International Journal of Research in Orthopaedics
Sharma J et al. Int J Res Orthop. 2026 Sep;12(5):1438-1443
https://www.ijoro.org

Original Research Article

DOI: https://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20262917

Outcomes of antiglide plate fixation for vertical medial malleolar fractures in supination-adduction ankle injuries: a prospective observational study

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Received: 08 July 2026
Accepted: 12 August 2026

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ABSTRACT

Background: Vertical fractures of the medial malleolus associated with supination-adduction ankle injuries represent an uncommon but inherently unstable fracture pattern because of the predominance of vertical shear forces across the fracture site. Conventional fixation techniques may fail to provide sufficient resistance to these forces, increasing the risk of displacement, delayed union and unsatisfactory functional recovery. Antiglide plate fixation has been proposed as a biomechanically advantageous method that enhances fracture stability by counteracting shear stresses.
Methods: A prospective observational study was conducted in the Department of Orthopaedics at a tertiary care teaching hospital. Twenty adult patients with vertical medial malleolar fractures resulting from supination-adduction ankle injuries were enrolled. All patients underwent open reduction and internal fixation using an antiglide plate. Clinical evaluation, radiographic assessment and functional outcome measurements were performed at 3 weeks, 6 weeks and 6 months following surgery. Functional recovery was assessed using the Olerud-Molander Ankle Score (OMAS).
Results: The study included patients with a mean age of 38.1±8.87 years, of whom 70% were men. Road traffic accidents accounted for the largest proportion of injuries (45%). Radiological union was achieved within 10–12 weeks in more than half of the patients (55%). At the final follow-up, 70% regained full ankle range of motion. The mean OMAS improved progressively from 34.05±5.93 at 3 weeks to 83.00±17.99 at 6 months. Functional outcomes were excellent in 50% of patients and good in 35%, while postoperative complications were uncommon, with 80% of patients experiencing an uncomplicated recovery.
Conclusions: Antiglide plate fixation offers reliable stabilization for vertical medial malleolar fractures associated with supination-adduction ankle injuries. The technique promotes satisfactory fracture healing, facilitates early rehabilitation and results in favorable functional outcomes with a low incidence of postoperative complications. These findings support its use as an effective surgical option for this challenging fracture pattern.

Keywords: Antiglide plate, Medial malleolus fracture, Olerud-molander ankle score

INTRODUCTION

Ankle fractures are among the most frequently managed injuries in orthopaedic practice and continue to represent a significant source of morbidity across all age groups. Their occurrence has increased steadily over recent years, reflecting changes in population demographics, greater involvement in recreational activities and the growing number of high-velocity road traffic accidents. Population-based studies indicate that these injuries account for nearly one-tenth of all fractures and remain one of the commonest fractures affecting the lower extremity.[1]

The pattern of ankle fractures varies considerably according to the mechanism of trauma and patient characteristics. Younger adults usually sustain these injuries following high-energy mechanisms such as road traffic accidents or sports-related trauma, whereas elderly individuals, particularly women, more commonly present with fractures after low-energy falls. Several host-related factors, including increasing age, obesity, tobacco use, diabetes and excessive alcohol intake, may further influence both the risk of injury and the biological process of fracture healing.[2,3]

Regardless of the fracture configuration, the principal objective of treatment is to restore the normal anatomy of the ankle mortise while providing sufficient stability to permit fracture healing without displacement. Failure to achieve anatomical reduction may alter joint biomechanics, resulting in persistent pain, stiffness, instability and eventually degenerative arthritis. In open injuries, associated soft-tissue damage adds another layer of complexity and often requires meticulous surgical planning to optimize clinical outcomes.[4]

Understanding the mechanism of injury is essential for selecting an appropriate fixation strategy. The Lauge-Hansen classification remains clinically valuable because it explains fracture patterns based on the position of the foot and the direction of the applied force. Within this classification, the supination-adduction injury pattern is distinctive because it frequently produces a vertically oriented fracture of the medial malleolus. Unlike transverse fractures, these injuries are subjected predominantly to vertical shear forces, making stable fixation considerably more challenging.[5]

Traditional methods of fixation, including cancellous lag screws and tension band wiring, have demonstrated satisfactory outcomes in transverse medial malleolar fractures where compression across the fracture line is readily achieved. However, these techniques may provide limited resistance to shear stresses in vertically oriented fractures. As a consequence, maintenance of reduction may become difficult, particularly in fractures with a steep vertical inclination or in patients with compromised bone quality.[6]

The concept of antiglide or buttress plating was introduced to overcome these biomechanical limitations. Instead of relying solely on interfragmentary compression, the plate functions as a buttress that prevents proximal migration of the fracture fragment under physiological loading. This construct enhances stability by resisting shear displacement while preserving fracture reduction during the healing phase. Experimental investigations have demonstrated improved mechanical stability with antiglide plating when compared with isolated screw fixation in vertical medial malleolar fractures.[7]

Although the biomechanical advantages of antiglide plating are well recognized, evidence describing its clinical performance remains relatively limited. Most available studies include small patient cohorts and uncertainty persists regarding the optimal method of fixation for these uncommon injuries. Consequently, additional prospective clinical data are required to better define the effectiveness of this technique in routine orthopaedic practice.

The present prospective observational study was undertaken to evaluate the clinical, radiological and functional outcomes of antiglide plate fixation in patients with vertical medial malleolar fractures associated with supination-adduction ankle injuries. Fracture healing was assessed radiographically, while postoperative functional recovery was evaluated using the Olerud-Molander Ankle Score (OMAS). The findings are expected to provide further clinical evidence regarding the role of antiglide plate fixation in managing this challenging fracture pattern.

METHODS

A prospective observational study was conducted in the Department of Orthopaedics at a tertiary care hospital between December 2025 and May 2026. After received approval from the Institutional Ethics Committee before patient enrollment. Written informed consent was obtained from all patients prior to surgery.

The study included adult patients presenting with vertical fractures of the medial malleolus caused by supination-adduction ankle injuries. Since this fracture pattern is encountered infrequently in routine clinical practice, every eligible patient treated during the study period was considered for inclusion. Using this consecutive enrollment approach, 20 patients were enrolled in the study.

Inclusion criteria

Patients were enrolled if they fulfilled all of the following criteria age greater than 21 years. Radiological evidence of a vertical medial malleolar fracture associated with a supination-adduction injury. Planned operative management using antiglide plate fixation. Ability to provide informed written consent and comply with the follow-up schedule.

Exclusion criteria

Patients were excluded in the presence of any of the following ankle fractures produced by mechanisms other than supination-adduction. Neglected or chronic fractures. Open fractures. Active infection involving the affected limb. Serious medical illnesses likely to interfere with fracture healing, including uncontrolled diabetes mellitus or severe cardiovascular disease, pregnancy.

Each patient underwent a comprehensive clinical assessment at the time of admission. Details regarding the

mechanism of injury, interval between injury and hospital presentation, associated complaints and relevant medical history were documented. General physical and systemic examinations were performed to identify associated injuries or underlying medical conditions. Plain radiographs of the ankle were obtained in anteroposterior, lateral for all patients. These images were reviewed to determine fracture orientation, displacement, joint congruity and associated injuries. Computed tomography was obtained whenever additional information regarding fracture configuration or articular extension was considered necessary for operative planning.

All patients underwent open reduction and internal fixation using an antiglide plate. The procedure was performed under appropriate anaesthesia with the patient in the supine position under strict aseptic precautions.

Procedure

A longitudinal incision was made along the medial aspect of the distal tibia, providing adequate exposure of the fracture site. Soft-tissue dissection was performed carefully to preserve adjacent neurovascular structures and tendons. After removal of hematoma and interposed tissue, the fracture fragments were anatomically reduced.

The reduction was maintained temporarily while an appropriately sized antiglide plate was positioned along the medial or posteromedial cortex of the distal tibia. The plate served as a buttress to resist vertical shear forces acting across the fracture. Definitive fixation was achieved using suitable cortical and cancellous screws according to the fracture configuration and intraoperative stability. Implant position and fracture reduction were verified before layered wound closure. A sterile dressing and protective immobilization were applied at the completion of the procedure.

The postoperative rehabilitation protocol was identical for all patients. Active toe movements were encouraged from the first postoperative day to promote circulation and reduce edema. Antibiotic therapy and analgesics were administered according to institutional guidelines.

Gentle ankle range-of-motion exercises were introduced once pain and soft-tissue condition permitted, usually between the third and seventh postoperative day. Progression to weight-bearing was individualized and guided by clinical examination together with serial radiographic evidence of fracture healing. Patients were reviewed at 3 weeks, 6 weeks and 6 months after surgery. Radiographs obtained at follow-up were examined for evidence of fracture union, maintenance of reduction and implant integrity. Functional recovery was assessed using the OMAS, a validated scoring system that evaluates pain, stiffness, swelling, stair climbing, running, jumping, squatting, need for external support and performance of routine daily activities.

Statistical analysis

All collected data were entered into Microsoft Excel before statistical analysis using IBM SPSS Statistics version 26.0. Continuous variables are presented as mean±standard deviation, whereas categorical variables are expressed as frequencies and percentages. Changes in functional outcome over the follow-up period were analysed using repeated-measures analysis. Associations between categorical variables were evaluated using the Chi-square test or Fisher's exact test whenever indicated. Statistical significance was defined as a two-tailed p value of less than 0.05.

RESULTS

In this study, we looked at a group of participants with an average age of 38.1 years, with most of them falling into the 31 to 40 age range, making up 35% of our study group. We had 14 males (70%) and 6 females (30%) involved in the research. More of the injuries were on the right side of the body (Table 1). The data revealed that road traffic accidents were the leading cause of these injuries, affecting 9 individuals, which is about 45% of the cases. This aligns with the findings that road traffic incidents are commonly responsible for injuries like these (Table 2).

Surgical intervention was quite frequent, with 10 participants (50%) undergoing surgery between 4 to 6 days after their injury, while 7 patients (35%) had their operations less than 3 days post-injury. This shows that most people received surgical care within the first week after their injuries. After surgery, a little over half (55%) of the fractures showed union on radio-graphs within 10 to 12 weeks (Table 3).

Following surgery, 80% of the participants had no complications. Additionally, 70% of the patients regained full motion in their ankle, with none reporting any severe movement restrictions. This suggests that using the antiglide plate for fixation led to fewer complications and a good recovery for most participants (Table 4). When looked at the ankle function over time using the OMAS (Olerud Molander Ankle Score), we found significant improvement. At 3 weeks post-surgery, the average score was 34.05, which rose to 60.80 at 6 weeks and reached 83.00 at the 6-month mark. This indicates a clear upward trend in ankle function following the antiglide plate fixation (Table 5).

In summary, about half of the participants (50%) experienced a good to excellent recovery after the surgery and most (55%) were able to bear full weight within 10 weeks of the procedure. Furthermore, 70% returned to their regular daily activities within five months after treatment (Table 7).

Table 1: Demographic and biochemical distribution of study participants.

Variables	No of patients	(%)
Age group (in years)		
21-30	6	30.00
31-40	7	35.00
41-50	4	20.00
51-60	3	15.00
Gender		
Female	6	30.00
Male	14	70.00
Side of injury		
Left	8	40.00
Right	12	60.00
Mean age±SD(in years)	38.1±8.87	
Hb (g/dl)±SD	12.11±1.40	
Creatinine (mg/dl)±SD	0.98±0.15	
TLC (×10³/µl)±SD	8346.05±1286.38	
Random blood sugar (mg/dl)±SD	114.25±15.75	
ESR (mm/hr)±SD	16.5±5.55	

Table 2: Distribution of study participants according to mode of injury.

Mode of injury	No of patients	(%)
Road traffic accident	9	45.00
Twisting injury	6	30.00
Fall from height	3	15.00
Sports injury	2	10.00

Table 3: Distribution of study participants according to duration between injury and surgery and radiological union.

Parameters	No of patients	(%)
Duration between injury and surgery (in days)		
≤ 3	7	35.00
4-6	10	50.00
≥ 7	3	15.00
Time for radiological union (in weeks)		
<10	4	25
10–12	11	55
>12	5	20

Table 4: Post-operative complications and range of motion following antiglide plate fixation.

Parameters	No of patients	(%)
Complications		
Delayed union	2	10.00
Implant prominence	1	5.00
Superficial infection	1	5.00
Nil	16	80.00
Range of motion		
Full range	13	70.00
Mild restriction	5	20.00
Moderate restriction	2	10.00
Severe restriction	0	0.00

Table 5: Mean and standard deviation of OMAS Score during follow-up.

Follow-up periods	Mean OMAS*	SD
3 weeks	34.05	5.93
6 weeks	60.80	11.29
6 months	83.00	17.99

*Olerud-molander ankle score.

Table 6: Functional outcome following antiglide plate fixation according to OMAS Score.

Functional outcomes	OMAS* Score	No of patients	(%)
Excellent	91–100	10	50.00
Good	61–90	6	35.00
Fair	31–60	3	10.00
Poor	0–30	1	5.00

*Olerud-molander ankle score.

Table 7: Distribution of study participants according to time taken to full weight bearing and return of activities.

Parameters	No of patients	(%)
Time to full weight bearing (in weeks)		
<8	5	30.00
8–10	12	55.00
>10	3	15.00
Return to activities (in months)		
0-2	4	20.00
3-5	10	50.00
6-8	6	30.00

DISCUSSION

This study focused on how well the antiglide plate fixation method worked for patients with vertical fractures of the medial malleolus caused by supination-adduction ankle injuries. The results show that this approach not only helped with healing but also led to a good recovery with minimal complications. From the findings, the average age of participants was 38.1 years, with the majority being in their thirties. There was a notable male predominance matching similar studies by researchers like Herscovici et al.[8] Authors found that road traffic accidents were the primary reason for these injuries (45%), followed by twisting incidents. This is consistent with Lamontagne et al, reported.[9] Additionally, more injuries occurred on the right side, which aligns with previous observations in orthopedic trauma research.[1]

Most people had surgery within 4 to 6 days after being injured. Performing surgery early is vital for restoring ankle stability and avoiding long-term problems. Egol et al, have shown that timely intervention leads to better outcomes.[10] The majority of the patients (55%) achieved radiological union within 10 to 12 weeks, which is comparable with prior studies by Blake and Yakubek et al.[11] We also noted an impressively low complication rate. Most patients (80%) did not face any postoperative issues, which is similar to results by Weber et al.[12] By the final follow-up, 70% of participants had regained full movement of their ankle, while only 10% had some moderate restriction. The improvement in OMAS scores highlighted this recovery, with scores rising from 34.05 three weeks post-surgery to 83.00 six months later. This aligns with findings from Olerud and Molander et al, who emphasized the importance of stable fixation and early mobilization in recovery.[13]

Overall, the study showed that 85% of patients achieved good to excellent functional outcomes based on OMAS scores. Similar positive outcomes regarding functional recovery have been noted in studies like those by De Souza et al.[14]

In the last this research supports the effectiveness of antiglide plate fixation in treating vertical fractures of the medial malleolus due to supination-adduction ankle injuries. This technique not only provides stable fixation but also ensures good healing rates, allows early mobilization and yields positive health outcomes with minimal complications.

CONCLUSION

In conclusion, our findings suggest that antiglide plate fixation is an effective surgical option for managing vertical fractures of the medial malleolus due to

supination-adduction ankle injuries. This technique proved to be stable, supported satisfactory healing and led to favorable recoveries with a low occurrence of complications. Most participants were able to show signs of healing within 10 to 12 weeks after surgery, returned to full weight-bearing as expected and demonstrated steady improvements in ankle function, as reflected in rising OMAS scores over time. Most patients managed to resume their routine daily activities a few months after the surgery, highlighting the procedure's effectiveness in promoting recovery.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Sharma J, Garg A Bubna A, Wadhwa S. Outcomes of antiglide plate fixation for vertical medial malleolar fractures in supination-adduction ankle injuries: a prospective observational study. Int J Res Orthop 2026;12:1438-43.