

A PROSPECTIVE STUDY ON THE FUNCTIONAL OUTCOME OF MEDIAL MALLEOLUS FRACTURES MANAGED BY HEADLESS COMPRESSION SCREW FIXATION

T. Saravana Muthu¹, A. Prakash Raj², K. V. Karthick Raj³

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Corresponding Author:

Dr. T. Saravana Muthu,

Email: majorscaphoid@gmail.com

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¹Assistant Professor, Department of Orthopaedics, Madurai Medical College, Tamilnadu, India

²Senior Resident, Department of Orthopaedics, Namakkal Medical College, Tamilnadu, India

³Senior Resident, Department of Trauma & Orthopaedic Surgery, Namakkal Medical College, Tamilnadu, India

ABSTRACT

Background: Medial malleolus fractures can affect ankle stability, mobility, and functional recovery. Headless compression screws provide stable fixation while allowing the implant to remain flush with or below the bone surface, potentially reducing soft-tissue irritation. This prospective study evaluated the functional and radiological outcomes of medial malleolus fractures treated with headless compression screw fixation. **Materials and Methods:** This prospective interventional clinical study included 20 patients aged 20–60 years with medial malleolar fractures treated by open reduction and internal fixation using headless compression screws. Functional outcome was assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot score. Secondary outcomes included time to radiological union, postoperative mobilisation, return to normal activities, and complications. Patients were followed for 6 months to 2 years, with assessments at 1, 3, 6, and 12 months. **Result:** The mean age was 40.5 years, with males comprising 60.0% of patients. Road traffic accidents accounted for 70.0% of injuries, and supination–external rotation was the commonest fracture pattern (45.0%). Excellent AOFAS outcomes were observed in 60.0%, while 80.0% achieved excellent or good outcomes; the mean AOFAS score was 79/100. Radiological union occurred within 10 weeks in 70.0% of patients. Early mobilisation was achieved in 85.0%, and the mean time to return to normal activities was 2.5 months. Complications occurred in 25.0%, including superficial infection (10.0%), ankle stiffness (10.0%), and fracture fragmentation (5.0%). No implant irritation, nonunion, or implant failure was observed. **Conclusion:** Headless compression screw fixation was associated with satisfactory functional and radiological outcomes, with limited implant-related complications.

INTRODUCTION

Ankle fractures are common lower-limb injuries in orthopaedic practice, and the medial malleolus is involved either alone or as part of bi- or trimalleolar fractures. The Swedish Fracture Register recorded more than 56,000 ankle fractures over ten years, with falls and high-energy trauma contributing according to age and sex.^[1] An analysis of the U.S. National Trauma Data Bank reported traffic-related injuries as a major mechanism associated with complications after foot and ankle fractures.^[2] Road traffic accidents (RTAs) are also frequently reported as a leading cause of injury among younger adults in Asian and developing-country settings.^[3,4] These injuries can affect ankle stability, weight-bearing, and return to

daily activities, making appropriate fracture fixation an important part of treatment.

Secure fixation of the medial malleolus is important because fracture displacement or a persistent gap can alter load distribution across the ankle and contribute to post-traumatic arthritis. Partially threaded cancellous screws and Kirschner wires have traditionally been used, but screw loosening, loss of compression, and hardware prominence can occur beneath the thin soft-tissue covering of the medial ankle.^[5] Headless compression screws address these concerns by allowing the screw head to remain flush with or below the bone surface. Their thread design provides interfragmentary compression and supports axial and shear stability during fracture healing.^[5,6] Comparative studies have reported outcomes comparable to or better than conventional partially

threaded screws, particularly for symptomatic hardware and subsequent implant removal.^[6,7]

A case series of headless compression screws for medial malleolar fixation also reported excellent AOFAS scores in most patients and few complications.^[5] The low-profile design is also relevant in the medial ankle, where the implant lies close to the skin and surrounding soft tissues.

Functional recovery after ankle fracture depends on both patient and injury characteristics. A systematic review of nearly 2,500 patients reported poorer functional scores among patients with female sex, older age, diabetes, higher BMI, and smoking.^[8] Other large cohort studies have reported poorer patient-reported outcomes with more complex fracture patterns, irrespective of fixation method.^[9] Assessment of fracture healing alone is not sufficient; functional recovery also includes walking, return to work, and resumption of normal activities. Measures such as the AOFAS score provide a clinical assessment of pain, function, and ankle-hindfoot status during follow-up, while time to union provides information on fracture healing.^[10]

The present prospective study evaluated functional and radiological outcomes of medial malleolus fractures treated with headless compression screw fixation. AOFAS scores, time to radiological union, postoperative mobilisation, return to normal activities, and complications were assessed in patients aged 20–60 years. Demographic characteristics, fracture pattern, mechanism of injury, and side involved were also recorded.

Aim and Objectives

Aim: To evaluate the functional results of medial malleolus fractures treated with headless compression screw fixation.

Objectives

- To minimize the rate of soft tissue irritation and implant failure

MATERIALS AND METHODS

This prospective interventional clinical study was conducted in the Department of Orthopaedics at Madurai Medical College, Madurai, between August 2022 and August 2024, over a period of 2 years following approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants after explaining purpose of the study, treatment procedures, potential complications, and available alternatives.

Study population: The study included 20 patients with displaced bimalleolar and medial malleolar fractures who fulfilled the predefined eligibility criteria. All included patients underwent open reduction and internal fixation of the medial malleolus using headless compression screws.

Inclusion and Exclusion Criteria: Patients aged >20 and <60 years with isolated medial malleolus fractures or associated fibular fractures, fractures less

than 2 weeks old, and no associated comorbidities were included in the study.

Patients aged <19 years or >60 years, those with associated comorbidities, fractures more than 2 weeks old, segmental fibular fractures, comminuted medial malleolar fractures, polytrauma, or malunited ankle fractures were excluded.

Initial management: Initially, patients were stabilised with ATLS protocol and looked for any associated comorbidities and associated other injuries. Careful history and mechanism of injury, previous operative and treatment details were noted. Affected limb temporarily was stabilised with posterior splint. Distal neurovascular status was checked. If open wound was present, under local or spinal anaesthesia thorough wound debridement is done and washed with profuse amount of normal saline. Loading dose of IV antibiotics were given.

Radiological evaluation: X ray Ankle with leg Anteroposterior and lateral view were taken after giving gentle traction to disimpact the crowded fracture fragments. It provides better understanding of fracture morphology. Fracture was stabilised with below knee slab.

Open Injuries were graded according to Gustilo-Anderson Classification. Fractures were classified according to Lauge-hansen AO Classification system. All cases were managed with Headless compression screw under Open Reduction and Internal fixation under spinal anaesthesia.

Surgical procedure: All patients underwent open reduction and internal fixation under spinal anaesthesia. The patient was positioned supine on a radiolucent table, with a sandbag placed beneath the contralateral pelvis to facilitate external rotation of the affected limb. Preoperative antibiotics were administered 30 minutes before incision. The surgical site was prepared, painted, and draped using standard aseptic precautions.

A standard medial approach was used for exposure of the medial malleolus. The medial approach provides access to medial malleolar fractures through internervous interval between the dorsiflexors, supplied by the deep peroneal nerve, and the invertors and plantarflexors, supplied by posterior tibial nerve. A straight longitudinal incision directly over the medial malleolus or a curvilinear incision anteriorly over the medial malleolus was used according to the fracture configuration. Care was taken to protect the great saphenous vein and saphenous nerve.

In patients with bimalleolar fractures, the fibular fracture was exposed and reduced. The fracture site was cleared of haematoma, reduction was achieved and maintained with pointed reduction forceps. Fibular fixation was performed using a one-third tubular plate in 14 cases, K-wires in 2 cases, a hook plate in 1 case, and conservative reduction in 3 cases. The medial malleolar fracture was then exposed through the standard medial approach. Haematoma was evacuated and fracture reduction was performed. Headless compression screws were inserted over guide wires under C-arm guidance. Two screws were

used to provide fixation and counteract rotational malalignment.

Headless compression screw fixation: Headless compression screws were used for fixation of the medial malleolar fractures. The screws were inserted under fluoroscopic guidance following satisfactory fracture reduction. The headless design allows the implant to be positioned at or below the bone surface.

Ankle-hindfoot scale	
Parameter	Points
Pain (40 points)	
None	40
Mild	30
Moderate	20
Severe	0
Function (50 points)	
Activity limitations	
None	10
Limitations on recreational activities	7
Some limitations on daily and recreational activities	4
Severe limitations on daily and recreational activities	0
Maximum continuous walking distance	
600m or more	5
400 m to less than 600m	4
100 m to less than 400m	2
Less than 100m	0
Walking surfaces	
No difficulty on any surface	5
Some difficulty on uneven terrain, stairs, inclines	3
Severe difficulty or inability to walk on uneven terrain, stairs, inclines	0
Gait abnormality	
None or slight	8
Obvious (walking possible but gait abnormality obvious)	4
Marked (walking difficult and gait abnormality obvious)	0
Sagittal motion (flexion plus extension)	
Normal or mild restriction (30° or more)	8
Moderate restriction (15°–29°)	4
Severe restriction (less than 15°)	0
Hindfoot motion (inversion plus eversion)	
Normal or mild restriction (75%–100% normal)	6
Moderate restriction (25%–74% normal)	3
Severe restriction (less than 25% normal)	0
Ankle-hindfoot stability (anterior drawer, varus-valgus stress)	
Stable	8
Unstable	0
Alignment (10 points)	
Good, plantigrade foot, well aligned	10
Fair, plantigrade foot, mild to moderate degree of malalignment	5
Poor, nonplantigrade foot, severe malalignment	0

Figure 1: AOFAS Score

Postoperative rehabilitation: Postoperatively, the affected limb was elevated, and active toe movements and quadriceps exercises were initiated. Patients received parenteral ceftriaxone 1 g and gentamicin 80 mg for three days, followed by oral antibiotics. The drain, when placed, was removed and the first wound inspection was performed on the second postoperative day. A second wound inspection and dressing change were performed on the fifth postoperative day. Subsequent wound inspections and dressing changes were performed according to wound condition. If wound drainage was present, the sample was sent for culture and sensitivity and appropriate antibiotics were administered. Sutures were removed between the 12th and 14th postoperative days.

Patients were discharged in a below-knee cast. Postoperative radiographs were routinely obtained to assess joint congruity and fracture alignment.

Follow-up: Patients were followed for a minimum of 6 months and a maximum of 2 years. Follow-up assessments were performed at 1, 3, 6, and 12 months. Clinical and radiological evidence of fracture union was assessed during follow-up. Once satisfactory union was evident, gradual weight

bearing was initiated. Physiotherapy was provided for ankle joint mobilisation.

Functional outcome assessment: Functional outcome was assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot score. Functional outcomes were graded according to the AOFAS functional grading system.

Outcome assessment: The primary outcome was functional status assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot score at follow-up. Secondary outcomes included time to radiological fracture union, time to return to normal activities, postoperative mobilisation, and postoperative complications. Complications assessed during follow-up included superficial infection, ankle stiffness, fracture fragmentation, implant irritation, non-union, and implant failure.

Preoperative AOFAS score	
<60 poor	
TOTAL	
POST operative AOFAS score	
Poor 60>	
Fair 69 - 60	
Good 79 - 70	
Excellent 92 - 80	
Total	

Figure 2: AOFAS functional Grading system

Statistical analysis: Data were entered and analysed using appropriate statistical software. Categorical variables were expressed as frequencies and percentages. Continuous variables were summarised using mean and range. The AOFAS functional outcome, time to radiological union, return to normal activities, and postoperative complications were summarised descriptively.

RESULTS

Twenty patients were included, with a mean age of 40.5 years (range, 20–60 years). Males comprised 60.0% of the study population. The right side was involved in 65.0% of patients, and RTAs were most common mode of injury (70.0%). Supination–

external rotation was most common fracture pattern (45.0%) [Table 1].

Table 1: Demographic and clinical characteristics of the study population

Category	Characteristic	n (%) / Value
Age	Mean age, years	40.5
	Age range, years	20–60
Sex	Male	12 (60.0%)
	Female	8 (40.0%)
Side involved	Right	13 (65.0%)
	Left	7 (35.0%)
Mode of injury	RTA	14 (70.0%)
	Accidental fall	6 (30.0%)
Fracture pattern	Supination–external rotation	9 (45.0%)
	Pronation–external rotation	3 (15.0%)
	Supination–adduction	3 (15.0%)
	Pronation–abduction	2 (10.0%)
	Isolated medial malleolus fracture	3 (15.0%)

An excellent AOFAS outcome was observed in 60.0% of patients, with a mean AOFAS score of 79/100. Radiological union most commonly occurred at 10 weeks (40.0%). Early postoperative

mobilisation was achieved in 85.0% of patients, and the mean time to return to normal activities was 2.5 months [Table 2].

Table 2: Functional and clinical outcomes following headless compression screw fixation

Category	Outcome	n (%) / Value
AOFAS functional outcome	Excellent	12 (60.0%)
	Good	4 (20.0%)
	Fair	3 (15.0%)
	Poor	1 (5.0%)
Time to radiological union	8 weeks	6 (30.0%)
	10 weeks	8 (40.0%)
	12 weeks	3 (15.0%)
	16 weeks	2 (10.0%)
	>16 weeks	1 (5.0%)
Return to normal activities	Mean time	2.5 months
	Range	2–4.5 months
Postoperative mobilisation	Mobilised early	17 (85.0%)
	Not mobilised early	3 (15.0%)

Postoperative complications occurred in 25.0% of patients. Superficial infection and ankle stiffness were most common complications (10.0% each). No

implant irritation, non-union, or implant failure was reported [Table 3].

Table 3: Postoperative complications following headless compression screw fixation

Complication	n (%)
Superficial infection	2 (10.0%)
Ankle stiffness	2 (10.0%)
Fracture fragmentation	1 (5.0%)
Implant irritation	0
Non-union	0
Implant failure	0

DISCUSSION

Medial malleolus fractures are important ankle injuries that can affect joint stability, mobility, and functional recovery. Headless compression screws provide stable fixation while allowing the implant to remain below the bone surface, reducing soft-tissue irritation. This study aimed to evaluate the functional outcomes of medial malleolus fractures treated with headless compression screw fixation. In 20 patients, 80% achieved excellent or good AOFAS outcomes, while most fractures united within 10 weeks and no implant irritation or nonunion was observed. Our study consists of 20 cases of unstable bimalleolar and medial malleolus ankle fractures. Injury was

more common in males (60%) and females being (40%). Right side was more commonly involved-13 patients. RTAs contributed to 70% of injuries, followed by accidental falls (30%). Out of 20 patients, 9 are SER pattern, 3 patients are PER pattern, 3 cases of SAD pattern and 2 cases of PAB pattern. 3 patients had isolated Medial malleolus injury.

In our study, the supination-external rotation (SER) type was the most frequently observed injury pattern. Ahmad et al.'s study, subjective outcome scores were excellent or good in 84% of patients, while objective scores were good in 78.8% and poor in 4.2%.¹¹ These findings are consistent with our study, where the AOFAS functional scores were excellent or good

in 16 patients (80%), fair in 3 patients, and poor in 1 patient. In our series 5 cases had complications such as wound infection, ankle stiffness and fracture fragmentation. Superficial infection (10%) with mild cellulitis was the commonest complication we encountered.

In our study, no cases of nonunion in the medial malleolus were observed, likely due to the effective compression at the fracture site.

The results were comparable with study by Bulut and Gursoy reported where implant related complications and irritation seen in conventional fixation methods of Cancellous screw fixation and Tension Band wiring were not seen in Headless Compression screws.^[12]

Barnes et al evaluated the clinical results with the use of headless lag screws in medial malleolar fractures. Medial sensitivity was reported at a mild level in 23%, and the need for implant removal was reported for 2%.^[13]

Headless compression screws can be left at the same level as the bone surface during fixation or even at a level below the bone surface, just as they are used in scaphoid fractures and other intraarticular fractures. Therefore, compared with other fixation materials, the irritation to the deltoid ligament and subcutaneous tissue is less, resulting in lower rates of implant-related complications.

Tekin et al applied anterograde headless cannulated screws in a series of 12 patients and reported that no pain or discomfort originating from the implant was encountered in any patient, with no requirement for implant removal.^[14]

Cheng et al. reported that headless compression screw construct was significantly stiffer in both the proximal-distal and medial-lateral directions, indicating greater resistance to both axial and shear loading. Additionally, they had significantly greater load at clinical failure based on lateral displacement. The low-profile design of the headless compression screw minimizes soft tissue irritation and reduces need for implant removal.^[15]

Overall, headless compression screw fixation was associated with satisfactory functional and radiological outcomes in patients with medial malleolus fractures in this series. Most patients achieved excellent or good AOFAS scores (80%), with 70% achieving radiological union within 10 weeks and a mean return to normal activities of 2.5 months. Postoperative complications were limited to superficial infection, ankle stiffness, and fracture fragmentation, with no implant irritation, nonunion, or implant failure observed during follow-up.

CONCLUSION

Headless compression screw fixation provided satisfactory functional and radiological outcomes in patients with medial malleolus fractures. Most

patients achieved excellent or good AOFAS scores, with 70% achieving radiological union within 10 weeks. Early mobilisation and return to normal activities were achieved in most patients, with no implant irritation, nonunion, or implant failure. Larger comparative studies are needed to confirm these results.

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