Study of Results of Percutaneous Intramedullary Screw Fixation of Lateral Malleolus Fractures

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ABSTRACT

Background: Intramedullary fixation offers a minimally invasive approach to the distal fibula with little palpable metalwork. When compared to a smooth pin, the long intramedullary screw provides superior purchase within the fibular canal. **Objective**: To evaluation of the clinical and radiological results of utilizing percutaneous intramedullary screw fixation for non-comminuted fractures of the lateral malleolus of the ankle.

Subjects and Methods: This prospective study included twenty patients who had transverse or short oblique Weber A or B lateral malleolus fractures and were treated with closed reduction and percutaneous internal fixation using a fully threaded, self-tapping screw (3.5 mm) and a washer. At least 6 months of follow-up was conducted.

Results: There was significant statistical relation between the final clinical and radiological results as well as with associated medial malleolus fracture. While age, gender, side of injury, type of fracture, pattern of fracture, associated co-morbidities and screw length had no statistical significance. Both a rotational malunited lateral malleolus fracture and a superficial infection at the incision site occurred in 5% of patients. **Conclusion:** By avoiding extensive soft-tissue dissection, closed reduction reduces the risk of postoperative wound problems and hardware-related pain. The 80 mm to 100 mm range of screw length measures made it possible for the 3.5 mm little set screw utilised in this investigation to gain a purchase within the fibular medullary canal. The distal fibular bow was accommodated by the screw's pliability, and three points of contact were established within the fibular medullary canal.

Keywords: Screw Fixation, Percutaneous Intramedullary, Lateral Malleolus.

INTRODUCTION

As a weight-bearing joint, the ankle joint can't afford too many abnormalities if it's going to keep working properly [(1)]. Ankle fractures are becoming increasingly common among the elderly, especially among women. Unstable fracture patterns due to poor bone quality are common even with low-energy modes of damage. Skin is often thin and fragile, and bone quality is often low as well [(2)]. Two-thirds of all ankle fractures are isolated malleolar fractures, with only a quarter of patients experiencing bimalleolar fractures and seven percent experiencing trimalleolar fractures. Open fractures of the ankle are uncommon, making for about 2% of all such breaks. Rotational forces cause the vast majority of ankle fractures [(3)].

Non-surgical and surgical interventions are both viable choices for treating lateral malleolar fractures. Cast immobilisation is the standard treatment for stable, isolated lateral malleolus fractures. Fractures of the lateral malleolus that are displaced or unstable require surgical intervention. Wiring techniques including cerclages, lag screws, plates with screws, hook plates, tension bands, axial pins, and axial screws are all viable solutions for surgical procedures [(4,5)]. A fibular nail was inserted to stabilize the fracture [(6)].

Stable anatomic fixation can be achieved with a buttress plate and screws, a lag screw shielded by a laterally inserted neutralizing plate, and the outcomes of various clinical studies have been favourable. Patient complaints of pain over prominent hardware and the lack of lateral overlaying soft tissues have been cited as criticisms [(7,8)].

Intramedullary fixation is an option for the distal fibula that requires few incisions and minimum metal hardware. Rush nails, unlike conventional nails, were not fixed to the bone and often backed out, making them ineffective at controlling fibular length and halting talar shift [(9-12)]. Because of its ease of usage and lack of hardware complexities and backing out issues, the intramedullary screw has replaced buttress plating.

The distal fibular lateral bow can be accommodated by the long intramedullary screw, which also provides superior purchase within the fibular canal compared to a smooth pin and so prevents hardware migration. Furthermore, its design permits dynamic compression at the fracture site, which has been shown to hasten the healing process. As a result of the use of limited soft tissue incision, the occurrence of wound problems and unpleasant conspicuous hardware is reduced [(13,14)]. biomechanically the intramedullary screw was superior in strength than fixation with plate and screws [(15)].

It was the goal of our study, evaluation of the clinical and radiological results of utilizing percutaneous intramedullary screw fixation for non-comminuted fractures of the lateral malleolus of the ankle.

SUBJECTS AND METHODS

Subjects:

During period between February 2019 to August 2019, twenty cases who had transverse or short oblique Weber A or B lateral malleolus fractures were treated with closed reduction and percutaneous internal fixation using a fully threaded, self-tapping screw (3.5 mm) and a washer. At least 6 months of follow-up was conducted.

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Inclusion criteria:

1. Danis-Weber type A or B fibular fractures.
2. Fibular fractures with either transverse or short oblique pattern.

Exclusion criteria:

1. Danis-Weber type C fibular fractures.
2. Malleolar fractures associated with syndesmotic injury

Preoperative management:

- First aid management: Below knee plaster slab was done to support the affected ankle until surgery.
- Analgesics, anti-edematous drugs and thrombolytics was given. Thrombolytics was stopped 12 hours before surgery.
- Single dose of prophylactic antibiotic in the form of 3rd generation cephalosporin was given to the patient one hour before surgery.

Surgical technique:

Anesthesia: All patients received spinal anesthesia.

Preparation and positioning: A tourniquet wasn't necessary in this case. But only if open medial malleolar fracture fixation was also being performed. The patient was laid out flat on her(his) back. The contralateral hip was supported by a sandbag.

Closed reduction: By inverting the foot, the fracture could be reduced with the use of image intensification, and a pointed bone-holding clamp was utilized to keep the fracture in place through a small incision (Fig. 1).

Fig. (1): Percutaneous closed reduction of the fracture by a pointed bone-holding clamp

An incision 1 cm long was made starting 1 cm distal to the lateral malleolus. Using a 2.5 mm drill bit, a hole was drilled into the end of the lateral malleolus, positioning it as far back on the bone as possible. The proximal fibular fracture was fixed using a cortical, fully threaded, self-tapping bone screw with a washer inserted across the fracture site. Once the screw's head touched bone, it was at its tightest. The screw was fully threaded, and the serrations on either side of the fracture site prevented any more compression from being made by tightening the screw. To account for the lateral bow in the distal fibula, the screw was curved along its long axis. The fracture site and fracture pattern determined the screw length, which can be anywhere from 80 mm to 100 mm. The reduction of the fracture and the position of the screw were always confirmed with intraoperative imaging (AP, lateral, mortise) (Fig. 2). One interrupted suture was used to close the wound, and gauze was used for the dressing.

Fig. (2): Intraoperative imaging to confirm reduction of the fracture.

Follow up:

Each participant was required to come in once every week for 8 weeks, and subsequently once every month for at least 6 months. After two weeks, the sutures were taken out. Fracture repair dictated a gradual rise in partial weight bearing. After a successful radiological union, patients could begin bearing their whole-body weight.

Methods of assessment of the results:

McLennan and Ungersma's criteria for assessing radiological results, and **Ray *et al.*** [16] functional rating score (compared with normal ankle), were used to evaluate the functional and radiographic outcome of all patients at the end of the follow-up period (six months).

Ethical approval:

This experiment was ethically approved by the Zagazig University's. After being fully informed, all participants provided written consent. The study was conducted out in line with the Helsinki Declaration.

Statistical analysis

To conduct the quantitative study, we used version 20 of the Statistical Package for the Social Sciences (SPSS). The numerical data were presented with their respective means and standard deviations. Qualitative data were presented as frequency and %. Using Pearson's Chi-Square, we analysed data that were qualitatively different from one another (X^2). To be statistically significant, we determined that a P value of 0.05 or lower was necessary.

RESULTS

The age of the patients ranged from (20-65) with a mean±standard deviation (42.65±12.7) years. There were a total of eight male patients (40 percent) and twelve female patients (60 percent). In thirteen patients (65%), seven individuals (35%), and no bilateral cases occurred on the right side. The type, pattern and associated fractures are shown in table (1).

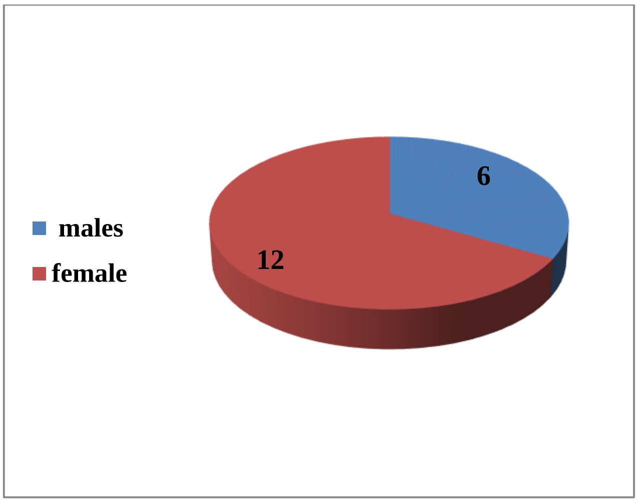


Fig. (3): Sex distribution.

Table (1): Type, associated, and pattern of fractures

Type of fracture	**N**	**Percentage**
Weber B	18	90%
Weber A	2	10%
Pattern of fracture		
Short oblique fracture	15	75%
Transverse fracture	5	25%
Associated malleolar fractures		
Isolated lateral malleolus	18	90%
Associated medial malleolus	2	10%
Associated trimalleolar fractures	0	0%
Total	**20**	**100%**

Relationship between clinical results and radiological results:

Statistically, there was significant association between clinical result and radiological reductions as shown in table (2).

Table (2): Distribution of clinical results regarding radiological results in this study

			Clinical result				**Total**	X^2	**P**
			Excellent	**Good**	**Fair**	**poor**			
Radiological result	**Good**	N	10	7	0	0	17	22.59	0.02*
		%	50%	35%	0.0%	0.0%	85%		
	Fair	N	0	2	0	0	2		
		%	0.0%	10%	0.0%	0.0%	10%		
	Poor	N	0	0	1	0	1		
		%	0.0%	0.0%	5%	0.0%	5%		
Total		N	10	9	1	0	20		
		%	50%	45 %	5 %	0.0 %	100 %		

*: Significant

Relationship between clinical results and fracture type:
Table (3) shows non significant association between type of fracture and clinical result.

Table (3): Distribution of clinical results regarding type of fracture in this study

			Clinical result				Total	X^2	P
			Excellent	Good	Fair	poor			
Type of fracture	Weber A	N	1	1	0	0	2	0.123	0.9
		%	5%	5%	0.0%	0.0%	10%		
	Weber B	N	9	8	1	0	18		
		%	45%	40%	5%	0.0%	90%		
Total		N	10	9	1	0	20		
		%	50%	45%	5%	0.0%	100.0%		

Relationship between clinical results and association of malleolar fractures:
Table (4) shows significant association between clinical results and association of malleolar fractures.

Table (4): Distribution of clinical results regarding association of malleolar fractures in this study

			Clinical result				Total	X^2	P
			Excellent	Good	Fair	poor			
Associated medial malleolus	Isolated lateral malleolus	N	10	8	0	0	18	4.71	0. 03*
		%	50%	40%	0.0%	0.0%	90%		
	Associated medial malleolus	N	0	1	1		2		
		%	0.0%	5%	5%	0.0%	10%		
Total		N	10	9	1	0	20		
		%	50%	45%	5%	0.0%	100.0%		

*: Significant

Relationship between radiological results and Association of malleolar fractures:
Table (5) shows significant association between radiological results and association of malleolar fractures.

Table (5): Distribution of radiological results regarding association of malleolar fractures in this study

			Radiological Results			Total	X^2	P
			Good	Fair	Poor			
Associated medial malleolus	Isolated lateral malleolus	N	16	1	1	18	3.971	0.02*
		%	80%	5%	5%	90%		
	Associated medial malleolus	N	1	1	0	2		
		%	5%	5%	0.0%	100%		
Total		N	17	2	1	20		
		%	85%	10%	5%	100%		

*: Significant

Relation between clinical results and screw length:
In this study, screws of lengths between 80 mm and 100 mm were employed with mean ± SD (87.14±9.51). Table (6) shows no significant association between clinical results and the length of the screw.

Table (6): Distribution of clinical results regarding to screw length in this study

			Clinical result				Total	X^2	P
			Excellent	Good	Fair	Poor			
Length of the screw	>85 mm	N	7	4	1	0	12	1.97	0. 1
		%	35%	20%	5%	0.0%	60%		
	<85mm	N	3	5	0	0	8		
		%	15%	25%	0.0%	0.0%	40%		
Total		N	10	9	1	0	20		
		%	50%	45%	5%	0.0%	100.0%		

Relation between radiological results and malunion complication:

Table (7) shows significant association between radiological result and postoperative malunion complication.

Table (7): Distribution of radiological results regarding to malunion complications in this study

			Radiological Results			Total	X^2	P
			Good	Fair	Poor			
Presence of malunion	Present	N	0	0	1	1	20.55	0.01*
		%	0.0%	0.0%	5%	5%		
	Absent	N	17	2	0	19		
		%	85%	10%	0.0%	95%		
Total		N	17	2	1	20		
		%	85%	10%	5%	100%		

*: Significant

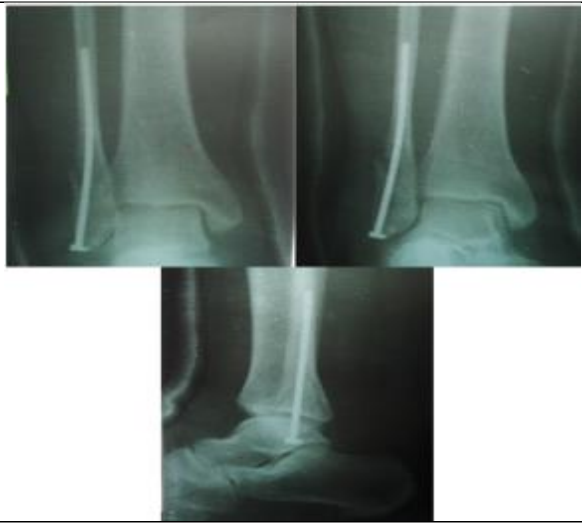
Time of union:

Time needed for complete radiological union varied between 4 weeks and 8 weeks with a mean 5.6 ± 1.39 weeks, there was no significant correlation between the radiological results or the clinical results and time of union (table 8).

Table (8): Time of fracture union

Time of union (weeks)	N	Percentage
≤ 6 weeks	17	85%
> 6 weeks	3	15%
Total	20	20

(A) The preoperative X-rays. Anteroposterior, mortise and lateral views of the ankle



(B) Immediate postoperative X-rays

(C) Anteroposterior and lateral views after a period of 6 months follow-up

Fig. (4): Female patient, 35 years old, house wife, had road traffic accident, right isolated weber type B lateral malleolus fracture with a short oblique pattern. Radiological result was good and clinical scoring was excellent. No intraoperative, early postoperative or late postoperative complications were encountered, follow-up period was 6 months.

DISCUSSION

When treating unstable lateral malleolus fractures, it is crucial to keep the tibia and talus in their proper anatomical positions [17]. The talus is attached to the lateral malleolus and that modest lateral malleolus fractures can cause talar displacement and joint incongruity [18,19]. It is possible to do closed or open reduction of the fracture [16]. The healing process is expedited and recovery time is reduced because the fracture hematoma is not disrupted during closed reduction. This is especially true for isolated lateral malleolus fractures [13].

This study, along with those by other authors, demonstrated that neither the patients' age nor their gender played a major role in determining the outcomes [2,13,16].

This study's radiological findings are consistent with those of **Ray *et al.*** [16], study in which 24 patients were treated with closed reduction and percutaneous internal fixation using a fully threaded, self-tapping screw placed intramedullary. 71% had a positive outcome, 20% had an intermediate outcome, and 7% had a negative outcome. The present study's radiological findings are also consistent with those of a previous investigation by **Latif *et al.*** [13]; outcomes were outstanding in 25 patients (54.3%), good in 20 (43.5%), and fair in 1 (6.6%) at the most recent follow-up for the 46 patients in the study (2.2 percent).

This study's clinical findings are consistent with those of a previous investigation involving 24 patients, by **Ray *et al.*** [16]. Final follow-up revealed that 42.1% had an excellent outcome, 42.1% had a good outcome, 5.3% had an intermediate outcome, and 10.5% had a poor outcome. The clinical findings of the current investigation are also consistent with those of a study conducted by **Latif *et al.*** [13], which analysed data from 46 patients. Results were outstanding in 25 patients (54.3%), good in 20 patients (43.5%), and fair in 1 patient (5.6%) at the most recent follow-up (2.2 percent).

The average time to union in the current study was 5.6 ± 1.39 weeks (range: 4-8 weeks), with a union rate of one hundred percent. The average time of full weight bearing was 6.8 weeks, and in patients with isolated lateral malleolus fractures, this time decreased to 4.5 weeks, whereas in the study by **Ray *et al.*** [16], the average time of fracture union was 8.2 weeks with one case developing nonunion, with a union rate of 95.5%.

Latif *et al.* [13] found the same thing; the median engagement was 8.2 weeks. In patients with isolated lateral malleolus fractures, the average time to full weight bearing was 4.5 weeks.

In this investigation, we used screws with lengths between 80 and 100 mm. The length of the screw varied from 62.5 mm to 100 mm in the study by **Ray *et al.*** [16], depending on the fracture site, fracture pattern, and proximal medullary canal width. Although **Latif *et al.*** [13] stated that screws ranged in length from 100 mm to 120 mm, according to research by **Smith *et al.*** [2], the length of the screw ranged from 50 to 100 mm. The results of this experiment were unaffected by the length of the screws used.

Two individuals in our analysis also suffered fractures of the medial malleolus. In contrast, five patients in the study by **Ray *et al.*** [16] also suffered from medial malleolar fractures, and one patient suffered from a trimalleolar fracture. One patient with a reasonable score had a malunited medial malleolus, and another patient with a poor score had a nonunited medial malleolus, therefore the results for the two patients with concomitant medial malleolus fractures were not good. However, **Latif *et al.*** [13] found that 15 patients also suffered a fracture of the medial malleolus and 10 patients suffered a fracture of the triad of malleoli. Acute alcohol withdrawal was a contributing factor in the failure of fracture repair in one of the eight patients with related medial malleolar fractures and thirteen patients with a trimalleolar fracture in the study by **Smith *et al.*** [2]. They did not mention whether or not the presence of medial malleolus fractures contributed to the final grade.

Nonunion was not a factor in any of the cases examined here. However, one individual suffered a rotatory malunited fracture of the lateral malleolus. The fracture may not have been properly reduced by the bone retaining clamp, leading to rotation during screw insertion. Malunion did not have an impact on the results of this study. While one patient with a fair score and a lateral malleolus that was too short by less than 2 millimetres was included in the study by **Ray *et al.*** [16]. Another low-scoring case; its nonunion was treated with ipsilateral closed intramedullary tibial nailing and distraction, and then bone grafting and plating. Malunited lateral malleolus manifested as shortening in one patient with a reasonable score in the study by **Latif *et al.*** [13].

Because the screws were placed intramedullary, no one in the current trial had any discomfort from a protruding screw or peroneal tendinitis. Due to implant discomfort, one patient in the trial by **Smith *et al.*** [2] had to have the screw removed because it had been inserted too far forward and to the medial side of the fibula. **Kim *et al.*** [20] found no cases of tendinitis of the peroneus brevis muscle. However, implant discomfort at the surgical site occurred in six patients (23.1%). Hardware-related discomfort was more common in laterally mounted plates (31%), and 23% of patients needed hardware removal to alleviate their pain, with 50% of those patients reporting relief and a reduction in pain score after their hardware was removed [21].

CONCLUSION

The use of limited soft-tissue dissection in closed reduction reduces the risk of wound complications and the discomfort associated with hardware sites. The 80 mm to 100 mm range of screw length measures made it possible for the 3.5 mm little set screw utilised in this investigation to gain a purchase within the fibular medullary canal. Three points of contact were made within the fibular medullary canal thanks to the 3.5 mm screw's ability to conform to the distal fibular bow.

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Conflict of interest: The authors state no conflict of interest.

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