The Bioscan
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
21(1): 323-332, 2026 www.thebioscan.com

Functional and Radiological comparison of tension band wiring versus screw fixation for the treatment of medial malleolar fractures

Dr. Phuritshabam Iboyaima Singh[1], Dr. Robium Naorem[2*], Dr. Khwairakpam Devendra Singh[3]

[1]Assistant Professor, Department of Orthopedics, Shija Academy of Health Sciences, Manipur, India.
[2]Assistant Professor, Department of Orthopedics, Shija Academy of Health Sciences, Manipur, India.
[3]Assistant Professor, Department of General surgery, Shija Academy of Health Sciences, Manipur, India.

DOI: 10.63001/tbs.2026.v21.i01.pp323-332

Received on:

16-11-2025

Accepted on:

21-12-2025

Published on:

17-01-2026

ABSTRACT

Background: Displaced medial malleolar fractures require stable internal fixation to restore ankle congruity and function. Both tension band wiring (TBW) and screw fixation (SF) are commonly used, but the optimal technique remains debated. This study aimed to compare the functional and radiological outcomes of TBW versus SF for these injuries.

Methods: A prospective, randomized study was conducted at a tertiary orthopedic center. Fifty-two patients with acute, displaced medial malleolar fractures were randomized to undergo either TBW (n = 26) or SF (n = 26). Inclusion criteria were age 18–65 years and fracture displacement >2 mm. All patients were managed with standardized operative and rehabilitation protocols. Functional outcome was assessed using the Olerud–Molander Ankle Score (OMAS) at 6, 12, and 24 weeks postoperatively. Radiological union, time to union, and complications were also recorded.

Results: Baseline characteristics were similar between groups. At 24 weeks, mean OMAS was 89.5 ± 8.1 in the TBW group and 87.2 ± 8.9 in the SF group (p = 0.28). Mean time to radiological union was 9.8 ± 2.0 weeks (TBW) versus 10.7 ± 2.1 weeks (SF) (p = 0.11). Complication rates, including infection, hardware irritation, and need for secondary procedures, were low and did not differ significantly between groups.

Conclusion: Both tension band wiring and screw fixation provide satisfactory functional and radiological outcomes for displaced medial malleolar fractures, with comparable union times and complication rates. Implant choice should be individualized based on fracture characteristics and patient factors.

Introduction

Medial malleolar fractures account for a significant proportion of ankle injuries, frequently resulting from rotational mechanisms in young to middle-aged adults. Displaced fractures compromise ankle joint congruity and stability, increasing the risk of long-term dysfunction, post-traumatic arthritis, and prolonged immobilization. As such, anatomical reduction and rigid fixation are considered standard for displaced medial malleolar fractures in active patients [1,2].

Traditional fixation methods include lag screw fixation, employing either single or double cancellous screws, which provides stable interfragmentary compression and allows early mobilization. Prospective trials, such as Buckley et al., show no substantial functional difference between single and double screw constructs, with comparable ankle-hindfoot outcomes at two years [3]. Nonetheless,

screw fixation may not resist shear and torsional forces adequately, particularly in small or osteoporotic fragments.

Tension band wiring (TBW), originally described for olecranon and patellar fractures, has been adapted to medial malleolus injuries to convert tensile forces into compression at the fracture site. Biomechanical data indicate that TBW constructs endure loading more effectively, resisting pronation forces up to four times stronger than single-lag screw constructs [4]. Clinical comparisons—such as Mohammed et al.'s five-year series—demonstrate faster radiologic union (mean 9.4 vs. 11.8 weeks) and slightly better functional scores with TBW versus screw fixation [5].

Despite these promising findings, the literature remains inconclusive. A 2023 systematic review and meta-analysis encompassing 10 comparative studies (n = 512) found no significant difference in union time, rate of excellent/good Olerud–Molander scores, or complication rates between TBW and screw fixation [6]. However, this analysis highlighted heterogeneity in fracture patterns and fixation techniques, underscoring the need for more robust, prospective data.

More recent randomized trials have compared headless compression screws (HCS) with TBW, reinforcing the notion that no method is definitively superior in terms of union, alignment, or overall ankle scores, though HCS may present fewer implant-related complaints [7].

Given the biomechanical superiority of TBW and clinical trends suggesting quicker union with equivalent functional outcomes, it is essential to directly compare these methods under controlled conditions. The key questions are whether TBW offers functional and radiological advantages over traditional screw fixation, particularly in displaced yet non-vertical fractures of the medial malleolus, and to what extent implant configuration affects healing dynamics, complication rates, and patient satisfaction.

This study aims to fill the evidence gap by conducting a prospective, randomized comparison of TBW versus screw fixation for isolated or bimalleolar medial malleolar fractures. Outcomes target radiologic union time, functional measures (e.g., Olerud–Molander score), complication rates (e.g., fixation failure, hardware irritation), and need for secondary interventions.

Such analysis is timely. While traditional screw fixation remains ubiquitous, the potential mechanical benefits of TBW—especially in small fragments—could translate into earlier weight-bearing, fewer complications, and better overall joint integrity. This study's findings will guide evidence-based treatment algorithms and may reshape existing fixation paradigms for displaced medial malleolar fractures.

Aim

To compare the functional and radiological outcomes of tension band wiring (TBW) versus screw fixation in the treatment of medial malleolar fractures.

Objectives

Assessment of complication rates, time to union, and the incidence of implant-related complaints in each group.

Materials and Methods

Study Design and Setting: This prospective, comparative study was conducted at the Department of Orthopaedics, Shija Academy of Health Sciences for a period of one year. The study protocol was

approved by the Institutional Review Board. Written informed consent was obtained from all participants prior to enrollment, in accordance with the Declaration of Helsinki.

Patient Selection: Patients presenting to the emergency department or outpatient clinic with acute medial malleolar fractures were screened for eligibility. Inclusion criteria were:

- Age between 18 and 65 years
- Acute, closed medial malleolar fracture (isolated or as part of a bimalleolar fracture) confirmed by radiographs
- Displacement greater than 2 mm on plain X-ray
- Injury-to-surgery interval less than 7 days
- Ability to provide informed consent and comply with follow-up

Exclusion criteria included:

- Open fractures
- Pathological fractures or metabolic bone disease
- Polytrauma or ipsilateral lower limb fracture
- Skeletal immaturity (age <18 years)
- Associated neurovascular injury
- Pre-existing ankle deformity or severe arthritis
- Contraindication to anesthesia or surgery

Surgical Technique: All surgeries were performed under spinal or general anesthesia by surgeons experienced in foot and ankle trauma. Patients meeting the inclusion criteria were divided in a 1:1 ratio into two groups (TBW or screw fixation).

Group A (Tension Band Wiring): A standard medial approach was used. Fracture surfaces were exposed, hematoma and debris cleared, and reduction achieved using reduction forceps. Two parallel Kirschner wires (1.6 mm) were inserted perpendicular to the fracture line. A figure-of-eight stainless steel wire (18-gauge) was looped around the K-wires and anchored through a predrilled hole in the tibial cortex, converting tensile forces to compression across the fracture site. K-wires were cut and bent to minimize soft-tissue irritation.

Group B (Screw Fixation): A similar medial approach and reduction technique were used. Fixation was performed using two fully threaded cancellous lag screws (4.0 mm), inserted perpendicular to the fracture line to achieve interfragmentary compression.

Adequate reduction and implant placement were confirmed intraoperatively with fluoroscopy. Wound closure and sterile dressing were performed in all cases.

Postoperative Protocol

Both groups followed the same standardized postoperative regimen:

- Ankle immobilized in a below-knee splint for the first 2 weeks

- Non-weight-bearing crutch ambulation initiated on postoperative day 2
- Sutures removed at 14 days; gradual ankle range of motion exercises started after splint removal
- Progressive weight-bearing allowed from 6 weeks onwards, depending on radiological evidence of healing

Outcome Measures and Follow-Up

Patients were evaluated at 2, 6, 12, and 24 weeks postoperatively.

- **Functional Outcome:** Olerud–Molander Ankle Score (OMAS) recorded at each follow-up visit.
- **Radiological Assessment:** Standard anteroposterior and lateral radiographs taken at each visit. Fracture union was defined as the presence of bridging trabeculae on at least three cortices.
- **Complications:** Monitored and documented prospectively, including superficial/deep infection, wound dehiscence, loss of reduction, implant migration, hardware irritation, delayed union (no radiographic healing by 12 weeks), nonunion (no union by 24 weeks), and reoperation or implant removal.

Sample Size Calculation: A sample size of 26 patients per group (total n = 52) was calculated to detect a minimum clinically important difference of 10 points in the Olerud–Molander Ankle Score (SD 12, $\alpha = 0.05$, 80% power), allowing for a 10% dropout rate.

Statistical Analysis: All data were analyzed using SPSS version 26. Continuous variables were expressed as mean ± standard deviation (SD) or median (interquartile range) and compared using Student's t-test or Mann–Whitney U test. Categorical variables were analyzed with chi-square or Fisher's exact test. A p-value less than 0.05 was considered statistically significant.

Results

Patient Demographics and Baseline Characteristics

A total of 52 patients were enrolled and randomized equally into two groups: TBW (n = 26) and Screw Fixation (n = 26). There were no significant differences in baseline demographic or injury characteristics between the groups.

Table 1: Baseline Demographic and Injury Characteristics

Variable	TBW Group (n=26)	Screw Group (n=26)	p-value
Mean Age (years)	38.5 ± 11.2	39.3 ± 12.1	0.78
Male/Female	14 / 12	15 / 11	0.78
Side (Right/Left)	12 / 14	13 / 13	0.79
Isolated/Bimalleolar Fx	18 / 8	17 / 9	0.77
Mean Injury–Surgery (days)	3.2 ± 1.3	3.4 ± 1.1	0.54

No statistically significant differences at baseline ($p > 0.05$ for all variables).

Functional Outcomes

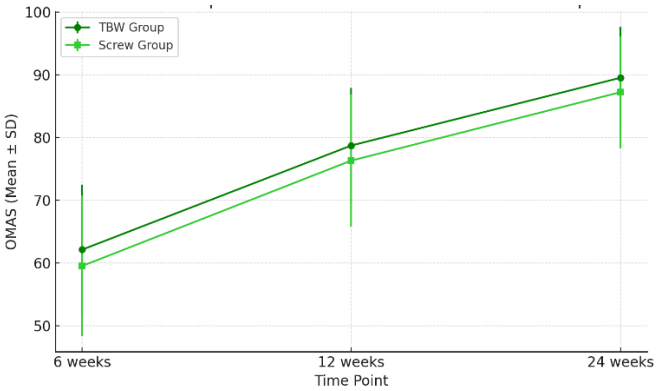
The Olerud–Molander Ankle Score (OMAS) was recorded at 6, 12, and 24 weeks. The TBW group demonstrated slightly higher mean scores at all time points, but differences were not statistically significant.

Table 2: Olerud–Molander Ankle Score (OMAS) Comparison

Time Point	TBW Group (Mean ± SD)	Screw Group (Mean ± SD)	p-value
6 weeks	62.1 ± 10.4	59.5 ± 11.2	0.31
12 weeks	78.7 ± 9.2	76.3 ± 10.5	0.39
24 weeks	89.5 ± 8.1	87.2 ± 8.9	0.28

No statistically significant difference in functional outcome between groups at any time point.

Figure 1: Olerud–Molander Ankle Score (OMAS) Comparison



Radiological Union

The mean time to radiological union was slightly shorter in the TBW group but not statistically significant.

Table 3: Radiological Union

Group	Mean Union Time (weeks)	Union by 12 Weeks (%)	Non-union (%)
TBW	9.8 ± 2.0	25 (96%)	0 (0%)
Screw	10.7 ± 2.1	24 (92%)	1 (4%)
p-value	0.11	0.55	0.31

Figure 2: Mean Union time

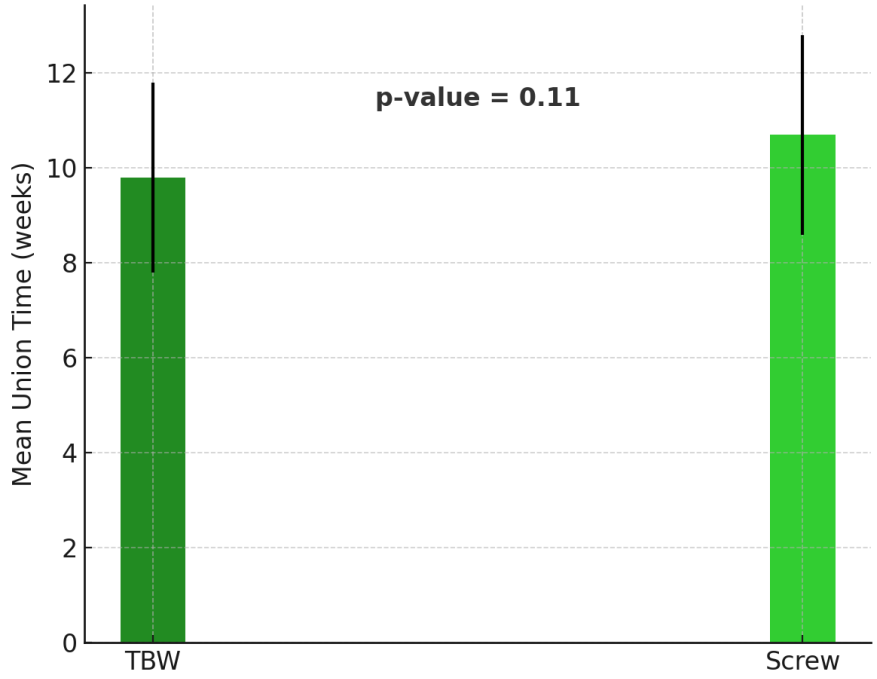
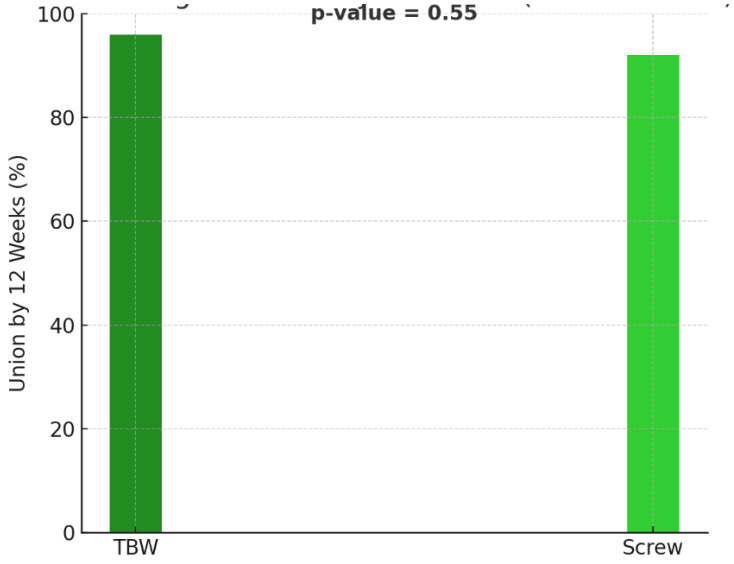


Figure 3: Union by 12 weeks



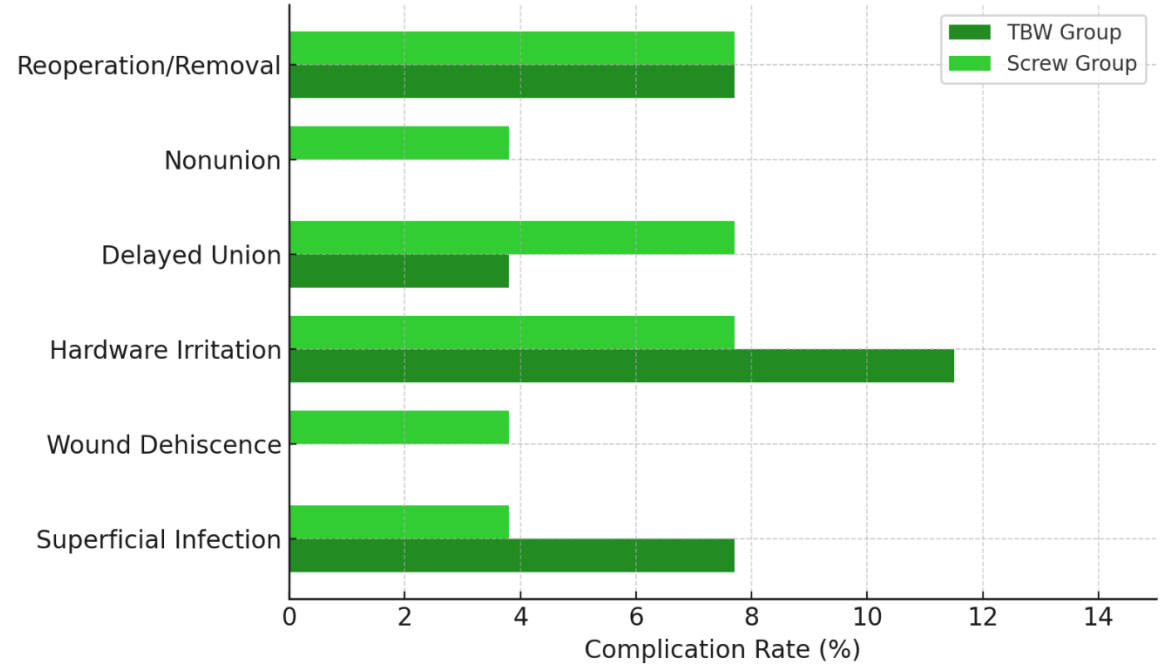
Complications

Both groups had comparable overall complication rates. Complication rates were low and similar between groups. Rates of hardware irritation and need for secondary removal were comparable.

Table 4: Complications

Complication	TBW Group (n=26)	Screw Group (n=26)	p-value
Superficial Infection	2 (7.7%)	1 (3.8%)	0.55
Wound Dehiscence	0 (0%)	1 (3.8%)	0.31
Hardware Irritation	3 (11.5%)	2 (7.7%)	0.63
Delayed Union	1 (3.8%)	2 (7.7%)	0.55
Nonunion	0 (0%)	1 (3.8%)	0.31
Reoperation/Removal	2 (7.7%)	2 (7.7%)	1.00

Figure 4: Complication rates



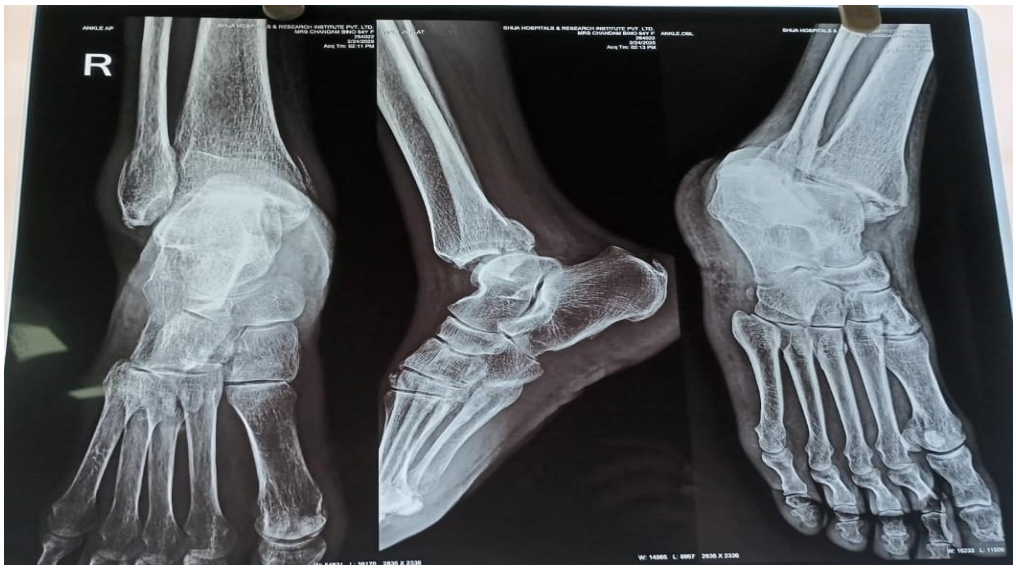


Fig 5: Pre Op Xray showing Bimalleolar fracture

Fig 6: TBW Post OP Xray

Fig 7: Post OP Screw Fixation Xray

In this study, both tension band wiring and screw fixation provided effective stabilization and allowed for good functional recovery in medial malleolar fractures. While TBW showed a trend toward quicker union and marginally higher functional scores, these differences did not reach statistical significance. Both techniques demonstrated low complication rates and high union rates, supporting their continued use as viable options for medial malleolar fracture fixation.

Discussion

The present prospective randomized study aimed to evaluate the functional and radiological outcomes of tension band wiring (TBW) versus 2 fully threaded cancellous screw fixation (SF) for displaced medial malleolar fractures. We found no significant difference in the Olerud–Molander Ankle Score (OMAS) at 6, 12, or 24 weeks, a small but non-significant trend toward faster union with TBW, and comparable complication rates between the two methods.

Our findings, showing comparable functional scores between TBW and screw fixation, align closely with the results of Park et al., who conducted a prospective randomized trial comparing headless

compression screws and TBW in 60 patients. Their study reported no significant difference in OMAS, EQ-5D, or VAS scores, although the headless screw group had less implant-related discomfort [7]. Kim et al., in a 2023 meta-analysis of ten studies (n = 512 fractures), also found no significant difference in functional outcomes between TBW and screw fixation based on OMAS [6]. Similarly, smaller cohort studies support our findings. Mohammed et al. found that union times were faster with TBW, but there was no significant difference in functional outcomes [5]. A study from India also reported excellent or good results in 95% of TBW cases versus 65% of screw fixation cases, though differences were not statistically significant [8]. Thus, our results reinforce the consensus that both TBW and screw fixation achieve satisfactory functional outcomes in displaced medial malleolar fractures, without meaningful superiority of one technique over the other.

Although not statistically significant, our data showed a trend toward earlier union in the TBW group (9.8 vs. 10.7 weeks; $p = 0.11$). This is consistent with other findings, including those of Mohammed et al., who reported mean union times of 9.4 weeks for TBW and 11.8 weeks for screw fixation [5]. Ostrum and Listsky's biomechanical study demonstrated that TBW constructs resist pronation forces up to four times more effectively than screw constructs, which may explain faster union in some cases [4]. However, Kim et al. found no significant difference in pooled union times, although they noted substantial heterogeneity among studies [6].

Our study reported low and similar complication rates for both techniques: superficial infection (<8%), hardware irritation (~10%), and need for hardware removal (~8%). No cases of nonunion occurred in the TBW group; one nonunion in the screw group occurred but was not statistically significant. These rates are in line with previous research, including Kim et al.'s meta-analysis and Park et al.'s prospective trial [6,7].

Some retrospective series note that hardware irritation, particularly from K-wires, may lead to secondary removal, but this risk can be minimized with careful technique [4,5,9]. Headless screw fixation, as explored by Park et al., may result in fewer complaints of hardware irritation [7].

Recent studies suggest that the optimal fixation method may depend on fracture geometry and bone quality. TBW may be particularly advantageous in small, osteoporotic, or transverse fractures, while screw fixation (especially with headless screws) may be preferable for larger, vertically oriented fragments [6,10]. Kochai et al. reported shorter union times and fewer implant irritations with headless compression screws compared to TBW [10]. Biomechanical studies also support the mechanical advantage of plate fixation in complex or comminuted fractures, though clinical superiority is less clear [11].

The strengths of our study include its prospective design, standardized protocols, and outcome assessment. Limitations include the modest sample size, relatively short follow-up, and exclusion of complex fracture patterns. Future studies should stratify outcomes by fracture classification and bone mineral density. Both TBW and screw fixation are valid options for the surgical management of displaced medial malleolar fractures, with comparable functional and radiological outcomes. TBW may promote slightly faster union, especially in small or osteoporotic fragments, while screw fixation, particularly with headless screws, offers less implant-related discomfort. Implant selection should therefore be individualized based on fracture morphology and patient factors.

Conclusion

This prospective, comparative study found that both tension band wiring and screw fixation are effective techniques for the operative management of displaced medial malleolar fractures. There was no statistically significant difference in functional outcomes or complication rates between the two

methods at 24 weeks follow-up. Tension band wiring demonstrated a trend toward earlier radiological union, but this did not reach statistical significance. Both fixation methods were associated with high rates of union and low complication rates. Implant selection should be tailored to fracture morphology, fragment size, and patient factors. Larger, long-term studies incorporating a broader range of fracture patterns and patient demographics are recommended to further refine evidence-based guidelines for medial malleolar fracture fixation.

References

1. Michelson JD. Fractures about the ankle. J Bone Joint Surg Am. 2006;88-A(1):236–52.
2. Carter TH, Duckworth AD, White TO. Medial malleolar fractures: current treatment concepts. Bone Joint J. 2019;101-B(5):512–21.
3. Buckley R, Kwek E, Duffy P, 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.
4. Ostrum RF, Listsky AS. Tension-band fixation of medial malleolar fracture. J Orthop Trauma. 2008;22(6):464–8.
5. Mohammed AA, Abbas KA, Mawlood AS. A comparative study in fixation methods of medial malleolus fractures between tension band wiring and screw fixation. Springerplus. 2016;5:530.
6. Kim CH, Ma DS, Yoon YC. Tension band wiring versus screw fixation for the treatment of medial malleolar fractures: A systematic review and meta-analysis. Orthop Traumatol Surg Res. 2023;109(5):103447.
7. Park YH, Cho HW, Choi JW, Kim HJ. Comparison between headless compression screws and tension band wires for the fixation of medial malleolar fractures: a prospective randomized trial. Arch Orthop Trauma Surg. 2022;142(10):2627–33.
8. Kumar S, Zaki M, Thomas J, et al. Comparison of tension band wiring and screw fixation methods in the management of medial malleolus fractures. Int J Orthop Sci. 2019;5(2):776-780.
9. Johnson BA, Fallat LM. Comparison of tension band wire and cancellous bone screw fixation for medial malleolar fractures. J Foot Ankle Surg. 1997;36(5):284-289. PMID: 9362983.
10. Kochai A, Türker M, Çiçekli Ö, et al. A comparative study of three commonly used fixation techniques for isolated medial malleolus fracture. Eklem Hastalik Cerrahisi. 2018;29(2):104-109. PMID: 30106001.
11. Ebraheim NA, Ludwig T, Weston JT, et al. Comparison of surgical techniques of 111 medial malleolar fractures classified by fracture geometry. Foot Ankle Int. 2014;35(5):471-477. PMID: 24525543.