Posterior versus lateral plating of lateral malleolus fractures using a posterolateral approach

Ahmed K. El Ghazawy, Mohamed Ismail Kotb, Ahmed Saeed Younis

Faculty of Medicine, Orthopedic Department, Ain Shams University, Egypt

Correspondence to Mohamed Ismail Kotb, Faculty of Medicine, Orthopedic Department, Ain Shams University, Cairo, Egypt
Tel: +201112590513;
Fax: 0112590513;
e-mail: mkotb37@gmail.com

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Aim
We compared the clinical outcomes of fixing lateral malleolus fractures with lateral or posterior plating in combined lateral and posterior malleolar ankle fractures.
Methods
We randomized thirty patients with ankle fractures involving the posterior and lateral malleoli into two groups. In group 1, we dissected laterally, raising a lateral skin and subcutaneous flap to allow lateral fixation of the lateral malleolus. In group 2, we did not raise the flap fixing the lateral malleolus posteriorly by deep dissection and retracting the peroneal tendons laterally. During the follow-up period, we assessed pain at six months and at the end of the follow-up, ankle range of motion, wound complications, reoperation rates, fracture union, implant failure, and foot and ankle disability index (FADI).
Results
The mean follow-up period was 24.33 months. The mean age of the included participants was 41.76 ± 7.3 years. The mean visual analogue score VAS score at six months follow-up was 2.13 ± 0.54 in group 1 and 3.6 ± 0.76 in group 2, which decreased to one in group 1 and two in group 2 at the end of follow-up. The mean FADI was 89.8 ± 3.76 in group 1 and 90.7 ± 2.45 in group 2. The reoperation rate was 6.6% in group 1 and 26.6% in group 2 Fixation of all posterior malleolus fractures was done in all patients, union was achieved with no complications.
Conclusion
There is no clinical difference between lateral and posterior plating of the lateral malleolus through the posterolateral approach.

Keywords:
ankle fractures, lateral plating, posterior plating, posterolateral approach to the ankle

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Introduction

Ankle fractures are common ankle injuries representing 10.2% of all fractures [1]. Tri-malleolar fractures represent 10% of all ankle fractures [1,2]. Tri-malleolar ankle fractures are rising in incidence, representing 40 per 100 000 people per year [3]. Posterior malleolar fracture may involve the posterior tibial tubercle or the posteromedial tibial plafond. The most common type is avulsion of the posterior tibial tubercle, which involves avulsion of the posterior inferior tibiofibular ligament [4]. Fixation of the posterior malleolus is critical for ankle stability when it involves more than 20 to 25% of the articular surface [4,5].

Combined lateral and posterior malleolus fixation can be done through a posterolateral approach to the ankle [6]. Fibular fractures can be fixed with either lateral or posterior plating. Weber first described posterior plating for distal fibula fractures as it provides buttress force to the distal fragment [7]. However, the biomechanical advantage of posterior plating of the distal fibula fractures, peroneal tendons irritation, and injuries may be caused by such a plating technique. Higher rates of plate removal due to ankle pain were noted using posterior plating [7,8].

There are limited data in the current literature comparing posterior antiglide fixation to lateral fixation of the lateral malleolus through the postrolateral approach to the ankle. We conducted a randomized control trial comparing posterior and lateral fixation of the fibular fracture together with fixation of the posterior malleolus through the posterolateral approach to the ankle. This study aims to evaluate the advantages and disadvantages, functional outcomes, and complication rates of these two fixation techniques.

Materials and methods

We conducted a randomized control trial in the authors' institution. From January 2021 to March

2022, we included all adult patients with tri-malleolar ankle fractures with posterior malleolar fragments of more than 20% of the articular surface (Fractures with Lauge–Hansen classification type supination external rotation three (SER III) or pronation external rotation (PER IV)) fractures requiring posterior fixation together with fibular fixation. We excluded patients with unimalleolar or bimalleolar ankle fractures not involving the posterior malleolus and pilon fractures with an intact fibula. We randomized thirty patients into two groups using computer-generated sequences.

Preoperative data

Preoperative evaluation included history taking and reporting the age and sex of the patients. Radiological evaluation included plain X-rays of the ankle joint in two different planes and computed tomography of the ankle to evaluate the fracture pattern and its classification according to Lauge–Hansen classification system. Also, the American Society of Anaesthesiologists (ASA) score was used with all patients

Surgical details

Patients were positioned in a prone position with the knee slightly flexed to allow ankle dorsiflexion. We did not use a tourniquet in all patients. The skin incision was performed midway between the achilles tendon and the posterior border of the fibula. We used the posterolateral approach –between flexor hallucis longus (FHL) and peroneal tendons- to the ankle for open reduction and fixation of the posterior malleolar fragment. We raised the FHL tendon of the interosseous membrane caring not to injure the peroneal artery and its branches. We raised the periosteum of the posterior malleolus to ensure adequate reduction and fixation.

In group 1, we dissected laterally, raising a lateral skin and subcutaneous flap to allow lateral fixation of the lateral malleolus (Fig. 1) (Fig. 2). Care must be taken to avoid injury to the sural nerve.

In group 2, we fixed the lateral malleolus posteriorly by deep dissection and retracting the peroneal tendons laterally without raising skin and subcutaneous flap. We used anatomical distal fibula plate or one third tubular plate to fix the lateral malleolus and T plate for posterior malleolus fixation, fixation of the lateral malleolus was done first (Fig. 3).

Decision of posterior malleolus fixation was taken if the fractured fragment was more than 20% of the articular surface area.

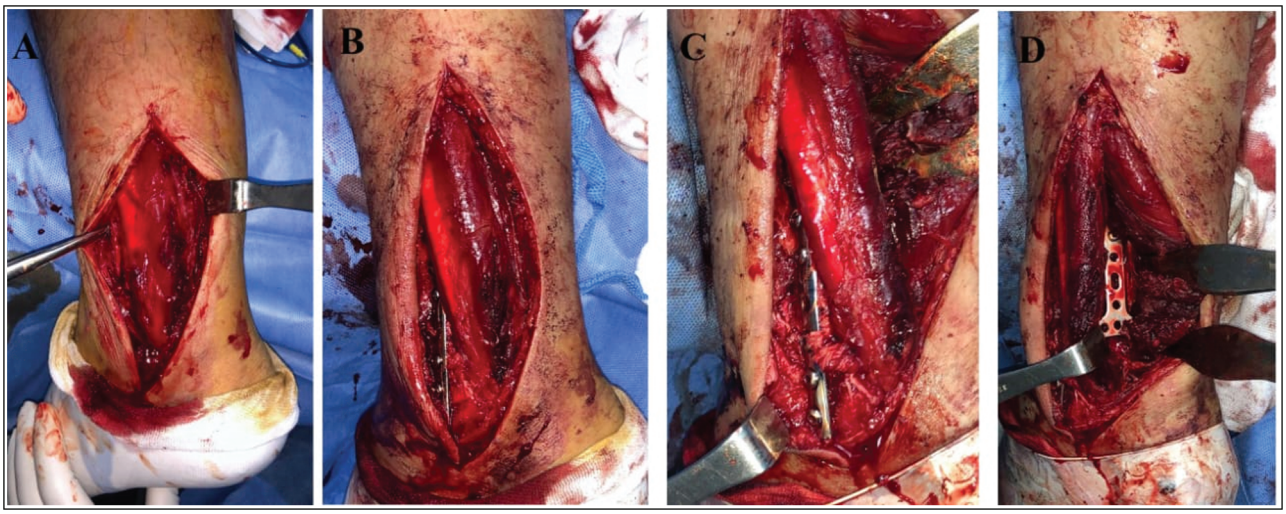
Postoperative data

Patients follow-up was done at 2, 4, 6, 8 weeks postoperatively then monthly till the end of follow-up period, patients were evaluated for early wound complications during the first three weeks postoperative, noting if any discharge, excessive swelling, skin sloughing was present, and late wound complications were evaluated later during follow-up period.

Follow-up x-rays were done every 2 weeks for assessment of fixation stability and fractures healing.

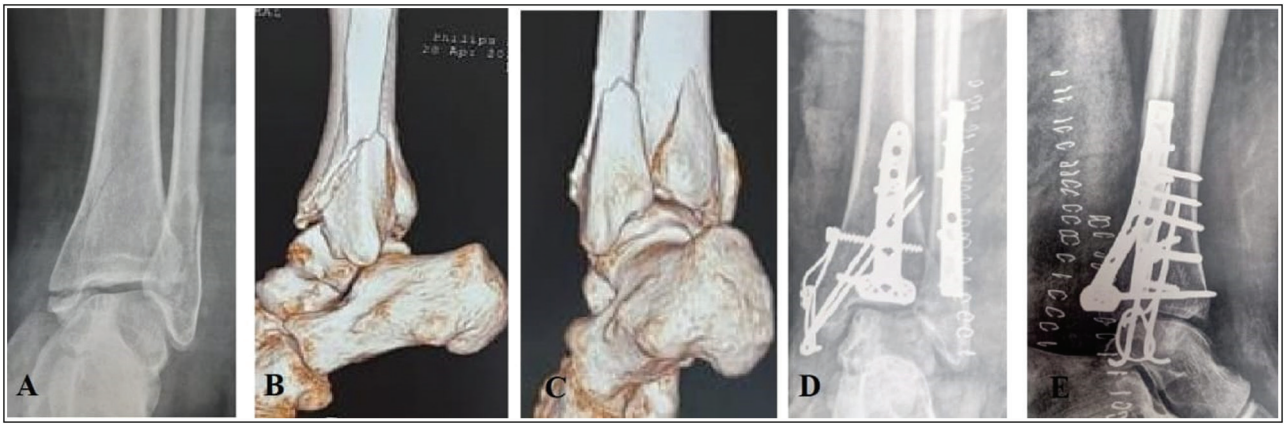
During follow-up, patients were evaluated for pain at 6 months and at the end of the follow-up, ankle range of motion, wound complications early in the first three weeks and late after three weeks, reoperation rates, fracture union, implant failure, VAS pain score and foot and ankle disability index (FADI). Patients performed physiotherapy after three weeks first range

Figure 1:



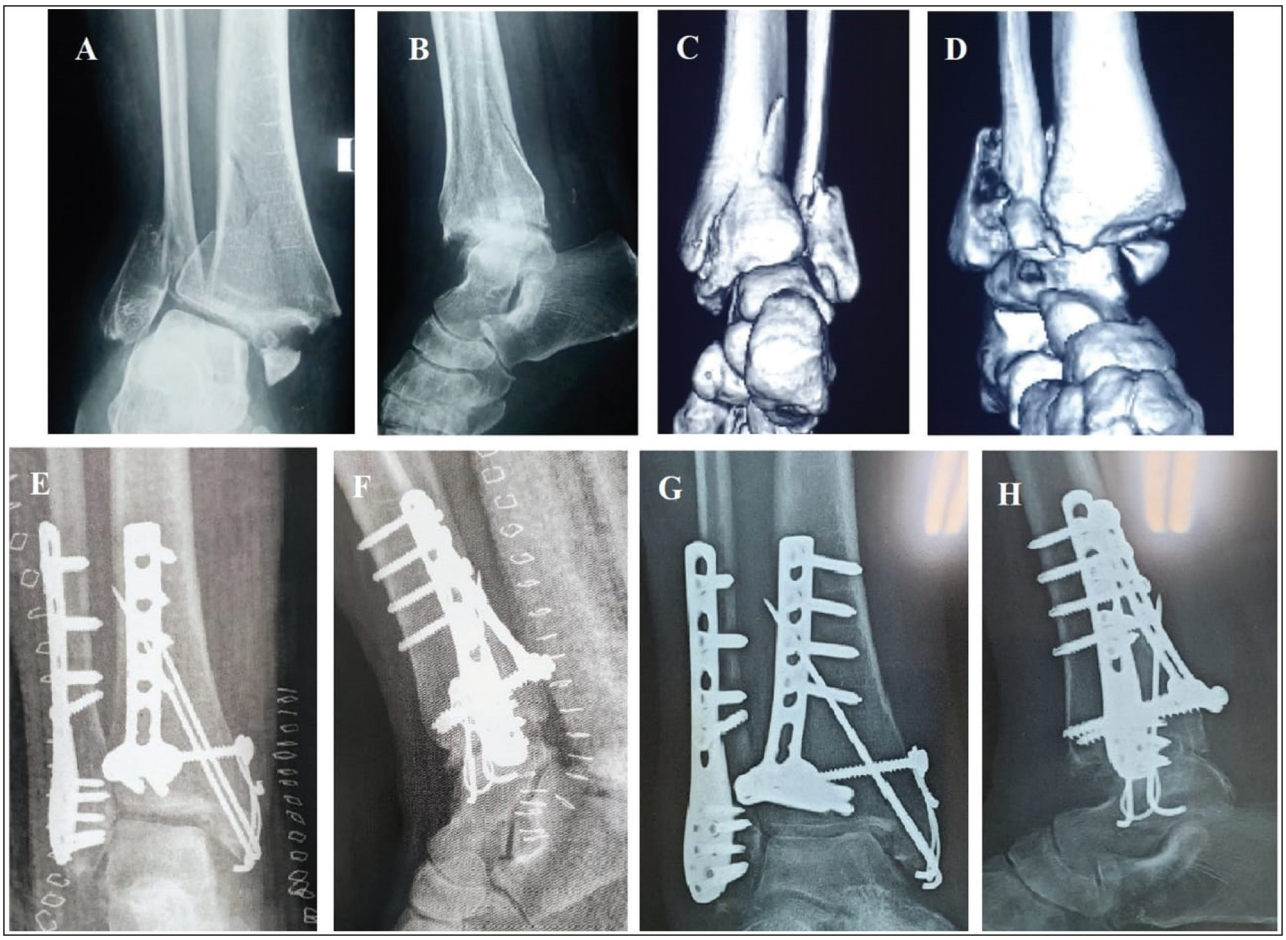
(a) Intraoperative photo showing the posterolateral approach. (b) Fibular plate inserted. (c) Medial dissection exposing posterior malleolus fragment. (d) Posterior plating of the posterior malleolar fracture using T plate distal radius.

Figure 2:



(a) PXR AP view showing Tri-malleolar ankle fracture PER type IV. (b) PXR lateral view showing lateral malleolar fracture configuration. (c) Postoperative PXR AP view showing lateral malleolar fixation using the lateral plating technique, and posterior malleolar fixation (T plate + percutaneous AP screw). (d) Postoperative PXR lateral view showing posterior plating of lateral malleolar fracture.

Figure 3:



(a) PXR AP view showing Tri-malleolar ankle fracture SER type IV. (b) CT with 3D reconstruction showing lateral malleolar fracture configuration. (c) CT with 3D reconstruction showing the posterior malleolar fragment. (d) Postoperative PXR AP view showing lateral malleolar fixation using a posterior plating technique, medial malleolar fixation (Tension band), and posterior malleolar fixation (T plate). (e) Postoperative PXR lateral view showing posterior plating of lateral malleolar fracture.

Table 1 Preoperative data

	ALL	Group 1	Group 2	*P* value
Age (mean)	41.76	42.8	40.73	0.6
Male	17 (56.6%)	8 (53.3%)	9 (60%)	
Female	13 (43.3%)	7 (46.6%)	6 (40%)	
Lauge-Hansen classification	SER3: 19(63.3%)	SER3:9(60%)	SER3:10(66.6%)	
	PER4:11(36.6%)	PER4:6(40%)	PER4:5(33.3%))	
ASA score	1: 19(63.3%)	1: 10(66.6%)	1:9(60%)	
	2:8(26.6)	2:3(20%)	2: 5(33.3%)	
	3:3(10%)	3:2(13.3%)	3:1(6.6%)	

of motion exercises then partial weight bearing at 6 weeks postoperatively, to full weight bearing exercises.

Ethical considerations

Informed consent was obtained from all patients included in this study for participating and publishing this study. All steps and details of the procedures were explained to the participants.

Study procedures

Data were collected for all the patients fulfilling the inclusion criteria and those who were managed with the procedure of the study. Data included history, examination, radiological evaluation, and functional outcome of all the patients

Statistical analysis

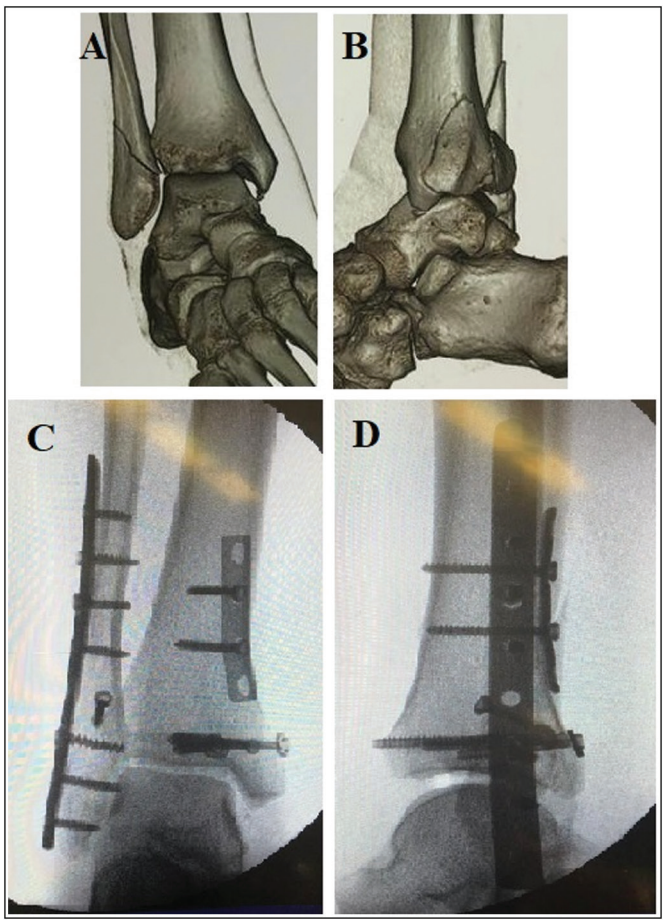
Data were analyzed using IBM SPSS statistics software, version 21 (IBM Corp., Armonk, NY). A paired sample *t*-test of significance was used when comparing related samples. A *P* value was considered significant when <0.05 and highly significant when <0.001.

Results

The mean follow-up period was 24.33 months. The participants' mean ageparticipants' mean age was 41.76 ± 7.3 years, including seventeen males (56.6%) and thirteen females (43.3%). Nineteen patients had SER III, and eleven had PER IV fractures by the Lauge-Hansen classification. Details of the preoperative data are illustrated in (Table 1).

The mean VAS score at six-month follow-up was 2.13 in group 1 and 3.6 in group 2 which was statistically significant, which decreased to one in group 1 and two in group 2 at the end of follow-up. The mean dorsiflexion range was 14.33 degrees in group 1 and 10.625 degrees in group 2. The mean plantar flexion range was 35.66 degrees in group 1 and 31.25 degrees in group 2. The mean FADI was 89.8 ± 3.76 in group 1 and 90.7 ± 2.45 in group 2 with no statistical difference between groups. In group 1, one patient (6.6%) developed wound edge discoloration and delayed wound closure which improved with follow-up, and another patient (6.6%) developed surgical site infection, which required superficial surgical debridement and closure. In group 2, one patient (6.6%) developed delayed wound healing with superficial inflammation and discharge, which

Figure 4:



(a) PXR AP view showing Tri-malleolar ankle fracture SER type IV with ankle dislocation. (b) PXR lateral view showing lateral malleolar fracture configuration. (c) CT with 3D reconstruction showing the posterior malleolar fragment. (d) CT with 3D reconstruction showing lateral and medial fragment configuration. (e) Postoperative PXR AP view showing lateral malleolar fixation using the lateral plating technique, medial malleolar fixation (Tension band), and posterior malleolar fixation (T plate). (f) Postoperative PXR lateral view showing lateral plating of lateral malleolar fracture. (g) Last follow-up PXR AP view showing the adequate union of lateral and medial malleolar fractures. (h) Last follow-up PXR Lateral view showing a united posterior malleolar fracture.

Table 2 Postoperative data

	ALL	Group 1	Group 2	
Follow-up (mean months)	24.33	24.4	24.26	0.88
Pain at 6 month VAS score		2.13	3.6	0.0006
Pain at the end of follow-up VAS score		1	2	0.009
ROM (dorsiflexion degrees)		14.33	10.625	0.017
ROM (plantar flexion degrees)		35.66	31.25	0.05
Wound complication	2 (6.6%)	1 (6.6%)	1 (6.6%)	
FADI (mean)		89.8	90.7	0.56
Union (mean weeks)		6.2	5.2	0.06
Implant failure		0/15	0/15	
Reoperation	5 (33.3%)	1 (6.6%)	4 (26.6%)	

improved with daily dressings and topical antibiotics. The mean time to union was 6.2 weeks in group 1 (Figs. 4) and 5.2 weeks in group 2. One patient in group 1 required surgical debridement, as mentioned before. In group 2, four patients required implant removal after union for chronic ankle pain (Table 2).

Discussion

We conducted a randomized control trial to compare the clinical outcomes of combined fixation of the lateral and posterior malleolar fragments using the posterolateral approach to the ankle either with lateral or posterior plating of the lateral malleolus. Our study showed that lateral plating causes less ankle pain at 6 month follow-up, but no statistically significant difference in pain at the end of the follow-up, both groups have no difference in functional outcomes.

Ankle fractures are among the most common fractures worldwide with a high morbidity rate including arthritis, chronic ankle pain, disability, and other physical and psychological consequences [9–12]. Ankle fracture surgeries are classified as one of the most painful surgeries with a high incidence of chronic postoperative ankle pain [13]. Posterolateral approach to the ankle allows adequate visualization and fixation of the posterior malleolas and fixation of the posterior and lateral malleolar fragments, and visualization of loose bodies and soft-tissue interpositions [6]. Posterior plating of the lateral malleolar fractures allows antiglide fixation in Weber B fractures and avoids subcutaneous position of the lateral plates and wound complications. While lateral plating may avoid peroneal tendons irritation and tendinopathy [14].

Kilian *et al.* compared lateral and posterior plating in 44 patients with Weber B ankle fractures and reported no difference in functional outcome scores measured by the American Orthopaedic Foot and Ankle Society hind foot-ankle score (AOFAS). They also reported one case of wound dehiscence in the lateral plating group, which did not occur with the posterior plating. Five cases of hardware irritation occurred in lateral plating compared to two cases in the same series [14].

Several studies reported no significant difference in peroneal irritation and tendinitis between both lateral and posterior plating. Lamontagne *et al.* did not find a significant difference between both techniques [15]. Winkler *et al.* found no peroneal complications in 93 patients with posterior plating during routine plate removal [16]. Treadwell and Fallat found tendinitis in two patients in their 71 patients series, which resolved with hardware removal [17]. Ostrum *et al.* reported that of 32 patients, two had peroneal tendinitis, which resolved and did not require hardware removal [18]. Ahn *et al.* in their cohort of seventy patients with isolated unilateral ankle fractures, reported the incidence of peroneal tendinitis to be 4.29% with lower incidence with good surgical dissection, low-profile plates, and short four or five-hole plates away from the peroneal groove [19].

On the other hand, in 2005, Weber conducted a combined cadaveric and clinical study to study the relation between antiglide plating of Weber B fractures and the peroneal system. The clinical part of the study reported a significant number of peroneal tendon lesions as it reported: 'Nine of 30 patients with plate removal were found to have a lesion of the peroneus brevis tendon, ranging from tenosynovitis (two) to superficial abrasion (four), partial transverse rupture (one), and longitudinal split (two)'. The cadaveric part of the study described the detailed anatomy of the distal fibula and the peroneal system. They found that lower plate placement opens the osteo-synovial sheath and makes the tendons directly contact with the plate, especially with the posteroanterior lag screw, which is the most important risk factor [8].

Biomechanical studies showed that there is no difference in fixation strength between posterior and lateral plating in healthy bone, but posterior plating may have a biomechanical advantage in osteoporotic bone [20]. Minihane *et al.*, in their biomechanical study reported that the torque to failure and construct stiffness was significantly greater on the side with the posterolateral antiglide plate than on the side with the lateral locking plate [21].

Fixation of the posterior malleolar fractures via the posterolateral approach allows direct access and fixation of the bony fragments, but it has the same incidence of skin complications as other ankle approaches [22]. Abdelgawad *et al.* reported that wound complications after the posterolateral approach are less disastrous than those occurring with the other ankle approaches, as the hardware is placed deeper and has greater soft-tissue coverage [23]. The posterolateral approach to the ankle in the experienced hand is a safe approach for the management of posterior and lateral malleolus fractures [24].

To our knowledge, our study assessed pain and functional outcomes in patients who had undergone combined fixation of the lateral and posterior malleoli either by lateral or posterolateral plating of the lateral malleolus utilizing the same approach. It also assessed the rate of skin complications related to lateral dissection of the skin and subcutaneous flap for lateral fixation of the lateral malleolus.

The limitation of our study is the small sample size, but it was adequately powered, which did not affect the reliability of our results.

In conclusion,

There is no clinical difference between lateral and posterior plating of the lateral malleolus through the posterolateral approach.

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Conflicts of interest

The authors have no conflict of interest.

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