures, and 15 to 20% are bimalleolar fractures involving both the medial and lateral malleoli. Seven to 12% of all ankle fractures can be classified as trimalleolar fractures, which involve the posterior malleolus in addition to the medial and lateral malleoli[1].

Management of ankle fractures has evolved over the last 10 years. As scientific (laboratory, cadaveric and clinical) research has led to better understanding of the biomechanics and patho-anatomy of the ankle, this has allowed more accurate evaluation of all elements and characteristics of injuries to bone and soft tissues

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associated with malleolar fractures. As such, it has become apparent that the 'key issue' in achieving good outcomes when treating these common injuries is to follow the principle of restoring the stability and alignment of the fractured ankle, using either non-operative or operative treatment, as appropriate[2].

With limited evidence, antiglide plating with two screws proximal to the apex of the fracture and two screws distal seems to be the strongest fixation construct, but this method also requires significant soft tissue dissection compared to screw only methods[3]. The purpose of this research was to assess the radiological and functional outcomes of open reduction and internal fixation with T-shaped plate (antiglide plate) of vertical shear medial malleolus fracture and our study hypothesized that T-shaped plate (anti glide plate) provide better radiological union and functional outcome in vertical shear of medial malleolus fracture.

II. SUBJECTS AND METHODS

The present study represented an interventional clinical study. This study included 22 patients underwent open reduction and internal fixation with T-shaped plate (antiglide plate) for treating vertical shear fractures of the medial malleolus at orthopedic department, Zagazig University Hospitals. The fourteen (14) patients have isolated vertical medial malloulus fracture which fixated by small T antiglide plate , The other Eight (8) patients have vertical medial malleolus fracture associated with lateral malleolus whichfixated one third semi tubular plate then fixation the vertical medial malleolus fracture by small T antiglide plate. Inclusion criteria included: Age above 18 years and closed/Open Gustilo Type I, II. Exclusion criteria included: Open fracture type III and patients medically unfit for surgery. The patients then were assessed clinically to evaluate their general condition and the local injury.

Pre-operative Assessment:

Expose the anterior part of the fracture site, free the periosteum from the edges of the medial malleolus to the distal tibial joint surface and inspect the joint. Remove the periosteum posteriorly only sufficiently to control reduction (Figure 1).

Fig (1):Medial Malleolus Surgical dissection and Exposure of the fracture site.

Remove any small, loose fragments which may prevent anatomic reduction and free the periosteum from the bone edges. In the presence of an impacted medial corner fragment, gently open the main vertical fracture plane by retraction of the medial malleolus medially (opening the book)(Figure 2).

Fig (2): Medial Malleolus fracture Reduction.

Application of plate:

Once the fracture is identified and cleared of interposed periosteum in usual fashion, the anatomic reduction is confirmed on anteroposterior and lateral fluoroscopic images, the small T plate is contoured to the center of medial aspect of the medial malloulas. Position the plate firmly by hand so that proximal two holes lie on the main body of the tibia and the distal hole of T plate lie on the medial malleolar fragment. The screw hole just proximal to the fracture site is filled first by 3.5mm cortical screws to prevents further proximal displacement of the fracture, then filled the distal hole to the fracture site by 4.0mm cancellous screws After filling the all holes of plate by cortical and cancellous screws, confirm the position of plate and reduction by antero-posterior and lateral fluoroscopic images, It was essential to certain that no screws violates the ankle joint (Figure 3).

Fig 3: Medial mallolusefixtaione by small T antiglide plate

After irrigation of the surgical site by normal saline the Periosteum layer and subcutaneous and skin layer is closed with suture. In case with lateral malleolus we should be start close lateral site incision then close

medial site incision. Dressing and sterile 4x4 gauze dressing are placed over the wound. standard short leg plaster splint is applied for immediate postoperative comfort(Figure 4).

Figure 4; Skin incision after closure

Post operativemanagement :

Post operatively all patients received Antibiotics consisting of Cefotaxim and Amikacin were continued for 5 days. Analgesics and anti-edematous drugs were given. Elevation of the affected limb was done. X-raysanteroposterior,lateralandmortiseviewsweretaken. Woundswere inspected on 3rd day and Sutures were removed on 14thpost operative day on an average. Below knee plaster of paris cast was applied. Discharged patients with instruction of non-weight bearing crutch walk for a period of 6 weeks and to come for follow-up after 2 week.

FOLLOW UP :

Patients were followed up at 2 weeks, 4 weeks, 6 weeks post operatively. After two weeks remove the stitch and change the slab.

At 6 weeks x- ray of the ankle was taken both AP and lateral views and looked for signs of fracture union and then were advised partial weight bearing for further period of 6 weeks with elevation of the limb at night times.

Regular follow up was done at 1, 2 and 6 months after discharge till the fracture united, Patients were allowed full weight bearing on the affected limb after three 3 mouth.

III. RESULTS:-

This study showed that the mean age of the studied group was (44.9±14.7) years ranged from 21 to 65 years, about half of the studied group (45.4%) had age ranged from 50 to 65 years. that (54.5%) of the studied group were males and (45.5%) of them were females table (1).

Table (1): Demographic data:

Variable	The studied group(22) mean ± SD (Range) median	
Age (years):	44.9±14.7 (21-65) 50	
Variable	**NO(22)**	**%**
Age grouping		
20-35 years	8	`36.4%
35-50 years	4	18.2%
50-65 years	10	45.4%
Sex		
Male	12	54.5%
Female	10	45.5%

This study showed that (63.6%) of the studied group didn't have any associated injury and (36.4%) had fracture of lateral malleolus as an associated injury Figure (7).

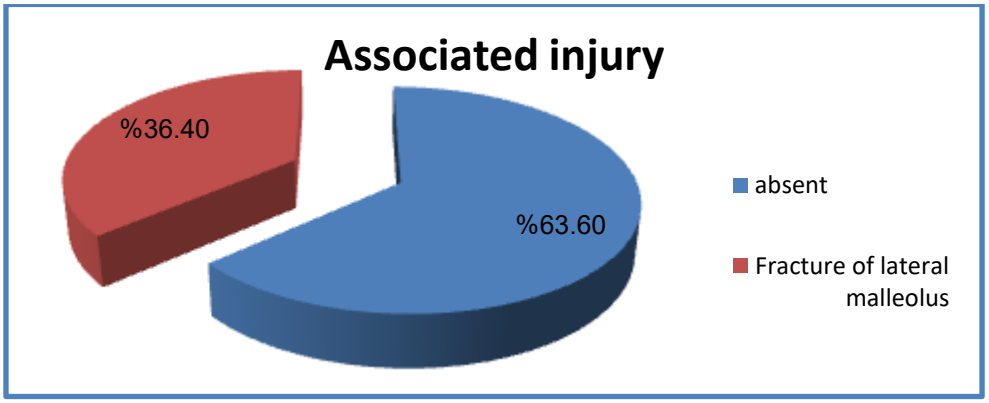

Fig (7): Bar chart for associated injury among the studied group

This study showed that the mean time of union duration of the studied group was (12.1± 2.2) weeks ranged from 9 to 16 weeks, most of the studied group (59.1%) had healing time ranged from 9 to 12 weeks, Figure (8).

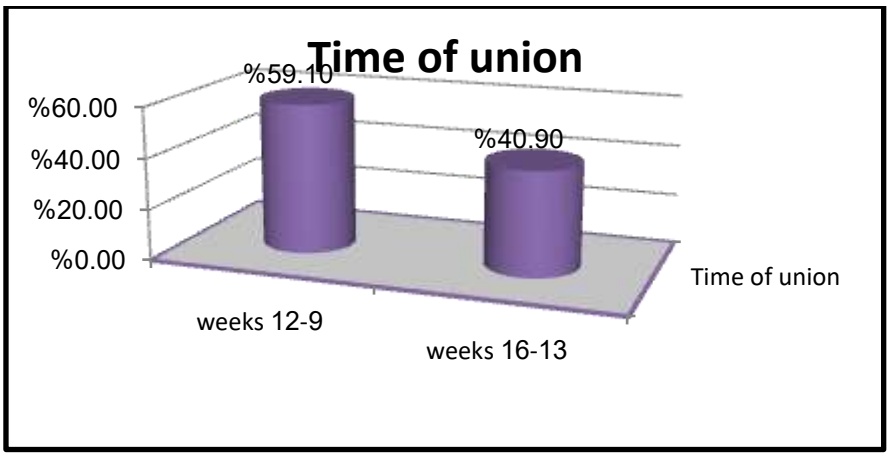

Fig (8): Bar chart for union duration among the studied group

This study showed that at the end of the follow up 15 patients (68.2%) had no pain and 7 patients (31.8%) had mild pain with strenuous activity. that at the end of the follow up 20 patients (90.9%) were able to walk desired distances without limp or pain while 2 patients (9.1%) were able to walk desired distances with mild limp or pain. that at the end of the follow up 18 patients (81.8%) were able to run desired distances without pain, 3 patients (13.6%) were able to run desired distances with slight pain while only one patient (4.5%) had moderate restriction in ability to run with mild pain. the end of the follow up 20 patients (90.9%) had clinical stability of the ankle and only two patients (9.1%) had instability with sports activities. the end of the follow up the motion of the ankle of 16 patients (72.7%) were within 10° of uninjured ankle, four patients (18.2%) had motion of ankle within 15° of uninjured ankle and two patients (9.1%) had motion of ankle within 20° of uninjured ankle table (2).

Table (2): Among the studied group:

Variable	**The studied group (22)**	
	NO (22)	**%**
Pain intensity		
Mild pain with strenuous activity	15	68.2%
No pain	7	31.8%
Ability to walk		
Able to walk desired distances without limp or pain	20	90.9%

Able to walk desired distances with mild limp or pain	2	9.1%
Ability to run		
Able to run desired distances without pain	18	81.8%
Able to run desired distances with slight pain	3	13.6%
Moderate restriction in ability to run, with mild pain	1	4.5%
Stability of ankle		
No clinical instability	20	90.9%
Instability with sports activities	2	9.1%
Motion of the ankle		
Within 10° of uninjured ankle	16	72.7%
Within 15° of uninjured ankle	4	18.2%
Within 20° of uninjured ankle	2	9.1%

Table (3), Regarding pain intensity, this study showed that the pain intensity among the studied group had average (14.1 ± 1.4) ranged from (12 to 15), the range of stability among the studied group had average (14.7 ± 0.2) ranged from (13 to 15), the range of walk had average (14.5±1.6) ranged from (8 to 15), the range of run had average (8.1±1.2) ranged from (6 to 10), the range of work had average (9.5 ±1.1) ranged from (6 to 10), the range of motion ankle had average (9.1±1.7) ranged from (4 to 10)and finally the range of X-ray had average (24.4 ± 0.4) ranged from (24 to 25).

Table (3): Baird and Jackson's Scoring Systemamong the studied group:

Variable	**Variables**	**The studied group(22)** Mean ± SD (Range)
	Pain intensity	14.1 ± 1.4

Baird and Jackson's Scoring System		(12-15)
	Stability	14.7 ± 0.2 (13-15)
	Walk	14.5±1.6 (8-15)
	Run	8.1±1.2 (6-10)
	Work	9.5 ±1.1 (6-10)
	Motion ankle	9.1± 1.7 (4-10)
	X-ray	24.4 ± 0.4 (24-25)

Table (4), showed that Baird and Jackson's Scoring Systemwas (95.3 ± 4.9) ranged from (76 to 98), most of the studied group (68.2%) had excellent outcome, (22.7%) of them had good outcome and (9.0%) had poor outcome.

Table (4): Final outcome by Baird and Jackson's Scoring Systemamong the studied group:

Final outcome	**The studied group(22)** Mean ± SD (Range)		
Final outcome	**Variables**	**NO(22)**	**%**
Baird and Jackson's Scoring System	***Excellent***	15	68.2%
	Good	5	22.7%
	Poor	2	9.0%
Total score	95.3 ± 4.9		

	(76-98)

Figure (9), showed that most of the studied group (90.9%) didn't have any complications and only two patients (9.1%) had superficial infection which controlled by antibiotic and dressing .

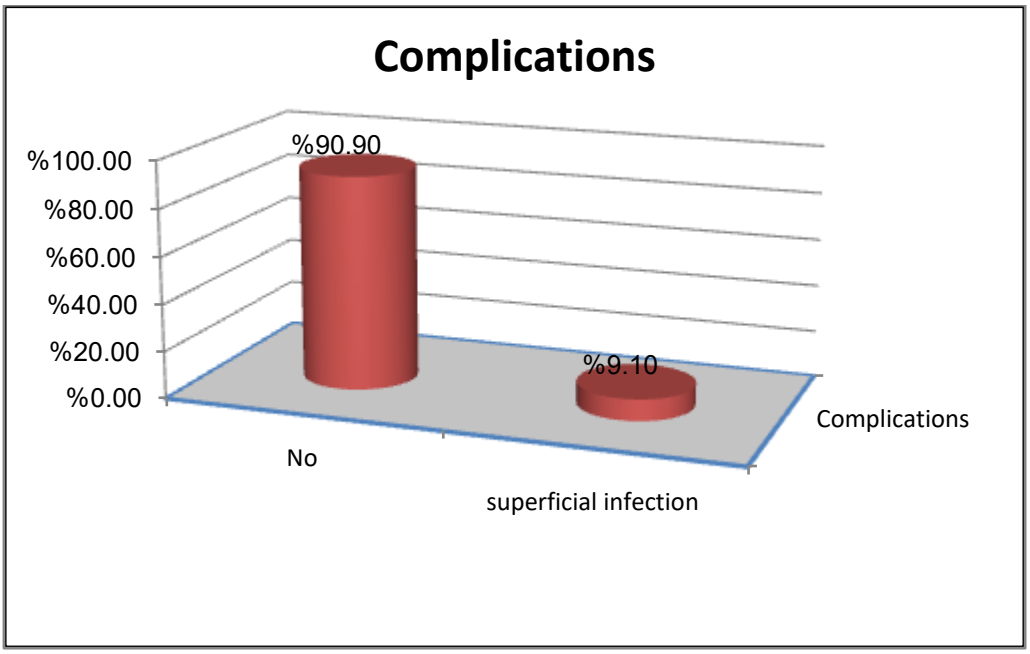

Fig (9): Bar chart for complications among the studied group

Table (5), there was statistically significant difference between patients with different functional outcome regarding union duration where (92.3%) of the least union duration (9 to 12) weeks had excellent outcome and all patients with poor outcome (100.0%) had the longest union duration (13 to 16) weeks. Regarding age, sex, affected side, mechanism of injury, associated injuries, management and complications, there was no statistically significant difference between patients with different functional outcomes.

Table (5): Comparison between patients with different functional outcome regarding patients characteristics among the studied group:-

Variable	NO.	Excellent		Good		Poor		χ^2	p
		No. (15)	%	No. (5)	%	No. (2)	%		
Age group									
20-35 years	8	7	87.5	1	12.5	0	0.0		
35-50 years	4	2	50.0	2	50.0	0	0.0	3.3	0.06

50-65 years	10	6	60.0	2	20.0	2	20.0		
Sex									
Male	12	8	66.7	3	25.0	1	8.3	0.08	0.9
Female	10	7	70.0	2	20.0	1	10.0		
Affected side									
Left	7	5	71.4	2	28.6	0	0.0	0.9	0.1
Right	15	10	66.7	3	20.0	2	13.3		
Mechanism of injury									
FFH	3	2	66.7	1	33.3	0	00.0	2.1	0.7
RTA	12	8	66.7	2	16.7	2	16.7		
SL	7	5	14.3	2	50.0	0	00.0		
Associated injuries									
No									
Fracture Lat. Malleollus	14	8	57.1	4	28.6	2	14.3	2.4	0.3
	8	7	87.5	1	12.5	0	00.0		
Management									
AGP &STP	8	7	77.8	1	11.1	1	11.1	1.2	0.6
AGP	14	8	61.5	4	30.8	1	7.7		
Time of union									
9-12 weeks	13	12	92.3	1	7.7	0	0.0	8.7	**0.01***
13-16 weeks	9	3	33.3	4	44.5	2	22.2		
Complications									
No	20	14	70.0	4	20.0	2	10.0		
Superficial infection	2	1	50.0	1	50.0	0	00.0	1.2	0.6

* Statistically significant difference ($P \leq 0.05$)

Table (6), there was statistically significant difference between complicated and non-complicated regarding age where complication were among the older age group (50 to 65) years. Concerning union duration, the complicated group had longer union duration (100.0%) of non-complicated cases had union duration less than (20) weeks while (50.0%) of the complicated cases had union duration more than (20) weeks. Regarding sex, affected side, mechanism of injury, union duration, associated injuries, management and complications, there was no statistically significant difference between the complicated and non-complicated patients.

Table (6): Comparison between the complicated and non-complicated cases regarding patients characteristics among the studied group:-

Variable	NO.	Uncomplicated		Complicated		χ^2	p
		NO. (20)	%	NO. (2)	%		
Age group							
20-35 years	8	8	100.0	0	0.0		
35-50 years	4	4	100.0	0	0.0	9.9	**0.01***
50-65 years	10	8	80.0	2	20.0		
Sex							
Male	12	11	91.7	1	8.3		
Female	10	9	90.0	1	10.0	FET	0.1
Affected side							
Left	7	7	100.0	0	0.0		
Right	15	13	86.7	2	13.3	FET	0.3
Mechanism of injury							
FFH							
RTA	3	3	100.0	0	0.00		
SL	12	12	100.0	0	0.00	4.7	0.09
	7	5	71.4	2	28.6		
Associated injuries							
No							
Fracture Lat. Malleollus	14	12	85.7	2	14.3	FET	0.3

	8	8	100.0	0.0	00.0		
Management							
AGP &STP	8	9	100.0	0	00.0	FET	
AGP	14	11	84.6	2	15.4		0.5
Time of union							
9-12 weeks	13	12	92.3	1	7.7	FET	0.7
13-16 weeks	9	8	88.9	1	11.1		

* Statistically significant difference ($P \leq 0.05$)

IV. DISCUSSION:

The mean age of the patients in the current study was (44.9±14.7) years ranged from 21 to 65 years, about half of the studied group (45.4%) had age ranged from 50 to 65 years. the same age was detected in a study conducted by **Kilian et al.** [4] where the average age of their participants were (47.9 ± 13.2) with a range from (29 to 74) years.

Sex distribution of the present study consisted of 12 males(54.5%) of the studied group and 10 females (45.5%) of the studied group. The male predominance in this type of injury may be explained by the fact that in our community, males are more exposed in work and traffic than females and so more prone to trauma in general and this was in agreement with**Kilian et al.** [4]whose study found that men comprised 12 (60%) and women 8 (40%) of patients .

Concerning of associated injury (63.6%) patients in our study with only medial malleolus injury and (36.4%) had Combined medial and lateralmalleolus injury , patients with combined both medial and lateralmalleoli were managed using antiglide plate for medial malleolus &semitubular Plate of lateral malleolus while patients with only medial malleolus injury was managed byantiglide platethis was in agreement with **Palmanovich. et al.,**[1]who reportedthat the majority of the ankle fractures commonly occur in relation to lateral or medial malleolar fractures.

Concerning bony union after antiglade plate of our study, the union duration was (12.1± 2.2) weeks ranged from 9 to 16 weeks, most of the studied group (59.1%) had healing time ranged from 9 to 12 weeksthis was the same as **Ahnet al.,** [5]in their study which included 70 patients were followed up for a minimum of 12 (mean 55, range 12 to 109) months. Bony union was obtained in all cases after a mean of 57 (range 37 to 81) days (nearly 14 weeks).

Additionally **Sukur. et al.,** [6]found in their study that the follow-up evaluation at the 12th postoperative week showed union in all patients where the presence of a bridging callus in at least 3 cortices or the disappearance of the fracture line was accepted as radiological union.

As regard to the outcome after the follow up period, The total final**Biard and Jackson score**was (95.3 ± 4.9) ranged from (76 to 98), most of the studied group (68.2%) had excellent outcome, (22.7%) of them had good outcome and (9.0%) had poor outcome.This was in consistent with the outcome of most studies as **Velez et al.,**[7] with 4.5% of cases with poor functional results similar as in the study of **Singh et al.,** [8]reported 5.4% of poor resultsalso the clinical outcome of plating fixation of displaced fractures is satisfying and poor results are infrequent asregard to **Ahnet al.**[5]and finally the total outcome of the current study was in agreement with **Jones, et al.**[9] who concluded that antiglide plating technique with lag-screw placement is biomechanically superior to the other 2 constructscommonly used.But the outcome of the current study was close to **Kilian et al.** [4]where the final total score was 94.5±6.0 (range 85–100) points but **Kilian** showed no dis-satisfied patients.

Regarding complications in our current study, most of the studied group (90.9%) didn't have any complications and only two patients (9.1%) had superficial infection with no other complications this was in contrast with **Kilian et al.** [4]where complications were observed in 3 (15%) patients of an antiglide plate (2 hardware irritation & 1 skin reaction with no infection.

Regarding age, sex, affected side, mechanism of injury, associated injuries, management and complications, there was no statistically significant difference between patients with different functional outcomes. These findings were similar to the results of all previous studies.

Concerning the relation between patients characteristics and the occurrence of complication, there was statistically significant difference between complicated and non-complicatedregarding age where complication were among the older age group (50 to 65) years.

Concerning union duration,the complicated group had longer union duration (100.0%) of non-complicated cases had union duration less than (20) weeks while (50.0%) of the complicated cases had union duration more than (20) weeks this may be explained by the fact that prolonged stay may cause superficial infection.

Regarding sex, affected side, mechanism of injury, union duration, associated injuries, management and complications, there was no statistically significant difference between the complicated and non-complicated patients.

Concerning the relation between patients characteristics and the final outcome, there was statistically significant difference between patients with different functional outcomeregarding union duration where (92.3%) of the least union duration (9 to 12) weekshad excellent outcome and all patients with poor outcome (100.0%) hadthe longest union duration (13 to 16) weeks.

V. CONCLUSION:

Osteosynthesis using the small T-plate in the vertical shear of medial malleolus fracture gives a good choice of rigid fixation. The antiglide construct is the superior for initial fixation, it provides better radiological union and functional outcome in vertical shear of medial malleolus fracture.

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