

Isolated lateral malleolus fractures; operative versus nonoperative treatment

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Background

Many surgeons would advocate surgical management for isolated stable Weber type B ankle fractures to avoid hazards of nonoperative management. Concerns about surgical risks urge other surgeons to consider nonoperative alternatives. Hence, it has become apparent that this type of fracture requires precise assessment of the overall ankle stability to achieve good outcomes using either operative or nonoperative treatment.

Aim

This study aimed to compare surgical and nonsurgical management of non or minimally-displaced stable Weber B ankle fractures regarding functional and radiological outcomes.

Patients and methods

This prospective randomized controlled trial was conducted between June 2021 and December 2022, involving 58 patients with stable isolated Weber B fractures with intact syndesmosis, in which stability was determined by Weight-bearing (WB) stress radiographs. Patients were randomized to group A [operative treatment with open reduction and internal fixation (ORIF)] or group B (nonoperative treatment with cast), including 29 patients in each group. Primary outcome analysis included American Orthopedic Foot and Ankle Society (AOFAS) score at 1-year follow-up for functional outcome. Secondary outcome analysis included an EQ-5D-5L questionnaire at 1 year for health status/functional outcome, in addition to a 3-weekly radiographic assessment till fracture union and at 6 months for radiological outcome.

Results

There were no significant differences identified between surgical and nonsurgical management of Weber B fractures concerning functional outcome; the mean American Orthopedic Foot and Ankle Society score at the end of the follow-up was (97.93 ± 4.123) for the operative group and (97.24 ± 4.549) for the conservative group (P -value= 0.548). Concerning quality of life (QoL), this study identified no differences between surgical and nonsurgical management. Radiological union was significantly earlier with the operative group, however, at 6 months, both groups showed fully radiologically united fibula on plain radiographs.

Conclusion

Nonoperative management is comparable with operative management for such type of fracture. Consequently, when deciding the optimal intervention for patients with such injuries it is important to consider individual surgeon's experience and other outcomes such as effects and cost. A conversation regarding treatment options should be held with the patient.

Keywords:

stable Weber B, isolated lateral malleolus fracture, treatment options, functional outcome

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Introduction

Isolated lateral malleolus fractures are among the most common fracture patterns in the orthopedic emergency room. Epidemiologic data state that isolated lateral malleolus fracture is the most common ankle fracture pattern (56–65% of all ankle fractures) [1]. The ankle joint resembles as a 'ring' in which bones and ligaments contribute to the overall stability. If this 'ring' is broken at one site only, it is stable, but if it is broken at two or more sites, it becomes unstable [2]. Being an intra-articular fracture of a crucial weight-bearing (WB)

joint, surgeons argue about the most appropriate management of such fracture that leads to the desired functional outcome with the least morbidity, many surgeons would advocate surgical management for isolated stable Weber type B ankle fractures to avoid

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hazards of nonoperative management, however, wound infections and dehiscence, complex regional pain syndrome (CRPS), hardware prominence and irritation, need for later removal and neuro-vascular injury [3]. Up to 20% of surgically managed distal fibular fractures result in injury to the superficial peroneal nerve [4]. Others adopt the non-operative treatment as it avoids the surgical risk with comparable functional outcomes [3,4]. Despite avoiding surgical risks, conservative treatment may be complicated by delayed or nonunion, displacement and loss of reduction, ankle stiffness, and CRPS [5]. When the medial malleolus is fractured together with the lateral malleolus, it is a bi-malleolar fracture requiring surgical intervention. But when it comes to isolated trans-syndesmotic lateral malleolus fractures, both a lateral malleolar fracture without an impaired deltoid ligament and the combination of a lateral malleolar fracture with a deltoid ligament rupture appear as uni-malleolar on initial plain radiographs [6]. It is therefore obligatory to identify the unstable fractures with accuracy. The deltoid ligament integrity as well as the syndesmosis are of key importance in assessing the stability of isolated trans-syndesmotic lateral malleolus fractures [2]. Currently used imaging to assess ankle stability includes manual stress radiographs, gravity stress radiographs, and WB radiographs, the latest have recently been shown to be the best radiographic method to evaluate the stability of isolated lateral malleolar fractures [2]. Generally, operative management includes many options, simplest option is using just interfragmentary lag screws, although this is usually possible only with good bone quality, one cannot depend on lag screws alone to withstand the deforming forces, and the addition of a neutralizing plate has been the standard care for such fractures. Other options include tension-band wiring, intramedullary fixation, and the most widely used plating [7]. Tension-band wiring is used more with the transverse noncomminuted Weber A fractures. Intramedullary fixation can be done using a screw or a flexible nail in selected cases. Plating is still superior to other options of fixation especially in the Weber B fractures as it provides the absolute stability required for such fracture type and pattern. Options for nonoperative management were also variable, commonly the ankle is immobilized in a short-leg cast or air-boot [8], other studies have suggested that even the use of the elastic bandage alone can end in the similar outcome in such stable fractures [9,10]. This study aims to compare the outcomes after fixation of isolated stable lateral malleolus fractures using either operative treatment in the form of open reduction and internal fixation (ORIF) using one third stainless-steel tubular plates or non-operative treatment in the form of immobilization in a below knee cast.

Patients and methods

The study was conducted between June 2021 and December 2022 on 58 patients. By the end of December 2021, all the cases had received the treatment and were enrolled in the study and followed-up till the end of December 2022. All patients were randomized using the closed envelope technique into two equal groups; group A (operative) and group B (nonoperative). The group A patients were managed operatively with ORIF using 1/3 tubular plates through a longitudinal lateral approach. All surgeries were performed in the supine position with a sandbag beneath the ipsilateral iliac bone under general or spinal anesthesia and tourniquet, with the help of an image intensifier. While group B patients were managed non-operatively in a below knee cast. Ethical committee approval of our institute was obtained before starting the study. Inclusion criteria included skeletally mature patients with closed isolated stable Weber type B ankle fractures with an intact syndesmosis as confirmed by initial and WB stress radiographs. Exclusion criteria included patients with associated other fractures, bi/tri-malleolar fractures, open fractures, unstable fractures, displaced lateral malleolus fracture more than 5 mm, and those with associated chronic debilitating diseases (e.g. DM, Malignancy...etc.).

A total of 58 patients with isolated stable Weber type B ankle fracture were included in the study and distributed randomly into two equal groups of 29 patients. Group A patients were operated upon, while group B patients received conservative treatment in cast, all patients were followed-up for 1 year. In group A, 25 patients reported low energy trauma and 4 patients reported high energy trauma. In group B, 24 patients reported low energy trauma and 5 patients reported high energy trauma. The right ankle was affected in 14 (48.3%) patients and the left ankle was affected in 15 (51.7%) patients in group A. While in group B, the right ankle was affected in 13 (44.8%) patients and the left ankle was affected in 16 (55.2%) patients. The age of the patients ranged from 18 to 72 years with mean 39.86 ± 16.071 years in group A and from 19 to 66 years with mean 40.79 ± 14.191 years in group B. The study included 14 (48.3%) females and 15 (51.8%) males in group A and 15 (51.7%) females and 14 (48.3%) males in group B. The time from injury to surgery was 1–10 days (average: 5.5 days). Casting was performed either immediately at presentation or after 1 week waiting for edema and ecchymosis to subside in a below-knee backslab. This was done to seven patients.

Preoperatively and precasting

All patients were evaluated clinically including neurovascular examination and soft-tissue status

and radiologically using plain radiographs in the AP, lateral and mortise views. In addition to WB stress radiographs of the ankle. AP view was used to assess fracture displacement and the talar tilt. Lateral view was used to assess the fracture displacement. Mortise view was used to assess the talocrural angle, the medial clear space and the syndesmosis [11]. The WB stress radiographs were used to assess the integrity of the medial ligaments as well as the syndesmosis [6,12,13].

Operative technique

Lateral approach to the distal fibula with careful sharp dissection were carried through subcutaneous fat to avoid injury to the superficial peroneal nerve which is variably encountered at this level. Reduction is achieved with the help of pointed reduction forceps or by putting the plate directly and holding it by plate holder. Reduction is assessed using the image intensifier with careful inspection of the normal radiographic parameters and criteria on AP, lateral and mortise views. ORIF with a lag screw and laterally applied protection (neutralization) plate using the precontoured 1/3 tubular plate (Fig. 1) or postero-laterally applied anti-glide plate without precontouring is done. Closure of the wound was done in a routine manner. Local anesthetic infiltrated around the wound to help optimize postoperative pain control.

Casting technique

The knee was placed on a support, and the ankle joint was put in neutral position. The padding material and the plaster/fiber bandage are rolled from distal to proximal. The padding was rolled extending distally and proximally slightly beyond the final extent of the plaster/fiber to ensure soft cast edges. The cast should be extending from the metatarsal heads up to the tibial tuberosity. Cast was molded softly to the contours of the foot, with the foot and ankle held in neutral (plantigrade) position while knee in flexion.

Post-operative protocol

WB was started Immediately in the form of progressive WB protected with crutches or walker; toe touch in the first 3 weeks post-operative. then partial WB is continued for the next 3 weeks. Range of motion (ROM) was started immediately in the form of active and passive plantarflexion/dorsiflexion in the first 3 weeks postoperative. then Active and Passive Eversion/Inversion were added in the next 3 weeks. Radiographs were obtained immediately postoperative (Fig. 2), every 3 weeks till fracture union, at 3 months, and at 6 months.

Postcasting protocol

Strict nonweight bearing (NWB) was instructed for 6 weeks (or the duration of the cast if required to be

kept longer) then full WB, as tolerated, was allowed immediately after cast removal. Full ROM was allowed immediately after cast removal. Radiographs were obtained 1 week post-cast to check for fracture displacement/stability, every 3 weeks till fracture union, at 3 months, and at 6 months.

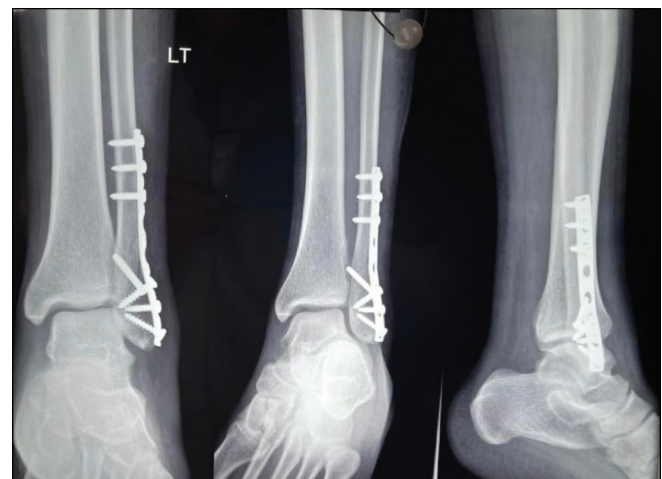
All patients of both groups were evaluated clinically for functional outcomes at the final follow-up at 1 year using the American Orthopedic Foot and Ankle Society score (AOFAS). On the AOFAS, a score more than 90 is considered excellent, more than 80 points is good, greater than 70 is considered fair, and less than 70 is considered poor. Secondary outcome measures included EQ-5D-5L score at 1 year as well as time to full union. The EQ-5D-5L (European Quality of Life 5 Dimensions 5 Level Version) is a generic tool that can assess patients' quality of life using 5 dimension (Mobility, Self-care, Usual activities, Pain/Discomfort, Anxiety/Depression) with 5 levels of

Figure 1



Showing the final plate fixation on the lateral surface of the lateral malleolus and shaft.

Figure 2



Showing immediate postoperative radiographs; anteroposterior, mortise and lateral views.

response to each dimension (No, Slight, Moderate, Severe, Extreme problem), it also includes a vertical EQ visual analog scale (EQ-VAS, 0–100 points) where 0 points correspond to the worst possible health status, while 100 points correspond to the best possible health status.

Rehabilitation to all patients

After 6 weeks for the operative group or cast removal for the conservative group, all patients were subjected to progressive strengthening, stretching and flexibility exercises applied by an expertise physiotherapist, aiming at gaining full ROM, WB and return to normal activities.

Statistical methods

The primary efficacy end-point was prospectively defined as reduction of AOFAS score from baseline score to 1 year post-management (range from 0 to 100) to evaluate the functional outcome. Assuming a SD of 2, a sample size of 58 was required to achieve 80% power to detect 15% of difference as statistically significant. Therefore, each group should include at least 29 patients. Allowing a drop off of 10%, each group should include 32 patients. The primary outcome was intention to treat, and involved all patients who were randomly allocated and assigned. Data was fed to the computer and analyzed using IBM SPSS software package version 20.0. Armonk, NY: IBM Corp. Qualitative data were described using number and percent. The Kolmogorov-Smirnov test was used to verify the normality of distribution. Quantitative data were described using range (minimum and maximum), mean and standard deviation. Significance of the results was judged at the 5% level. *P* values less than 0.05 were considered statistically significant.

Results

Our mean AOFAS score at the end of the follow-up of both the operative group (97.93 ± 4.123) and conservative group (97.24 ± 4.549) showed no statistically significant difference with a *P*-value of 0.548 (Table 1).

According to the EQ-5D 5 L questionnaire; the mobility dimension of the questionnaire was compared between both studied groups at 1 year follow-up. In group A (operative); 27 (93.1%) patients chose answer no. 1 (no problems) while the remaining two (6.9%) patients chose answer no. 2 (slight problems). In group B (conservative); 25 (86.2%) patients chose answer no.1 (no problems) while the remaining four (13.8%) patients chose answer no. 2 (slight problems). Showing no statistically significant difference between both groups with a *P*-value of 0.670. The pain/discomfort

Table 1 American Orthopedic Foot and Ankle Society score compared between both groups at 1 year follow-up

	Group	N	Mean	SD	<i>P</i> Value
AOFAS score	Operative	29	97.93	4.123	0.548
	Conservative	29	97.24	4.549	

Table 2 EQ-VAS % compared between both groups at 1 year follow-up

	Group	N	Mean	SD	<i>P</i> Value
EQ-VAS %	Operative	29	97.93	3.900	0.097
	Conservative	29	95.90	5.171	

dimension of the questionnaire was also compared between both studied groups at 1 year follow-up. In group A (operative); 23 (79.3%) patients chose answer no. 1 (no problems) while six (20.7%) patients chose answer no. 2 (slight problems). In group B (conservative); 21 (72.4%) patients chose answer no. 1 (no problems) while eight (27.6%) patients chose answer no. 2 (slight problems). Showing no statistically significant difference between both groups with a *P*-value of 0.539. All (100%) patients of both studied groups responded with (no problems) to the Self-care, Usual activities and Anxiety/Depression dimensions of the EQ-5D-5L questionnaire. The second part of the questionnaire; the EQ-VAS, was also recorded at 1 year follow-up for each patient in both studied groups with mean score $97.93\% \pm 3.900$ for the operative group (A), and $95.90\% \pm 5.171$ for the conservative group (B) with a *P*-value of 0.097 showing no statistically significant difference between both studied groups (Table 2).

The mean time for clinical union to occur was 6.31 ± 0.930 weeks in the operative group, and 7.86 ± 1.481 weeks in the conservative group. The mean time for radiological union to occur was 8.48 ± 1.617 weeks in the operative group, and 11.59 ± 1.053 weeks in the conservative group.

Mild stiffness (according to the AOFAS score) was encountered in four (13.7%) patients in the conservative group. While in the operative group, three (10.34%) patients experienced delayed wound healing with no signs of infections.

Discussion

The treatment of isolated lateral malleolus fractures of the Weber B type has long been a debated topic [14]. Over the last decades, literature has shown controversy over the appropriateness of either operative or conservative treatment of such injuries. To date, there is no clear determined answer as to which treatment

modality is appropriate when a minimally displaced fracture is present [14]. Operative treatment by ORIF has proved to accelerate bone union by direct healing after anatomic reduction of the fracture, with the rigid internal fixation making the external support dispensable, hence, allowing early ROM. However, surgical risks such as infection, neurovascular injury and DVT has been accused for directing decision towards the non-operative path [4,15]. Nonoperative treatment has shown to produce comparable functional outcome to the operative treatment, with the advantage of avoiding unpleasant surgical risks. However, complex regional pain syndrome (CRPS) remains the most challenging adverse effect of the conservative management to both the patient and the treating physician [5,15].

Many literature discussed treatment modalities of stable isolated trans-syndesmotic lateral malleolus fractures (Weber type B) according to Danis-Weber classification.

Bauer *et al.* in 1985, Vogler in 1994, Weber in 1966, and Michaelson *et al.* in 1994 [14,16–19] have asserted that fibular fractures with 2 mm of displacement or less should be treated conservatively. Mandracchia *et al.* [20] stated that more than 2 to 3 mm of displacement of a malleolus is an indication for surgery. Vander Griend *et al.* [21] suggested that fractures with as much as 3 mm of fibular displacement that were managed conservatively resulted in good clinical results. Other studies [5] suggested that stable fractures can be safely treated non-operatively, even despite fibular displacement up to 5 mm. In this study, fibular displacement less than or equal to 5 mm was included and there was no statistically significant difference between operative and conservative management in this type of fracture.

Cedell, and Solonen *et al.* [22,23] performed a study on 38 patients with isolated lateral malleolus fracture (SER II) managed operatively ORIF with follow-up (5–10) years and the result was 36 patients had excellent results, 1 patient had good results and one patient had fair results regarding pain and functional activities.

So Cedell, and Solonen *et al.* support open reduction and internal fixation of such fracture as shown in (Table 3). However, Cedell's study did not compare operative with nonoperative management. In this study; all patients with stable isolated trans-syndesmotic lateral malleolus fractures who were managed operatively with 1 year follow-up showed excellent results according to AOFAS score (>90 points) regarding pain and functional activities. However, the short term follow-

up for 1 year was a weak point in the study. This study is different from the study of Cedell in that the follow-up period is shorter (1 year) compared with the 5–10 years, and the number of patients treated operatively is less (29 patients) compared with the 38 patients in Cedell's study. In addition, the results of this study showed equal functional outcome with either operative or conservative management.

Kristian D. Kristensen and Tonny Hansen *et al.* [24] performed a study on 94 patients with isolated lateral malleolus fracture (SER II) treated conservatively with follow-up for about 20 years and found that 89 patients had excellent results regarding pain and functional activities, 5 patients had good results and none of the patients had poor results. So Kristian

D. Kristensen and Tonny Hansen *et al.* supported that this particular fracture is so benign that it can be treated closed without reduction as shown in (Table 3). In this study; all patients with stable isolated trans-syndesmotic lateral malleolus fractures who were managed conservatively showed excellent results according to AOFAS score (>90 points) regarding pain and functional activities. However, the short term follow-up for 1 year remained a weak point. This study is different from the study of Kristian D. Kristensen and Tonny Hansen *et al.* in that the follow-up period is shorter compared with the 16–25 years, and the number of patients treated conservatively is less (29 patients) compared with the 94 patients in Kristensen's study, but the results of this study were comparative showing equal functional outcome with either operative or conservative management.

Yde and Kristensen *et al.* in 1980 [25] performed a comparative study between operative and closed management on 69 patients with isolated lateral malleolus fracture (SER II) with 3–10 years follow-up and found that 30 patients with ORIF had excellent results while 29 patients with closed management had excellent results. They also found 4 patients with ORIF and 6 patients with closed management had good results regarding pain and functional activities, no patients had fair results. So Yde and Kristensen *et al.* found no statistical difference between the two groups as shown in (Table 3). This study agrees with Yde and Kristensen *et al.* in that both studies showed no statistical difference between operative and conservative management in such type of fracture.

Lauge-Hansen [26] suggested, more than 60 years ago, that stable SER-II ankle fractures (equivalent to stable Weber B fractures) do not require anatomic reduction, and satisfactory function is expected with

Table 3 Comparison between this study and other studies regarding functional outcome by (American Orthopedic Foot and Ankle Society) score and radiological union^[14,22,23,24,25]

	Yde and Kristensen <i>et al.</i>	Cedell and Solonen <i>et al.</i>		Kristian D., Kristensen and Tonny Hansen <i>et al.</i>	Krannitz <i>et al.</i>		This study	
	Open	Closed	Open	Closed	Open	Closed	Open	Closed
Treatment modality	Open	Closed	Open	Closed	Open	Closed	Open	Closed
Observation time	3-10 years	5-10 years		20 years	3 years		1 year	
No. of patients with (Excellent)	30	29	36	89			29	29
No. of patients with (Good)	4	6	1	5			0	0
No. of patients with (Fair)	0	0	1	0			0	0
Total no. of patients	34	35	38	94	26	26	29	29
Mean time to radiologic healing					48.69 days	89.38 days	8.48±1.617 wks (59.36±11.32 days)	11.59±1.05 wks (81.13±7.37 days)

nonoperative treatment. This is supported by this short-term study. Long-term outcome studies [17,25] had also supported this.

Krannitz *et al.* [14] performed a study on 52 patients with supination-external rotation type II fractures examined from (2001 to 2004). This included 26 surgically managed patients and 26 conservatively managed patients. Krannitz *et al.* found that the mean time for cortical bridging to occur was 89.38 days in the conservative group and 48.69 days in the surgical group, indicating a significantly longer time to radiological healing with the conservative management. However, the study did not take the functional outcome into consideration. This study supports Krannitz *et al.* in that the radiological healing took a significantly longer time to occur with conservative management (Table 3). However, the advantage of the earlier radiologic healing with the surgically treated patients did not add any privilege to the final functional nor radiological outcome at 6 months in these patients.

A recent systematic review [15] revealed no significant difference between operative and non-operative management of stable Weber B fractures with respect to functional and radiological outcomes.

The study (CROSSBAT: Combined Randomized and Observational Study of Surgery for Type B Ankle Fracture Treatment) agreed with this study in that surgical management is not superior to nonsurgical management for the treatment of 44-B1 ankle fractures with minimal talar shift at 1 year and is also associated with increased adverse events [27].

This study lacked the option of conservative treatment in a functional air boot, which have shown to result in lower risk of fracture displacement, DVT and delayed union, in addition to fewer outpatient clinic

visits and a reduced number of radiographs obtained in the clinic according to Abdelaal A *et al.* [28]. Despite the functional boot allowed early WB and ROM and prevented the stiffness and CRPS seen in cast patients, there was no significant difference regarding the final functional outcome [28]. This study agrees with Abdelaal A *et al.* in that in the absence of clinical and radiological evidence of instability, Weber B transyndesmotomic isolated fractures could be treated safely conservatively.

The limitations in this study included the short time of follow-up (1 year) and the small sample size (29 in each group), a larger sample size and longer term follow-up should be considered. Also this study did not consider the functional air boot which was difficult to apply in our community.

This study supported the emerging role of the WB stress radiographs in determining isolated lateral malleolus fracture stability, without over-diagnosing the instability, allowing surgeons to safely manage the patients conservatively. This in turn led to reduction of the surgical costs and hazards.

Conclusion

In conclusion, patients with isolated lateral malleolus fracture (Weber type B) that is minimally displaced and stable on initial radiographs, should have WB radiographs obtained to evaluate for syndesmosis widening, the medial clear space (MCS), the presence or absence of lateral talar subluxation/tilt, the length/rotational alignment of the fibula and fracture displacement. If stability is proven, nonoperative management is comparable with operative management in such type of fracture regarding functional and radiological outcomes; the two groups showed nearly equal results. A conversation regarding treatment options should be held with the patient.

Non-operative management requires close follow-up and compliant patients, both during cast and rehabilitation periods to prevent converting into unstable fracture (SER IV) before fracture union and to prevent CRPS after cast removal. Operative management requires compliant patients following range of motion and WB instructions as well as wound care instructions to avoid implant failure and surgical site infection. A longer follow-up period and a larger sample size are recommended for more accurate assessment. Clinical trials comparing operative with nonoperative treatment should consider including non-operative treatment with a functional boot versus cast.

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Conflicts of interest

There are no conflicts of interest.

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