

Percutaneous intramedullary screw fixation in lateral malleolar ankle fractures

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Abstract

Objectives: To evaluate the outcome of percutaneous fixation of lateral malleolar ankle fractures by intramedullary screw.

Methods: Twenty-five patients with Weber A and Weber B displaced lateral malleolus fractures were retrospectively reviewed after they had done closed reduction and percutaneous internal fixation with an intramedullary fully threaded screw with a washer. A 3.5-mm, fully threaded, self-tapping bone screw. The length of the screw varies between 90 mm and 110 mm, depending on the fracture location and pattern.

Results: All fractures united within an average time to union of 5.86 ± 1.74 weeks. There were no deep wound infections or complaints of painful hardware. At the latest follow-up, functional results were excellent in 16 patients (64%) good in 8 patients (32%), fair in one patient (4%).

Conclusion Percutaneous intramedullary screw fixation *is* a good technique in the management of lateral malleolar fracture that provides good clinical and radiological results as it is rapid, minimally invasive, and without prominent hardware.

1. Background

As the ankle joint has minimal tolerance for variation from normal anatomy, the key to functional restoration after ankle fracture is anatomic restoration^[1]. It is universally agreed that anatomical reduction with stable fixation is essential for preventing or at least delaying the onset of arthritis of the ankle joint after such injuries^[2]. Lateral malleolar fractures could be treated non-operatively or operatively, there are several fixation options include cerclage wiring, lag screws, a plate and screws, a hook plate, tension band wiring, axial pins, and axial screws^[1-3]. Recently, nails are introduced to fix the fibular fracture^[4]. buttress plate and/or a lag screw, depending on the fracture pattern provide stable anatomic fixation and the results of their clinical studies were satisfactory^[3, 5, 6].

However, due to the thin overlying soft tissues laterally and the frequent patients' complaints of prominent subcutaneous hardware is a problem, moreover, soft tissue complications are not uncommon after repair of lateral malleolus fractures by plate^[7-9].

Intramedullary fixation using Steinmann pins^[10] and Rush rods^[11] have been introduced, however, the concern about the hardware backing out has limited their use.

Cancellous screws alone have also been used in Weber A fibula fractures^[11,12], but, as with smooth pins, these fixation devices may allow rotation of the distal fragment. Several studies have described the fixation of fibular fractures with an axial screw^[14,15].

In this study, internal fixation was done for Weber A and Weber B fibular fractures with a long intramedullary cortical screw for different fracture patterns. This study aims to investigate the outcome

of this technique as it is minimally invasive and with fewer hardware complications with the comparable outcome with plates and screws. The long intramedullary screw also allows better purchase within the fibular canal than a smooth pin while accommodating the distal fibular lateral bow), therefore eliminating hardware migration [5]. Furthermore, Bankston *et al.* demonstrated biomechanically that this fixation device was superior in strength, compared to other fixations with plate and screws [15]. They reported a 100% rate of union in their series using an intramedullary screw-in open reduction and internal fixation of lateral malleolus fractures.

2. Patients

The study included 25 patients with Weber A or B lateral malleolus fractures (transverse or short oblique or spiral patterns) managed by closed reduction and percutaneous internal fixation with a 3.5 mm, fully threaded, self-tapping intramedullary screw with a washer. The duration of follow up was at least 6 months. All patients were subjected to thorough clinical and radiological examination, x-ray ankle in anteroposterior, mortise and lateral views were performed to confirm the diagnosis and rule out medial and syndesmotic ligamentous injuries. Other patients with Weber C lateral malleolus fractures or those with associated syndesmotic injury or those with comminuted fibular fractures were excluded from our study. Their mean age was 45.7 years old. There were 17 males and 8 females. 22 patients had isolated lateral malleolus fractures; the other 3 patients had associated medial malleolus fractures (Table 1). No posterior malleolar fractures required fixation in this group.

Age		Gender		Side	
Group	n	Male	Female	Right	Left
30 and younger	2	1	1	1	1
31 - 40	7	4	3	3	4
41 - 50	8	6	2	4	5
51 - 60	5	3	2	2	3
61 and older	3	3	0	2	1
Total	25	17	8	12	13
Percentage	100%	68%	32%	48%	52%

Table (1): Distribution of the studied cases according to age (n=25)

3. Surgical Technique

All cases have been performed under spinal anesthesia the use of a tourniquet was not needed. But it was required only if associated with medial malleolar fracture. Image intensification was used to aid closed reduction, the reduction is confirmed by fluoroscopy in different views to rule out translation and more importantly, rotation by confirming the standard radiographic parameters most importantly ball sign and medial clear space ⁽²⁾, then maintaining fracture reduction with a pointed bone- holding forceps percutaneously., about one cm incision was made just distal to the tip of the lateral malleolus and proceeding distally. A hole was made in the tip of the lateral malleolus with a 2.5 mm drill bit trying to be somewhat posterior on the lateral malleolus tip. Figure (1)

A cortical, stainless steel alloy, 3.5 mm, fully threaded, self-tapping bone screw with a washer was passed across the fracture site and into the proximal fibular fragment.

The screw was tightened until its head reached the bone. It was not possible to make more compression by a further tightening of the screw because it was a fully threaded screw and serrations were on both sides of the fracture site. The screw bent with the long axis of the distal fibula while accommodating the distal fibular lateral bow.

The screw length varies between 90 mm and 110 mm, according to the fracture location and pattern. Intraoperative imaging (AP, lateral, mortise) was always obtained to confirm the reduction of the fracture, the position of the screw. The wound was closed with one interrupted suture and gauze dressing.

Postoperatively, A short leg cast in a neutral position was applied for six weeks. Partial -weight-bearing ambulation with the aid of crutches was allowed from the first postoperative day as tolerated according to the fracture pattern and associated injuries and guided by the follow-up X-rays. full weight-bearing was allowed with the appearance of radiological signs of healing in follow up x-ray (Figure 2a and 2b) showing examples of lateral malleolus fracture fixed by intramedullary screw. also, figure 3a and 3b show another example for weber b lateral malleolus fracture.

4. Results

Among 25 patients participated in the study, 20 patients were due to twisting injury of the ankle when falling, while 5 patients were due to road traffic accidents (RTA) (table 2)

Mode of trauma		Pattern of fracture		
Mode	n	Transverse	Short oblique	spiral
RTA	5	2	2	1
Twisting ankle	20	5	11	4
Total	25	7	13	5
Percentage	100%	28%	52%	25%

Table (2): Distribution of the studied cases according to the pattern of fracture (n=25)

The results were assessed both clinically and radiologically at the end of the follow-up period. Olerud and molender for ankle scoring system were used to subjectively evaluate ankles by the patients the mean of the olerud and molender score was 93 ± 8.717 . The overall results were considered satisfactory in 24 patients (96%) and unsatisfactory in one patient (1%). All the cases were united with the union rate of 100%. Nineteen patients (76%) had a united fracture in 6 weeks or less and six patients (24%) had a united fracture in 8 weeks. The average time of union was 5.86 ± 1.74 weeks, ranging from 4 to 8 weeks. (table 3)

Olerud and Molender score	n	%
Satisfactory	24	96
Excellent	16	64
Good	8	32
Unsatisfactory	1	4
Fair	1	4
Poor	0	0
Total	25	100
Min. - Max.	60.0 - 100.0	
Mean \pm SD.	93 ± 8.717	
Median	95.0	

Table (3): Distribution of the studied cases according to Olerud and Molander score score

One patient (5%) had a superficial infection at the site of incision and one patient (5%) had malunion in the form of rotation. No patients had a deep infection, nonunion, joint stiffness, or painful prominent hardware.

5. Discussion

Stable anatomic fixation of the lateral malleolus fragment is highly appreciated to achieve satisfactory results in ankle fractures.

Yablon et al ⁽¹⁶⁾ pointed out that the talus follows the lateral malleolus, so the minor displacement of lateral malleolus fractures leads to talar shift and joint incongruity.

Various methods of lateral malleolar fixation have been utilized, all with acceptable results. Most commonly buttress plating and/or a lag screw. This provides reliable fixation and maintains the length and rotation of the lateral malleolus. It is preferred in comminuted fractures, as length could not be reliably maintained with an intramedullary screw as well as fractures with a syndesmotic injury where a syndesmotic screw is needed (Weber type C). The complications of plate fixation of the lateral malleolus are wound healing; especially in swollen ankles and painful prominent hardware often develops late.

The long intramedullary screw allows getting a purchase within the fibular canal, therefore eliminating hardware migration. The intramedullary position allows for dynamic compression at the fracture site with weight-bearing, thus enhances fracture healing. ⁽¹⁵⁾ The slight flexibility of the axial screw allows it to easily accommodate the distal fibular bow, resulting in three-point fixation of the fracture, as the lateral malleolus is normally in 10 to 15 degrees of valgus to the fibular shaft. ⁽¹⁷⁾

A biomechanical study by Bankston et al for evaluation of intramedullary screw versus buttress plate and lag screw. The fractures were fixed with one of the fixation methods and then placed under a torsional load to failure. It was found that the intramedullary screw provided 66.5% of the strength of native bone while the lateral buttress plate provided 61.5%. This was not statistically significant, but it did prove that an intramedullary screw provides stable fixation. So, rehabilitation can be started early without the risk of loss of reduction. ⁽¹⁵⁾

This study includes the postoperative evaluation of closed reduction and percutaneous internal fixation of unstable lateral malleolus fractures Weber types A or B with an intramedullary, stainless steel 3.5 mm, fully threaded, self-tapping screw with a washer. Regarding the results, 64% of patients had excellent results, 32% had good results and 4% had fair results. The mean of the score was 93 ± 8.717 ranging from 60 to 100.

The results of this study are comparable with the results of Ray TD et al ⁽¹⁷⁾ which included 24 patients treated with closed reduction and percutaneous internal fixation with an intramedullary, fully threaded, self-tapping screw. At the final follow-up, 42.1% had an excellent result, 42.1% had a good result, 5.3% had a fair result and 10.5% had a poor result.

The results of the present study are also comparable with the results of Latif G et al which included 46 patients with displaced lateral malleolus Weber A and low Weber B fractures who underwent closed reduction and percutaneous internal fixation with an intramedullary, 3.5 mm, fully threaded, self-tapping

bone screw were retrospectively reviewed. the results were excellent in 25 patients (54.3%), good in 20 patients (43.5%), and fair in one patient (2.2%).⁽¹³⁾

In the present study, the average time for union was 5.86 ± 1.74 weeks, ranging from 4 to 8 weeks with a rate of union 100%. While in the study of Ray TD et al⁽¹⁷⁾, the average time of fracture union was 8.2 weeks with one case developed nonunion, with a union rate of 95.5%. The average time of full weight-bearing was 6.8 weeks and in patients with isolated lateral malleolus fractures time decreased to 4.5 weeks. The same results in the study of Latif G et al⁽¹³⁾, the average time of union was 8.2 weeks. The average time to full weight-bearing was 6.8 weeks and 4.5 weeks in patients with isolated lateral malleolus fractures.

Regarding the use of tourniquet, in the present study, no tourniquet is used, except in the three cases with associated medial malleolar fractures who underwent open reduction and internal fixation. Medial malleolus fracture was fixed by 2 cancellous screws in two patients while the third patient had his medial malleolus fixed with a plate and screws.

In the study of Ray TD et al⁽¹⁷⁾ and Latif G et al⁽¹³⁾, using this percutaneous technique, the use of a tourniquet is optional, and they didn't report the use of tourniquet in isolated lateral malleolus fractures.

The use of tourniquet may lead to many complications as Nerve injury which is the most common complication. ranging from mild transient loss of function to irreversible paralysis. Other complications of a tourniquet include arterial injury due to indirect trauma and thrombosis, tourniquet pain, compartment syndrome, pressure sores, deep venous thrombosis, High pressures, and missed digital tourniquets can lead to severe ischemia of the digits.⁽¹⁸⁾

The length of the screw used in the present study ranging from 90 mm to 110 mm. In the study of Ray TD et al⁽¹⁷⁾, the length of the screw ranged from 62.5 mm to 100 mm depending on the location of the fracture, pattern, and the width of the medullary canal proximal to the fracture site. While in the study of Latif G et al⁽¹³⁾, the length of the screw varied between 100 mm and 120 mm, depending on the fracture location and pattern. In this study, the length of the screw didn't affect the results.

The small set 3.5 mm screw used in this study was long enough to get a purchase within the fibular medullary canal, with available screw length measures ranging from 60 mm to 120 mm. The flexibility of the 3.5 mm screw allowed it to accommodate the distal fibular bow, resulting in three-point contact within the fibular medullary canal. The small set 4.0 mm screw, either fully threaded or partially threaded, didn't have available length measures to get a purchase in the fibular medullary canal and doesn't have the same flexibility which allows engaging into the medullary canal of the fibula so its use may lead to implant breakage. The standard 6.5 mm screw, either fully threaded or partially threaded, is a rigid screw and not flexible to accommodate the distal fibular bow. So, the 4.0 mm and 6.5 mm screws can't be used in this study.

The age and sex of the patients were not statistically significant, which was proven in this study and other studies that were done by other authors^(13,17)

Of the twenty-five patients in the present study, three patients had associated medial malleolus fractures. While in the study of Ray TD et al⁽¹⁷⁾, five patients had an associated medial malleolar fracture and one patient had a trimalleolar fracture. Two of the patients with associated medial malleolus fractures had an unsatisfactory result, one patient with fair score had a malunited medial malleolus and one patient with poor score had an ununited medial malleolus. But in the study of Latif G et al⁽¹³⁾, fifteen patients had an associated fracture of the medial malleolus and ten patients had a trimalleolar fracture.

In this study, three patients had associated medial malleolus fracture. Two of them had satisfactory results, the remaining one had a fair score with mild pain and edema with activity and was able to walk the desired distance with mild limp despite the full range of motion of ankle joint.

In the present study, no single case complicated with nonunion. But, one patient had malunited lateral malleolus fracture in the form of rotation. Rotation most probably occurred during screw head tightening at the end of its insertion which might be due to early removal of the bone holding clamp with partial loss of fracture reduction. However, malunion didn't affect the results. While in the study of Ray TD et al⁽¹⁷⁾, one patient with a fair score who had a shortened lateral malleolus ≤ 2 mm. Another patient with a poor score who developed nonunion, which was internally fixed in distraction during ipsilateral closed intramedullary tibial nailing and was managed later by bone graft and plating. In the study of Latif G et al⁽¹³⁾, one patient, who had a fair score, developed malunited lateral malleolus in the form of shortening.

The overall infection rate in the present study was 4%, which were two patients with a superficial infection managed by daily dressing and adequate antibiotic. When compared to the study of Ray TD et al, one patient (4.2%) developed minor wound complications in the form of mild serous discharge from the operative site at the time of cast removal which response to conservative management. No superficial or deep infection was reported in the study of Latif G et al⁽¹³⁾.

In the study of Lamontagne J et al⁽¹⁹⁾, who used the lateral plate and anti-glide plate techniques, eleven patients had wound infection with an infection rate of 5.7%. Nine of them had a superficial infection and two of them had deep infection. One of them treated with surgical debridement and an antibiotic bead pouch technique and the wound was closed with the removal of the bead pouch, five days later. The second patient had a chronic infection. Wound dehiscence and reflex sympathetic dystrophy complicated the early postoperative period. The plate was removed after two years to control an open draining sinus.

The present study and the studies of Ray TD et al⁽¹⁷⁾ and Latif G et al⁽¹³⁾ had a low infection rate when compared to the study of Lamontagne J et al⁽¹⁹⁾, this might be due to the closed

reduction method and the percutaneous technique in fixation of lateral malleolus fractures through just a 1 cm skin incision without interruption of soft tissue like the traditional lateral skin incision in open

internal fixation.

Of the twenty-five cases in the present study, the studies of Ray TD et al⁽¹⁷⁾ and Latif G et al⁽¹³⁾, no one had a painful, prominent screw or peroneal tendinitis due to the intramedullary position of the screw.

In laterally applied plates hardware-related problems were more common. Brown et al reported that 31% of patients had hardware related pain and that 23% of patients required hardware removal, 50% of those patients who had their hardware removed reported improvement, and a decrease in pain score⁽²⁰⁾

Jacobsen et al reported that 66% of patients with a lateral plate had implant-related complaints that led to the removal of implants. 75% of these patients had relief after removal⁽²¹⁾ Tornetta and Creevy also reported that 56% of patients with a lateral plate had complaints of palpable hardware, 17% had pain related to the plates, 15% had a restriction in movements and 31% required removal of implants⁽²²⁾

Ostrum reported no wound problems, no palpable hardware, no nonunion or implant problems but noticed transient peroneal tendinitis in 4 patients, and 2 patients required removal of the implant in posterior plating of displaced fibula fractures⁽²³⁾ Furthermore, 43% of plates were removed because of peroneal tendonitis in the study of Weber and Kraus⁽²⁴⁾

The results of this study, which was also supported by many other studies proved that percutaneous fixation gave good clinical results in the management of lateral malleolus fractures Weber types A or B with minimal complication rate and without the need for another surgery for hardware removal.^(13,17)

This technique could be so valuable in cases of diabetic patients and patients with chronic vascular diseases where soft tissue complications are a concern.

6. Conclusion

Percutaneous fixation by intramedullary screw gave good clinical and radiological outcomes in the management of lateral malleolus Weber A or B fractures with transverse or short oblique or spiral patterns without prominent subcutaneous hardware, soft tissue complications or non-union.

Declarations

Ethics approval and consent to participate

Ethics committee approval (Ortho-
surg_60MedResearch_intramedullary_screw_Lateral_malleolus_0000060)

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Consent to publish:

A written consent has been taken from all patients to participate in the study without sharing their personal information (only x rays and data), signed in Arabic language and inserted in their medical files.

Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on request.

Competing interests

The authors declare that they have no conflict of interest.

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Authors' Contributions

M, I, Abulsoud: - Surgical technique and shared in writing manuscript, Data analysis

A, A, Al Sebaie: - Study design and developing the research question

A,R, Darwish: - Study statistics, data analysis, follow up of patients and revising the manuscript

M, Moawad: - Surgical technique and participation in writing manuscript

E, ElZahed: - Surgical technique and participation in writing manuscript

T, M, Abd El-Ghaffar: - Data analysis, revising the manuscript

M, Elmarghany Surgical technique and participation in revising manuscript

A, Elgeushy. Surgical technique and participation in writing manuscript .

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Figures



Figure 1

a preoperative x rays in AP, lateral and mortise views b: postoperative x rays 6 months postoperatively



Figure 2

a: preoperative x-ray in AP, Lateral and mortise views b: postoperative x rays

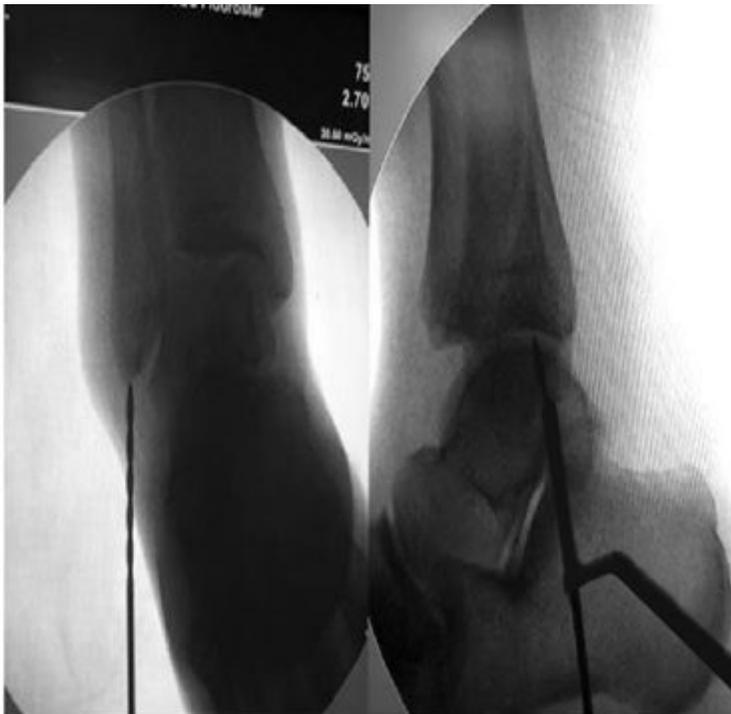


Figure 3

drill hole entry at anteroposterior, And lateral views