

Tension Band Wiring Versus Cancellous Screw Fixation for Displaced Medial Malleolar Fractures: A Prospective Comparative Study

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Received: 01-02-2026 / Revised: 15-03-2026 / Accepted: 21-04-2026

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Conflict of interest: Nil

Abstract

Objective: To compare radiological union, ankle function and complications after tension band wiring (TBW) versus cancellous screw fixation of displaced medial malleolar fractures.

Methods: This prospective comparative study included 64 adults treated at Victoria Hospital, Bangalore Medical College and Research Institute, Bengaluru, between March 2024 and August 2025. Participants with closed, displaced medial malleolar fractures amenable to either construct were allocated 1:1 to TBW or two 4.0-mm partially threaded cancellous screws. Vertical shear, open, pathological and comminuted fractures unsuitable for standard fixation were excluded. Participants were reviewed at 2 and 6 weeks, 3 months and 6 months. The primary outcomes were time to radiological union and the Olerud-Molander Ankle Score (OMAS) at six months; complications, reoperation, range of motion and return to activity were secondary outcomes.

Results: Thirty-two participants were analysed in each group. Mean time to union was shorter with TBW than with screw fixation (8.32 ± 1.61 versus 10.69 ± 3.35 weeks; $p=0.008$). By eight weeks, 26/32 (81%) TBW fractures and 9/32 (28%) screw-fixed fractures had united ($p<0.001$); no non-unions were reported. Six-month mean OMAS was 88.7 ± 8.4 after TBW and 85.2 ± 9.6 after screw fixation ($p=0.12$), while excellent or good outcomes occurred in 30/32 (94%) and 29/32 (91%), respectively ($p=0.68$). Symptomatic hardware was more frequent after TBW (7/32 [22%] versus 1/32 [3%]; $p=0.02$), and five TBW participants underwent elective implant removal. Overall complication rates did not differ significantly (34% versus 25%; $p=0.38$).

Conclusion: TBW was associated with earlier radiological union but not better six-month function. Its union advantage must be balanced against greater hardware-related morbidity and implant removal. Implant selection should reflect fracture morphology, bone quality and patient preferences.

Keywords: Medial Malleolar Fracture; Tension Band Wiring; Screw Fixation; Radiological Union; OMAS.

DOI: 10.25258/ijcpr.18.5.288

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Introduction

Ankle fractures are common injuries in orthopaedic practice, and restoration of a congruent, stable mortise is central to treatment. The medial malleolus contributes to the medial buttress of the ankle and anchors the deltoid ligament complex. Displacement or instability may therefore disturb tibiotalar mechanics and expose the joint to persistent pain, loss of function and post-traumatic degeneration. Operative fixation is generally considered when the fracture is displaced, the mortise is unstable or the medial injury accompanies an unstable bi- or trimalleolar pattern [1]. Two familiar constructs are used for transverse and oblique medial malleolar fractures. Partially

threaded cancellous screws apply interfragmentary compression across the fracture and are technically straightforward, but purchase may be limited in a small fragment or poor-quality cancellous bone. Tension band wiring (TBW) uses parallel Kirschner wires and a figure-of-eight cerclage to resist distraction and maintain compression. A small comparative study reported earlier union and slightly better modified Olerud-Molander outcomes with TBW, but its sample comprised only 20 patients [2]. The clinical choice remains nuanced because neither construct is free of implant-related morbidity. Traditional wire tension bands can irritate the thin medial soft-tissue envelope and lead

to painful hardware or removal. A retrospective comparison of conventional and knotless tension-band constructs was developed specifically in response to these problems and showed that lower-profile constructs may reduce treatment cost while retaining fixation performance [3]. Screw design also matters: fully threaded and headless compression screws have been investigated to improve purchase or reduce prominence, with clinical and biomechanical studies suggesting that different screw constructs should not be treated as a single homogeneous intervention [4,5].

Evidence directly comparing conventional TBW with cancellous screws remains dominated by small, heterogeneous studies. Earlier radiographic healing would be valuable only if it translates into better function or earlier activity without imposing additional reoperation. This study therefore compared TBW with cancellous screw fixation for displaced medial malleolar fractures. The primary

objectives were to compare time to radiological union and six-month ankle function; secondary objectives were to compare range of motion, complications, secondary surgery and return to activity.

Materials and Methods

Study Design and Setting: This prospective comparative study was conducted in the Department of Orthopaedics, Victoria Hospital, Bangalore Medical College and Research Institute, Bengaluru, from March 2024 to August 2025. The dissertation records 1:1 allocation using a computer-generated random-number table or sealed envelopes. Further details of sequence generation, allocation concealment and blinding were not available. Reporting was structured with reference to CONSORT principles for a two-group allocated comparison. Participant flow is summarised in Figure 1.

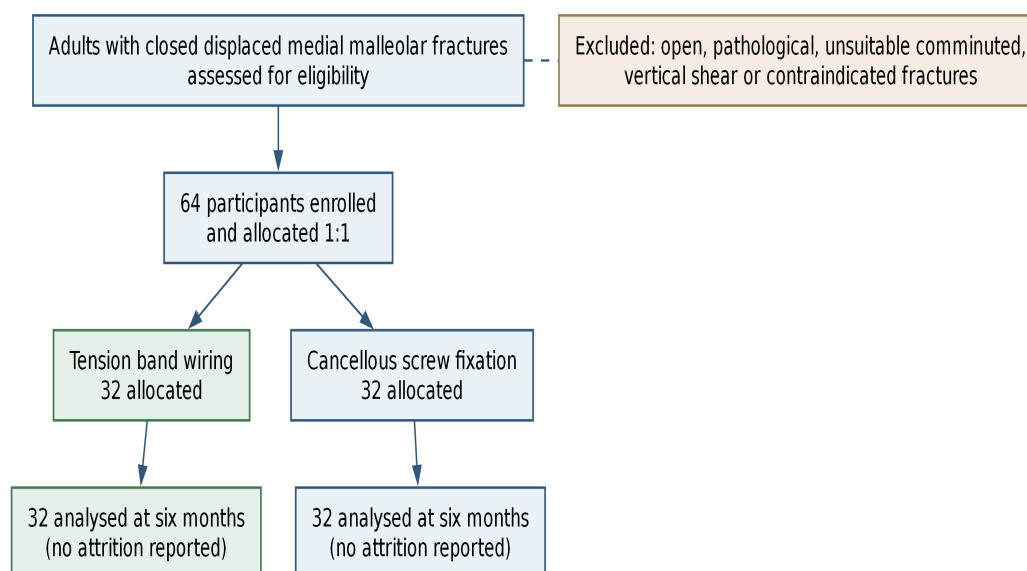


Figure 1: Participant flow from enrolment through six-month analysis. The dissertation reported outcome denominators of 32 in each group and did not report attrition.

Participants: Adults older than 18 years with a closed, displaced (>2 mm) medial malleolar fracture were eligible.

Isolated Herscovici type B or C fractures and medial malleolar components of bi- or trimalleolar injuries were included when medial fixation was required. Participants had to be skeletally mature and able to provide written informed consent.

Exclusion criteria were open fractures, pathological fractures, active local infection or cellulitis, neurovascular deficit or compartment syndrome, long-term steroid or immunosuppressant use, and comminution that precluded standard fixation. Supination-adduction vertical shear fractures were

excluded because their fracture geometry was considered unsuitable for TBW.

Interventions: Both procedures used spinal or epidural anaesthesia, a supine position and a thigh tourniquet. A standard anteromedial incision was used, with protection of the saphenous vein and nerve. Haematoma and interposed periosteum were cleared and reduction was obtained under direct and fluoroscopic control. In the TBW group, two parallel 1.6- or 2.0-mm Kirschner wires were advanced from the malleolar tip into the tibial metaphysis. An 18-gauge stainless-steel wire was passed through a transverse tibial tunnel 3–4 cm proximal to the fracture, crossed in a figure-of-eight configuration and tightened. Kirschner-wire ends were bent, cut and impacted, and the wire

knot was buried. In the screw group, reduction was stabilised with two parallel 4.0-mm partially threaded cancellous screws inserted perpendicular to the fracture line; washers were permitted when bone quality was considered poor. Postoperatively, participants received elevation, analgesia and antibiotics, with suture removal at 10–14 days. Non-weight-bearing mobilisation was used initially. Active ankle movement and progressive partial weight bearing were introduced after radiographic review, and full weight bearing was allowed when union was evident. Scheduled assessments occurred at 2 weeks, 6 weeks, 3 months and 6 months.

Outcomes: Radiological union was defined as bridging trabeculae across at least three cortices on standard anteroposterior and lateral radiographs. Time to union, union by 8 and 12 weeks, delayed union after 12 weeks, and non-union were recorded. Functional outcome at six months was assessed with the Olerud-Molander Ankle Score (OMAS), a 0–100 patient-reported scale covering pain, stiffness, swelling and activity.

Published work supports the clinical interpretability of OMAS in unstable ankle fractures [6]. Scores were classified as excellent (91–100), good (81–90), fair (61–80) or poor (<60). Secondary outcomes included ankle dorsiflexion, plantarflexion, inversion and eversion at six months; maintenance of reduction; adverse radiological outcome; infection; wound and skin complications; hardware symptoms; fixation failure; stiffness; elective removal; hospital stay; and time to return to light activity and full duty.

Sample size and statistical analysis: The dissertation reports a single-proportion calculation using an expected favourable outcome proportion of 0.88, 12% absolute precision and 95% confidence, which yielded 28 participants. Sixty-four participants were ultimately included.

Analyses were performed in IBM SPSS Statistics for Windows, version 29.0. Continuous variables were summarised as mean $\pm$ standard deviation and compared with an independent-samples Student's *t*

test. Categorical variables were reported as counts and percentages and compared with the chi-square or Fisher exact test, as appropriate. Statistical significance was set at two-sided $p < 0.05$. Confidence intervals and an intention-to-treat analysis were not reported in the dissertation.

Ethics The Institutional Ethics Committee of Bangalore Medical College and Research Institute approved the study (BMCRI/PG/338/2023-24; 14 February 2024). All participants provided written informed consent.

Results

Participants and baseline characteristics: Sixty-four participants were included, with 32 analysed in each group at six months. The mean age was 41.3 ± 14.76 years in the TBW group and 39.65 ± 15.34 years in the screw group. Men comprised 20/32 and 21/32 participants, respectively. Road traffic injury was the most frequent mechanism (50% versus 47%), and the supination-external rotation pattern was most common (63% versus 66%). Baseline fracture displacement and articular involvement were similar. Alcohol use was the only reported statistically significant baseline imbalance (41% versus 13%; $p = 0.01$) (Table 1).

Radiological and functional outcomes: Mean radiological union occurred 2.37 weeks earlier after TBW (8.32 ± 1.61 weeks) than after screw fixation (10.69 ± 3.35 weeks; $p = 0.008$). Union by eight weeks occurred in 26/32 (81%) and 9/32 (28%) participants, respectively ($p < 0.001$). By 12 weeks, the corresponding proportions were 31/32 (97%) and 29/32 (91%; $p = 0.32$). Delayed union occurred in one TBW and three screw participants; no non-unions were reported. At six months, mean OMAS was 88.7 ± 8.4 after TBW and 85.2 ± 9.6 after screw fixation ($p = 0.12$). Excellent or good results were recorded in 30/32 (94%) and 29/32 (91%), respectively ($p = 0.68$). Range of motion did not differ significantly in any measured plane. Anatomical reduction was reported for all participants, although two screw-treated participants had an adverse radiological outcome and one had hardware loosening (Table 2).

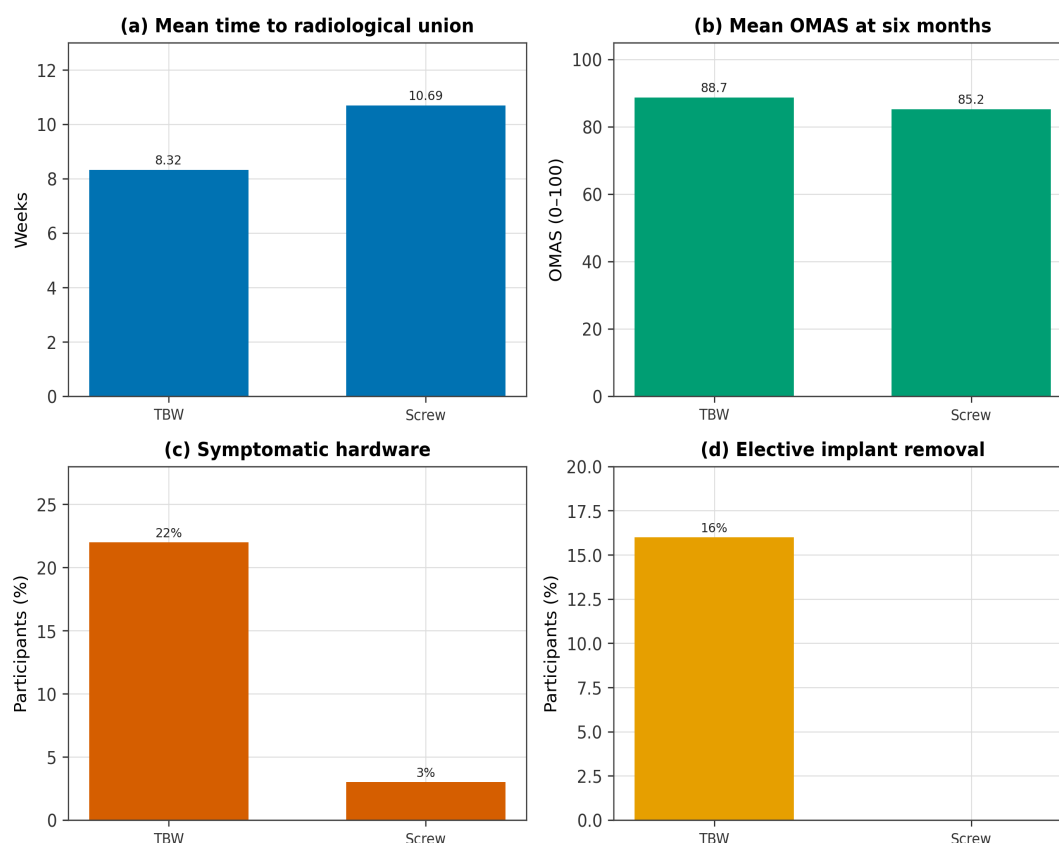
Key outcomes after medial malleolar fracture fixation (n = 64)

Figure 2: Key radiological, functional and hardware-related outcomes by fixation group. A lower value favours TBW for time to union and a higher value favours TBW for OMAS; lower values favour the intervention for hardware symptoms and removal.

Complications, secondary surgery and activity:

Overall complications occurred in 11/32 (34%) TBW and 8/32 (25%) screw participants ($p=0.38$). Superficial infection occurred in two participants per group. Symptomatic hardware was more frequent after TBW (7/32 [22%] versus 1/32 [3%]; $p=0.02$). Five TBW participants underwent elective implant removal for symptomatic hardware, compared with none in the screw group ($p=0.02$);

overall reoperation occurred in 5/32 and 1/32, respectively ($p=0.09$). There were no deep infections or Kirschner-wire migrations. Mean return to light activity was 8.5 ± 2.1 weeks after TBW and 9.2 ± 2.8 weeks after screw fixation ($p=0.28$). Return to full duty occurred at 14.3 ± 3.5 and 16.1 ± 4.2 weeks, respectively ($p=0.08$). Total and postoperative hospital stay were similar.

Table 1: Baseline Demographic, Injury and Operative Characteristics.

Characteristic	TBW (n=32)	Screw fixation (n=32)	p value
Age, years	41.3 $\pm$ 14.76	39.65 $\pm$ 15.34	0.71
Male sex	20 (63%)	21 (66%)	0.68
Right side	19 (59%)	20 (63%)	0.78
Road traffic injury	16 (50%)	15 (47%)	0.84
Smoking	6 (19%)	13 (41%)	0.06
Alcohol use	13 (41%)	4 (13%)	0.01
Supination-external rotation	20 (63%)	21 (66%)	0.75 ^a
Fracture displacement, mm	4.2 $\pm$ 1.8	4.5 $\pm$ 2.1	0.58
Injury-to-surgery interval, days	2.9 $\pm$ 1.2	3.1 $\pm$ 1.5	0.65
Operative duration, minutes	88.90 $\pm$ 15.05	82.75 $\pm$ 16.29	0.05

^aFor the overall Lauge-Hansen classification distribution. Values are mean $\pm$ standard deviation or number (%).

Table 2: Radiological, functional and safety outcomes.

Outcome	TBW (n=32)	Screw fixation (n=32)	p value
Time to union, weeks	8.32 ± 1.61	10.69 ± 3.35	0.008
Union by 8 weeks	26 (81%)	9 (28%)	<0.001
Union by 12 weeks	31 (97%)	29 (91%)	0.32
Delayed union (>12 weeks)	1 (3%)	3 (9%)	0.31
Non-union	0	0	—
Six-month OMAS	88.7 ± 8.4	85.2 ± 9.6	0.12
Excellent/good OMAS	30 (94%)	29 (91%)	0.68
Symptomatic hardware	7 (22%)	1 (3%)	0.02
Overall complications	11 (34%)	8 (25%)	0.38
Elective implant removal	5 (16%)	0	0.02
Reoperation	5 (16%)	1 (3%)	0.09
Return to full duty, weeks	14.3 ± 3.5	16.1 ± 4.2	0.08

OMAS, Olerud-Molander Ankle Score; TBW, tension band wiring. Values are mean ± standard deviation or number (%).

Discussion

The principal finding was a shorter reported time to radiological union with TBW, accompanied by a much larger proportion united at eight weeks. This early radiographic advantage did not produce a statistically significant six-month functional benefit. Instead, the clearest clinical trade-off was greater hardware-related morbidity after TBW: approximately one in five participants reported symptomatic implants and one in six underwent elective removal. Overall complications, six-month range of motion, hospital stay and return to activity were otherwise similar.

Earlier union with TBW is biologically and mechanically plausible when the construct is appropriately applied to a transverse or avulsion-type fracture. The figure-of-eight wire is intended to resist distractive forces and maintain compression while the ankle moves. Mohammed and colleagues reported mean union at 9.4 weeks with TBW and 11.8 weeks with screws in a 20-patient comparative study, with favourable modified Olerud-Molander outcomes in 90% and 80%, respectively [2]. The direction of that union difference agrees with the present findings, although the earlier study was small and used alternate allocation. Differences in fracture morphology, postoperative loading and the definition or frequency of radiographic assessment may materially affect measured union time.

The six-month mean OMAS difference in the present study was 3.5 points and was not statistically significant. Penning and colleagues reported anchor-based estimates of clinically important OMAS change of approximately 15 points between three and six months and 9.5 points between six and twelve months [6]. Those values concern within-person change rather than a cross-sectional treatment contrast, so direct equivalence is inappropriate; nevertheless, they provide context suggesting that the observed group difference was

modest. By six months, anatomical reduction, fracture consolidation and rehabilitation may dominate patient-reported function more than a two-week difference in radiographic union.

Hardware symptoms substantially alter the balance of benefits. Conventional TBW places bent Kirschner-wire ends and a twisted wire knot beneath a thin subcutaneous envelope. Downey and colleagues described hardware irritation and subsequent removal as persistent problems with traditional stainless-steel tension bands and evaluated a lower-profile knotless construct as a response [3]. The present 22% symptomatic-hardware rate and 16% elective-removal rate in the TBW group are consistent with that mechanism. Meticulous impaction of wire ends, knot burial and avoidance of excessive soft-tissue tension are therefore essential, but they may not eliminate symptoms intrinsic to the construct.

Screw fixation also represents a family of constructs rather than a single technique. The present study used 4.0-mm partially threaded cancellous screws. A clinical comparison of partially and fully threaded 4-mm cancellous screws found broadly similar functional and radiographic outcomes while emphasising the potential importance of purchase and screw strategy [4]. In a synthetic-bone biomechanical model, headless compression screws and partially threaded cancellous screws showed comparable resistance to failure, while the headless design offered a plausible route to reduce prominent-hardware symptoms [5]. These alternatives may be relevant when conventional screws are selected, although biomechanical equivalence does not substitute for comparative clinical evidence.

Fracture morphology remains a practical determinant of implant choice. TBW is best suited to transverse or avulsion patterns in which the wire loop can oppose distraction. The study appropriately excluded supination-adduction

vertical shear fractures, which usually require a construct capable of resisting shear, such as lag screws oriented perpendicular to the fracture or a buttress plate. Conversely, a small distal fragment or poor cancellous purchase may make screw fixation difficult. A treatment algorithm should therefore integrate fracture-plane orientation, fragment size, bone quality and the condition of the medial soft tissues rather than treating TBW and screws as interchangeable in every fracture [1]. The groups had similar reported age, sex, side, injury mechanism and fracture classification, but alcohol use differed significantly and smoking showed a numerical imbalance. These factors may affect adherence, wound healing or union, and the summary data did not permit adjusted analysis. The dissertation also did not report confidence intervals, protocol registration, and details of allocation concealment, blinding of radiographic assessment or handling of missing data. Although outcome denominators remained 32 per group, explicit attrition reporting was absent. These gaps limit certainty about internal validity and the precision of treatment effects.

Clinically, TBW may be attractive when early union and robust fixation of a small fragment are priorities and the patient accepts a greater chance of implant irritation or removal. Conventional cancellous screws may be preferable when the medial soft-tissue envelope is vulnerable or avoiding a second operation is particularly important. The absence of a six-month functional advantage argues against choosing TBW solely to accelerate radiographic union. Shared decision-making should make the union-versus-hardware trade-off explicit.

Strengths and Limitations: Strengths include prospective data collection, equal group sizes, six-month follow-up, use of a fracture-specific patient-reported outcome and simultaneous evaluation of union, function, complications and activity. The cohort included isolated and combined malleolar injuries encountered in routine trauma practice. The single-centre sample was modest, follow-up was too short to assess post-traumatic arthritis or late implant failure, and neither patients nor assessors were reported as blinded. Randomisation and concealment were incompletely described, no trial registration was reported, and no confidence intervals or adjusted analyses were available. Bone density, fragment size and comminution were not stratified. Most importantly for this manuscript conversion, the patient-level dataset was not supplied, so the dissertation's aggregate results could not be independently recomputed; all numerical findings should be checked against the

masterchart before journal submission.

Conclusion

TBW was associated with earlier radiological union than partially threaded cancellous screw fixation, but six-month OMAS and range of motion were similar. Symptomatic hardware and elective removal were more frequent after TBW. The choice of fixation should be individualised according to fracture morphology, fragment size, bone quality, soft-tissue conditions and patient preferences concerning potential secondary surgery.

Ethics Approval: Institutional Ethics Committee, Bangalore Medical College and Research Institute, Bengaluru (BMCRI/PG/338/2023-24; approved 14 February 2024). Written informed consent was obtained from all participants.

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