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Original Article

Antegrade screw fixation for reverse oblique fractures of the medial malleolus

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Abstract

Objective: To assess the safety and effectiveness of antegrade minifragment lag screws in patients with reverse obliquity medial malleolar fractures.

Methods: A retrospective case series was conducted at a tertiary care institution between January 2019 and December 2024. Eligibility criteria included skeletally mature patients with reverse oblique medial malleolar fractures identified by radiographs and computed tomography, treated with antegrade minifragment screws. Functional outcomes were assessed using the AOFAS ankle-hindfoot score and the Olerud-Molander ankle score.

Results: Over the study period, two fellowship-trained orthopedic trauma surgeons performed 177 malleolar fracture fixations, of which 84 involved the medial malleolus. Six patients presented with the reverse oblique fracture configuration, all resulting from torsional trauma. All medial malleolar fractures achieved complete union without adverse events, with consolidation occurring within six weeks at the latest. After healing, no patient reported pain around the medial malleolus or implant-related discomfort.

Conclusion: The use of bicortical antegrade minifragment screws resulted in functional outcomes comparable to those described for standard fixation methods, without complications such as loss of reduction, nonunion, or malunion. Although the small sample size limits the external validity of the findings, the favorable results suggest that this technique may represent a viable alternative, especially in cases involving small fragments where bone preservation is essential.

Level of Evidence IV; Case Series.

Keywords: Ankle fractures; Fracture Fixation, Internal; Bone Screws.

Introduction

The incidence of ankle fractures is estimated at 112 to 187 per 100,000 people annually, with a rising trend observed in recent decades, particularly among aging populations[1,2]. Medial malleolar fractures account for approximately 32.5% of all ankle fractures and represent a clinical challenge due to their variability and implications for ankle stability[3-5].

Traditional classification systems, such as Herscovici et al.[6] and Pankovich[7], have been used to categorize medial malleolar fractures based on two-dimensional radiographs. However, beyond the AO/OTA[8] classification, these systems face limitations in terms of reproducibility and comprehensiveness, especially when applied to more complex configurations or uncommon variants, such as reverse obliquity fractures[9].

Study performed at the Felicio Rocho Hospital, Belo Horizonte, MG, Brazil.

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Advancements in three-dimensional (3D) mapping have enabled detailed characterization of medial malleolar fractures, revealing recurrent patterns that assist in surgical planning and the selection of fixation methods[10-12]. These patterns highlight the high morphological variability of such fractures, emphasizing the need for precise and clinically relevant classification systems[9,10]. However, while the interesting classification systems describe transverse or oblique patterns, they fail to adequately address reverse obliquity patterns.

From the mechanical efficiency perspective, interfragmentary fixation achieves optimal stability and effectiveness when the lag screw is placed perpendicular to the fracture line. In this context, retrograde screw fixation may not be ideal in reverse oblique patterns, as it does not provide an adequate angle for perpendicular fracture fixation. Consequently, antegrade fixation emerges as a mechanically more promising fixation alternative[13,14].

This study aims to assess the safety and effectiveness of antegrade minifragment lag screws in patients with reverse obliquity medial malleolar fractures, thereby advancing therapeutic approaches for this often-overlooked condition.

Methods

This retrospective case series was conducted in a tertiary institution from January 2019 to December 2024. Ethical approval to conduct the study was obtained from the Institutional Review Board. The medical records of patients who underwent surgery for a displaced/unstable malleolar fracture were evaluated. The inclusion criteria consisted of skeletally mature patients with reverse oblique medial malleolar fracture patterns who underwent fixation with antegrade minifragment screws. The reverse oblique medial malleolar fracture pattern was defined based on the orientation of the fracture line in the coronal plane, as identified on both plain radiographs and computed tomography. Specifically, the fracture line was characterized by an obliquity opposite to that of typical medial malleolar fractures, extending in a reverse oblique direction. Patients with medial malleolar fractures who did not undergo fixation with the aforementioned technique were not included. Exclusion criteria comprised patients who did not meet the minimum six- month follow-up period or had incomplete imaging exams.

The functional outcomes were assessed using the American Orthopaedic Foot & Ankle Society (AOFAS) ankle-hindfoot score[15] and the Olerud-Molander ankle score[16]. Epidemiological data, fixation techniques, functional outcomes, follow-up duration, and complications were thoroughly assessed.

Complications were defined as loss of reduction, fracture-related infection, nonunion, malunion of the medial malleolus, and soft tissue necrosis requiring additional surgical intervention.

Antibiotic prophylaxis consisted of intravenous cefazolin (1 g every 8 hours) administered for 24 hours in all patients. Upon discharge, thromboprophylaxis for deep vein thrombosis was prescribed using either enoxaparin (40 mg subcutaneously daily) or apixaban (2.5 mg orally twice daily) for 35 days, according to surgeon preference.

In our series, the indication for temporary transarticular external fixation was primarily based on the inability to maintain adequate reduction of the fracture-dislocation after initial splint immobilization.

Results

From January 2019 to December 2024, two fellowship-trained orthopedic trauma surgeons performed 177 fixations of malleolar fractures in one tertiary institution. Among the sample of 177 malleolar fractures, 84 involved the medial malleolus, and six had a reverse obliquity pattern. Torsional trauma was the characteristic mechanism of injury in all six patients.

Table 1 provides the characteristics of the six patients with reverse obliquity fractures. Figures 1-6 illustrate the fixation strategy for medial malleolus fractures using antegrade minifragment screws.

A transarticular external fixator was applied in three patients. After the appearance of the wrinkle sign, patients underwent definitive open reduction internal fixation.

To illustrate the surgical technique and the evolution of treatment, we present two case examples below.

Patient 2

A 42-year-old woman sustained a torsional ankle injury and was diagnosed with an AO/OTA(8) 44B3 fracture of the left ankle (Figures 1 and 2). The soft tissues were in suitable condition for surgical fixation, and the patient underwent operative treatment eight days after the trauma. The procedure was conducted entirely in the prone position, thereby eliminating the need for intraoperative patient repositioning.

Table 1. Characteristics of the six patients presenting a reverse oblique medial malleolar fracture pattern.

Patient	Age	Sex	AO/OTA Classification	Fixation method
1	78	F	44-B3	1 antegrade minifragment screw (2.7 mm)
2	42	F	44-B3	1 antegrade minifragment screw (2.4 / 2.0 mm)
3	70	F	44-B3	2 antegrade minifragment screws (2.4 / 2.0 mm)
4	45	F	44-B3	2 antegrade minifragment screws (2.4 / 2.0 mm)
5	57	F	44-B2	1 antegrade minifragment screw (2.4 mm)
6	62	F	44-B3	1 antegrade minifragment screw (2.7 mm) + minifragment plate

F: Female.

Postoperative radiographs showed the quality of the reduction, and the patient was stimulated to move the operated ankle on the first day after surgery. Partial flat-foot weight-bearing in a boot was allowed as tolerated, and full weight-bearing was allowed after six weeks.

Figure 2 illustrates the range of motion after 12 weeks postoperatively.

Patient 3

A 70-year-old female patient presented with a torsional ankle trauma and sustained a fracture-dislocation of the right ankle (AO/OTA[8] 44B3) (Figures 3-5).

The patient was referred to our institution after eight days, presenting with significant edema and hemorrhagic blisters. A transarticular external fixation was initially applied due to poor soft-tissue conditions (Figure 3).

The patient was operated on 12 days after hospital admission, and the postoperative radiographs after six weeks show complete fracture healing.

Functional outcomes according to the AOFAS[15] and the Olerud-Molander[16] scores are presented in Table 2. Regarding complications, none of the patients with a reverse obliquity pattern experienced any of the aforementioned complications. All medial malleolar fractures healed uneventfully within a maximum period of six weeks. No patient reported medial perimalleolar pain or discomfort caused by the implants after fracture healing.

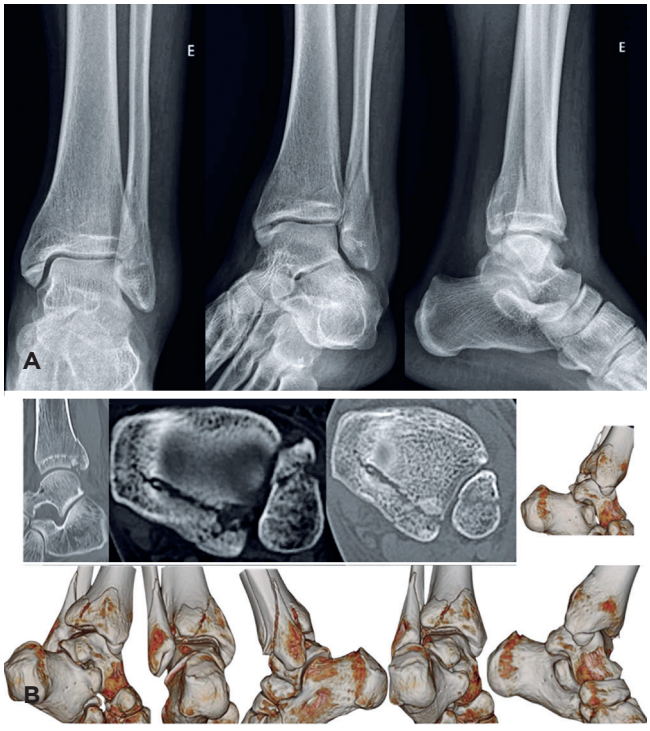

Figure 1. (A) Radiographs of the left ankle showing a trimalleolar ankle fracture. Observe the reverse oblique pattern of the medial malleolus. (B) Computed tomography scan in sagittal, axial, and 3D reconstruction of the left ankle showing a trimalleolar fracture.

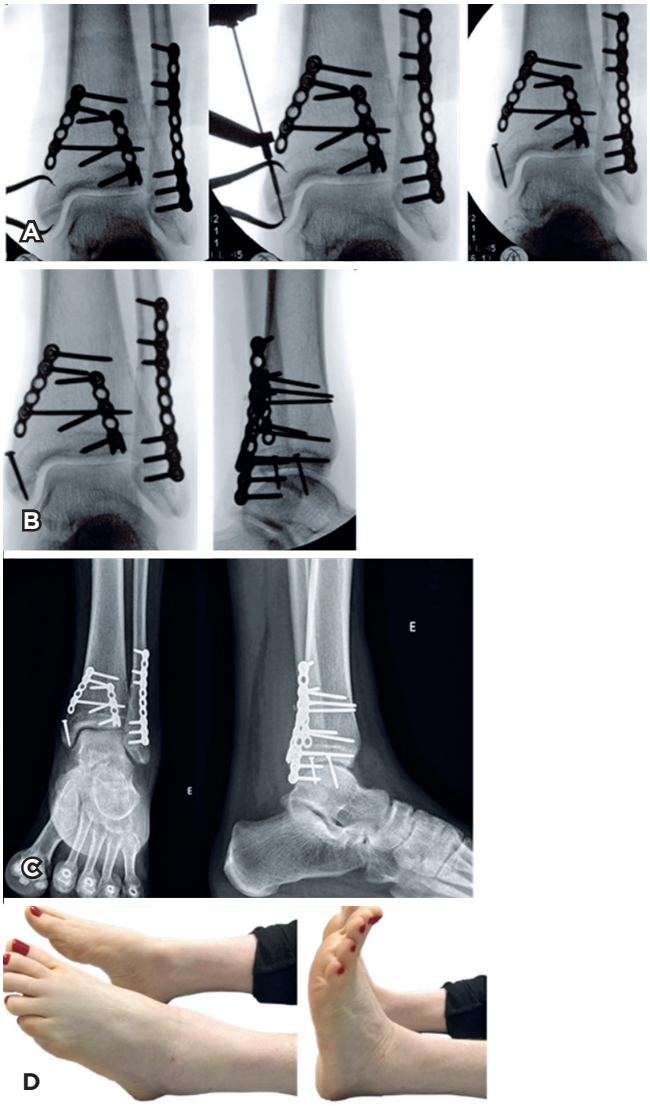

Figure 2. (A) Intraoperative fluoroscopic images showing fracture reduction and antegrade fixation of the medial malleolus using minifragment lag screws (2.4- and 2.0 mm screws). Observe the reverse obliquity of the medial malleolar fracture. (B) Postoperative fluoroscopy images in anteroposterior and lateral views showing fracture fixation using minifragment implants. (C) Postoperative radiographs after six weeks showing complete fracture healing. (D) Observe the symmetric range of motion of both ankles after 12 weeks postoperatively.

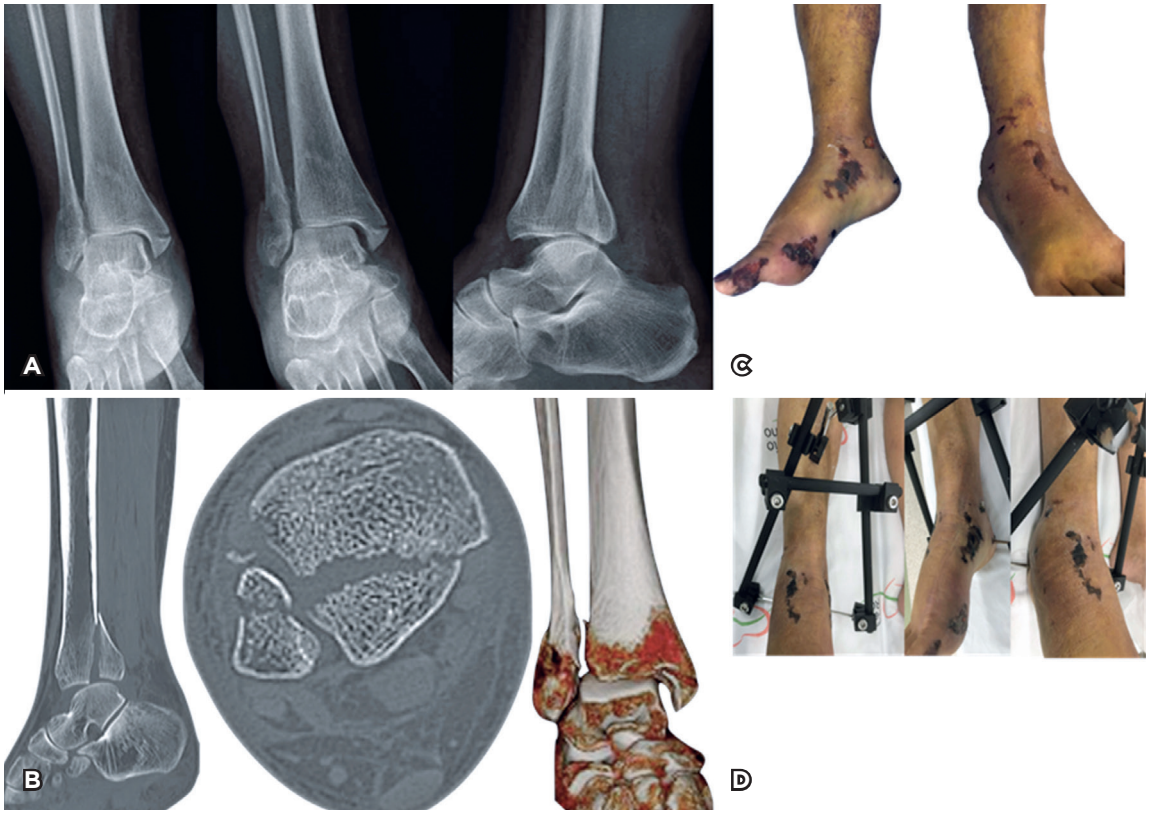

Figure 3. (A) Radiographs of the right ankle in anteroposterior and lateral views show the trimalleolar fracture-dislocation. Observe the reverse obliquity pattern of the medial malleolus. (B) Observe the sagittal, the axial, and the 3D reconstruction of the computed tomography scan showing the trimalleolar fracture dislocation. Observe the reverse oblique pattern of the medial malleolus. (C) Observe the clinical aspect of the right foot/ankle with edema and hemorragic blisters. (D) The right ankle was reduced and spanned. Note the presence of the wrinkle sign on the skin 12 days postoperatively, indicating improved soft tissue condition.

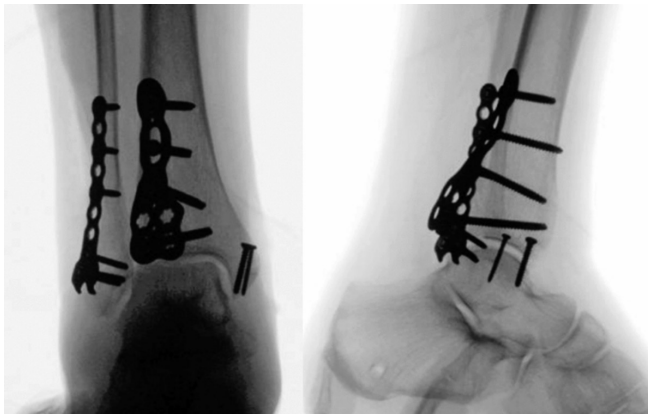

Figure 4. Observe the postoperative fluoroscopy images of the ankle showing fixation of the lateral malleolus with a 2.7 mm hook plate, fixation of the posterior malleolus with a 3.5 mm posterior plate, and fixation of the reverse oblique fracture of the medial malleolus with 2 antegrade minifragment screws (2.4 mm and 2.0 mm).

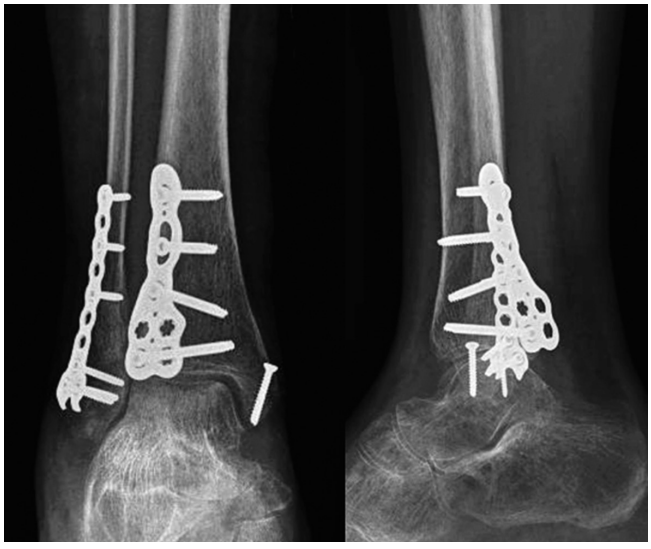

Figure 5. Radiographs of the right ankle in anteroposterior and lateral views showing complete fracture healing after eight weeks.

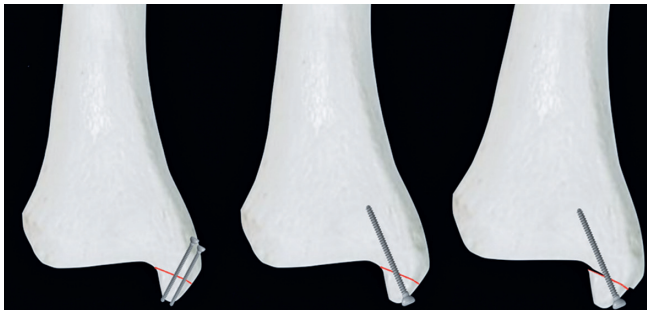

Figure 6. Illustration depicting the fixation of medial malleolar fractures using antegrade lag minifragment bicortical screws (A) and the standard retrograde screw technique (B). Note a potential complication associated with the retrograde screw technique in reverse oblique fractures. Due to compression, shearing forces may cause displacement of the fracture, as the compression is not perpendicular to the fracture line (C).

Table 2. AOFAS and Olerud-Molander scores

Patient	AOFAS[15] Total/100	Olerud-Molander[16] Total/100	Healing time (weeks)/ follow-up (months)	Complications
1	98	95	6/12	None
2	100	95	6/11	None
3	98	95	6/17	None
4	100	95	6/12	None
5	98	95	6/6	None
6	98	95	4 /7	None

AOFAS: The American Orthopaedic Foot & Ankle Society.

Discussion

In recent years, increasing attention has been directed toward the management of medial malleolar fractures. While the literature supports nonoperative treatment for undisplaced and minimally displaced fractures of the medial malleolus[17], a recent study reported that fixation of the medial malleolus in unstable ankle fractures, following fibular stabilization, was not superior to non-fixation in terms of primary outcomes[18]. However, one in five patients who underwent non-fixation exhibited radiographic non-union. Despite the low reintervention rate to address this complication, the long-term implications remain uncertain. These findings suggest that selective non-fixation of anatomically reduced medial malleolar fractures may be appropriate after successful stabilization of the lateral malleolus. It is important to note that this debate primarily pertains to medial malleolar fractures that are anatomically reduced following lateral malleolar fixation, which represents a different clinical scenario from the displaced and unstable fracture pattern evaluated in the present study.

Several fixation methods are currently available for the management of medial malleolar fractures, including retrograde lag screws fixation (uni- or bicortical) using one or two screws (in parallel or divergent directions), headless screws, absorbable screws, combination of screw and K-wire, tension band wiring, modified tension bands, minifragment plates, and pre-contoured hook plates[19-31].

While the standard and most commonly used fixation method for medial malleolar fractures is open reduction and internal fixation with two lag screws, clinical and biomechanical studies in the literature also support fixation using a single screw[32,33].

However, the configuration of the fracture line in the coronal plane has received limited attention in the literature, despite the clear need for a more precise approach that optimizes interfragmentary compression by positioning screws perpendicular to the fracture line. In this context, Tekin et al.[13] and Chami et al.[14] reported favorable outcomes using headless antegrade screws to treat medial malleolar fractures with a reverse obliquity pattern.

Tekin et al.[13], in a study of 12 patients with a mean follow-up period of 17.2 ± 5.3 months (range, 12-23 months), reported that complete fracture union was achieved in all patients. The mean time to union was 3.4 ± 1.5 months (range, 2-5 months). No cases of instability, loss of reduction, nonunion, or infection were observed. The mean AOFAS[15] score was 95.0 (range, 87-99), with four patients showing good and eight achieving excellent outcomes. The mean time to return to the previous level of activity was 4.0 ± 2.5 months (range, 2-5 months). These findings suggest that anterograde headless cannulated screw fixation yields favorable clinical outcomes in the surgical treatment of Herscovici et al.[6] type B fractures.

Perhaps because of the limited literature on the treatment of medial malleolar fractures with antegrade screws, surgeons may be hesitant to adopt this fixation, given their unfamiliarity with the technique[34]. In this study, we employed bicortical minifragment screws (2.0, 2.4, or 2.7 mm) using the interfragmentary compression technique. Although, to our knowledge, there are no preclinical or clinical studies comparing these implants for the fixation of reverse oblique medial malleolus fractures, we chose bicortical cortical screws over headless compression screws. The choice of bicortical cortical screws over headless compression screws was deliberate and based on anatomical and biomechanical considerations. In small medial malleolar fragments, bicortical fixation may provide improved cortical purchase and greater construct stability. In the subcutaneous medial aspect of the ankle, the use of headless screws may still be associated with soft tissue irritation depending on implant positioning and fragment morphology. Bicortical screws also offer a readily available and technically straightforward option in most surgical settings. Additionally, the use of smaller-diameter screws would help preserve bone stock, as reverse obliquity fractures typically involve a small fragment. Despite this deviation from the standard technique, the functional outcomes were comparable to those previously reported

in the literature, with no complications related to loss of reduction, nonunion, or malunion of the medial malleolar fractures.

Our study presents limitations. Firstly, the choice to use bicortical compression minifragment screws was based on the surgeons' preference rather than evidence. Secondly, the sample size was limited, making any comparative statistical analysis inadequate, as the study lacks the power for such evaluations. Thirdly, there was no control group using conventional techniques. Additionally, patient quality of life was not assessed, as only functional scores were used. The AOFAS ankle-hindfoot score, despite its widespread use, has recognized limitations in its clinimetric properties, including the lack of a fully patient-reported component and the inclusion of physician-assessed items. To mitigate this limitation, we also used the Olerud-Molander ankle score, a validated patient-reported outcome measure, to provide a more comprehensive functional assessment. A further limitation of this study is the heterogeneity in fixation technique, as one patient (Patient 6) required a different construct consisting of an antegrade minifragment screw combined with a minifragment plate. This variation, likely related to intraoperative factors such as fragment size or stability, may limit the series' internal consistency and should be considered when interpreting the overall results. Another limitation of this study is that all patients were female, which may limit the generalizability of the findings to a broader population. Given the small sample size, it is not possible to assert that the method used is reproducible or that similar outcomes would be achieved if the technique were applied in other centers.

However, some strengths should be highlighted. Despite the limited sample, this represents one of the largest case series on this topic in the literature. The modification of the technique using minifragment screws yielded functional outcomes comparable to those reported in similar studies, and no complications were observed. We believe that using minifragment screws is a promising alternative in such cases, as reverse obliquity fracture patterns involve small fragments and require techniques that preserve bone stock. Although the results are not supported by biomechanical studies, limited clinical observations suggest that reverse obliquity medial malleolar fractures should be safely and effectively fixed perpendicular to the fracture line rather than obliquely. This approach avoids unstable fixation or shear forces at the fracture site during interfragmentary compression (Figure 6).

Conclusion

This study highlights the challenges and opportunities in managing reverse oblique medial malleolar fractures. By utilizing bicortical minifragment screws via an antegrade approach, we achieved functional outcomes comparable to those reported with conventional techniques, with no observed complications such as loss of reduction, nonunion, or malunion. While our sample size limits the generalizability of these findings, the promising results suggest that this technique may be a viable alternative, particularly in cases with small fracture fragments where bone preservation is critical.

Author's contribution: Each author contributed individually and significantly to the development of this article: PRE *(https://orcid.org/0000-0002-3572-5576) Conceived and planned the activities that led to the study, participated in the review process, wrote the article, formatting of the article, and clinical examination; REVF*(https://orcid.org/0009-0003-1435-1311), SGW *(https://orcid.org/0000-0001-9330-4094), TLFD* PMLA *(https://orcid.org/0009-0006-9800-4422), SPHR *(https://orcid.org/0009-0008-6911-2234) interpreted the results of the study, participated in the review process, and clinical examination; GV *(https://orcid.org/0000-0002-4429-312X), PR *(https://orcid.org/0000-0002-5728-3115) interpreted the results of the study, wrote the article, and formatted the article. All authors read and approved the final manuscript. *ORCID (Open Researcher and Contributor ID).

References

1. Ebraheim NA, Ludwig T, Weston JT, Carroll T, Liu J. Comparison of surgical techniques of 111 medial malleolar fractures classified by fracture geometry. Foot Ankle Int. 2014;35(5):471-7.
2. Liu Y, Lu H, Xu H, Xie W, Chen X, Fu Z, et al. Characteristics and classification of medial malleolar fractures: A study based on CT fracture mapping. Bone Joint J. 2021;103-B(5):931-8.
3. Court-Brown CM, Caesar B. Epidemiology of adult fractures: A review. Injury. 2006;37(8):691-7.
4. Lokerman RD, Smeeing DPJ, Hietbrink F, van Heijl M, Houwert RM. Treatment of a scientifically neglected ankle injury: The isolated medial malleolar fracture. A systematic review. J Foot Ankle Surg. 2019;58(5):959-8.
5. Carter TH, Duckworth AD, White TO. Medial malleolar fractures: Current treatment concepts. Bone Joint J. 2019;101-B:512-21.
6. Herscovici D, Scaduto JM, Infante A. Conservative treatment of isolated medial malleolar fractures. J Bone Joint Surg Am. 2007;89(1):89-96.
7. Pankovich AM, Shivaram G. Fractures of the medial malleolus. Clin Orthop Relat Res. 1979;143:138-47.
8. Meinberg EG, Agel J, Roberts CS, Karam MD, Kellam JF. Fracture and Dislocation Classification Compendium-2018. J Orthop Trauma. 2018;32(Suppl 1):S1-S170.
9. Fowler TT, Pugh KJ, Litsky AS, Taylor BC, French BG. Medial

malleolar fractures: a biomechanical study of fixation techniques. Orthopedics. 2011 Aug 8;34(8):e349-55.

10. Hu F, Bu G, Liang J, Huang H, He J. A novel classification for medial malleolar fracture based on the 3-D reconstruction CT. J Orthop Surg Res. 2021;16:538.
11. Lu H, Liu Y, Xie W, Liang H, Guo H, Quan Y, et al. The reliability and accuracy of the medial malleolar fracture classification based on 3D CT reconstruction. Orthop Surg. 2023;15(7):1790-8.
12. Briet JP, Hietbrink F, Smeeing DP, Dijkgraaf MGW, Verleisdonk EJ, Houwert RM. Ankle Fracture Classification: An Innovative System for Describing Ankle Fractures. J Foot Ankle Surg. 2019;58(3):492-6.
13. Tekin AÇ, Çabuk H, Dedeoğlu SS, Saygılı MS, Adaş M, Büyükkurt CD, et al. Anterograde Headless Cannulated Screw Fixation in the Treatment of Medial Malleolar Fractures: Evaluation of a New Technique and Its Outcomes. Med Princ Pract. 2016;25(5):429-34.
14. Chami S, Lima T, Pallottino A, Scorza B, Franco J, Bitar R. Anterograde fixation of inverted oblique medial malleolus fractures: case report. J Foot Ankle, 2021;15(1),66-9.
15. Rodrigues RC, Masiero D, Mizusaki JM, Imoto AM, Peccin MS, Cohen M, et al. Translation, cultural adaptation, and validation of the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Scale. Acta Ortop Bras. 2008;16(2):107-11.
16. Olerud C, Molander H. A scoring scale for symptom evaluation after ankle fracture. Arch Orthop Trauma Surg. 1984;103(3):190-4.
17. Hoelsbrekken SE, Kaul-Jensen K, Mørch T, Vika H, Clementsen T, Paulsrud Ø, Petursson G, et al. Nonoperative treatment of the medial malleolus in bimalleolar and trimalleolar ankle fractures: a randomized controlled trial. J Orthop Trauma. 2013;27(11):633-7.
18. Carter TH, Oliver WM, Bell KR, Graham C, Duckworth AD, White TO. Operative vs Nonoperative Management of Unstable Medial Malleolus Fractures: A Randomized Clinical Trial. JAMA Netw Open. 2024;7(1):e2351308.
19. Ricci WM, Tornetta P, Borrelli J Jr. Lag screw fixation of medial malleolar fractures: a biomechanical, radiographic, and clinical comparison of unicortical partially threaded lag screws and bicortical fully threaded lag screws. J Orthop Trauma. 2012; 26(10):602-6.
20. Parada SA, Krieg JC, Benirschke SK, Nork SE. Bicortical fixation of medial malleolar fractures. Am J Orthop (Belle Mead NJ). 2013;42(2):90-2.
21. Parker L, Garlick N, McCarthy I, Grechenig S, Grechenig W, Smitham P. Screw fixation of medial malleolar fractures: a cadaveric biomechanical study challenging the current AO philosophy. Bone Joint J. 2013;95-B(12):1662-6.
22. Ostrum RF, Litsky AS. Tension band fixation of medial malleolus fractures. J Orthop Trauma. 1992;6(4):464-8.
23. Barnes H, Cannada LK, Watson JT. A clinical evaluation of alternative fixation techniques for medial malleolus fractures. Injury. 2014;45(9):1365-7.
24. Cheng RZ, Wegner AM, Behn AW, Amanatullah DF. Headless compression screw for horizontal medial malleolus fractures. Clin Biomech (Bristol, Avon). 2018;55:1-6.
25. Li ZH, Yu AX, Guo XP, Qi BW, Zhou M, Wang WY. Absorbable implants versus metal implants for the treatment of ankle fractures: a meta-analysis. Exp Ther Med. 2013;5(5):1531-7.
26. Clyde J, Kosmopoulos V, Carpenter B. A biomechanical investigation of a knotless tension band in medial malleolar fracture models in composite Sawbones®. J Foot Ankle Surg. 2013; 52(2):192-4.
27. May H, Alper Kati Y, Gumussuyu G, Yunus Emre T, Unal M, Kose O. Bioabsorbable magnesium screw versus conventional titanium screw fixation for medial malleolar fractures. J Orthop Traumatol. 2020;21(1):9.
28. Herber V, Labmayr V, Sommer NG, Marek R, Wittig U, Leithner A, et al. Can hardware removal be avoided using bioresorbable Mg-Zn-Ca screws after medial malleolar fracture fixation? Mid-term results of a first-in-human study. Injury. 2022;53(3):1283-8.
29. Hanhisuanto S, Kortekangas T, Pakarinen H, Flinkkilä T, Leskelä HV. The functional outcome and quality of life after treatment of isolated medial malleolar fractures. Foot Ankle Surg. 2017;23(4):225-9.
30. Carter THMS, Mackenzie SP, Bell KR, Hollyer MA, Gill EC, MacDonald DJ, et al. Selective fixation of the medial malleolus in unstable ankle fractures. Injury. 2019;50(4):983-9.
31. Pinski JM, Ryan SP, Pittman JL, Tornetta P. Is fixation of the medial malleolus necessary in unstable ankle fractures? Arch Orthop Trauma Surg. 2023;143(6):2999-3005.
32. Buckley R, Kwek E, Duffy P, Korley R, Puloski S, Buckley A, et al. Single-Screw Fixation Compared With Double Screw Fixation for Treatment of Medial Malleolar Fractures: A Prospective Randomized Trial. J Orthop Trauma. 2018;32(11):548-53.
33. Giordano V, Rodrigues A, Voelcker L, Alves G, Pires RE, Freitas A, et al. Is just one screw really enough? Single- versus double-screw fixation in the medial malleolus in supination-external rotation ankle fractures: A comparative biomechanical study using partially threaded cancellous screws. Injury. 2024;55(2):111175.
34. Konigsberg MW, Vosseller JT. Antegrade Screw Fixation of Medial Malleolus Fractures: A Technique Tip. J Surg Orthop Adv. 2020;29(1):50-2.