



Original Research Article

Comparison of Mean Time to Radiological Union between Tension Band Wiring and Fully Threaded Cannulated Cancellous Screws for Medial Malleolus Fracture Fixation

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Abstract: **Background:** Medial malleolus fractures constitute a significant proportion of ankle injuries and can compromise ankle stability, especially when associated with deltoid ligament injuries. Surgical fixation is recommended for displaced fractures to prevent complications such as post-traumatic osteoarthritis. Tension band wiring (TBW) and fully threaded cancellous cannulated screws are commonly employed fixation techniques, but comparative data on radiological union time are limited. **Objectives:** To compare the mean time to radiological union between TBW and fully threaded cancellous cannulated screws in the fixation of medial malleolus fractures **Study Design & Setting:** This study was conducted in the Department of Orthopaedic Surgery, DHQ Hospital Gujranwala from 2-06-2025 to 2-9-2025. **Methodology:** A total of 60 patients with bimalleolar fractures meeting the inclusion criteria were allocated into two groups: Group A (TBW, n = 30) and Group B (Cannulated Screws, n = 30). All patients underwent open reduction and internal fixation under standardized operative procedures. Postoperative care included routine antibiotics, analgesia, and weekly radiographic follow-up to assess radiological union. Data were analyzed using SPSS version 26.0, with independent sample t-tests applied to compare mean union times. Stratification for age, gender, duration since injury, and side of fracture was performed to control effect modifiers. **Results:** The mean time to radiological union was significantly shorter in Group B (8.41 ± 1.72 weeks) compared to Group A (10.52 ± 2.12 weeks) ($p = 0.001$). Stratified analysis demonstrated consistently faster union in the cannulated screws group across all subgroups. **Conclusion:** Fully threaded cannulated screws provide earlier radiological union compared to TBW and may be considered the preferred fixation method for medial malleolus fractures.

Keywords: Cannulated screws, Medial malleolus fracture, Radiological union, Tension band wiring

INTRODUCTION

The Ankle fractures represent a significant portion of musculoskeletal injuries worldwide; accounting for nearly 9% of all fractures reported in orthopedic practice.¹ Over recent decades, their incidence has continued to rise due to increasing participation in sports activities, road-traffic accidents, occupational injuries, and the aging population. Epidemiological

projections suggest that by the year 2030, the global burden of ankle fractures may triple, highlighting the growing clinical and socioeconomic impact of these injuries. Among these, fractures involving the medial malleolus comprise approximately one-quarter of all ankle fractures, making them an important subgroup requiring focused clinical attention.²

The medial malleolus contributes substantially to ankle stability by forming the medial buttress of the ankle mortise and serving as the attachment site for the deltoid ligament complex, which is critical for maintaining the alignment of the talus. Injuries to this region typically occur due to twisting mechanisms, high-energy trauma, or falls, and may involve bony fractures, avulsion fragments, or ligamentous disruptions.³ Medial malleolus fractures can present either in isolation or as part of a more complex injury pattern involving the lateral malleolus, posterior malleolus, or syndesmotic structures.⁴ The management strategy—conservative or surgical—largely depends on the degree of displacement, fragment size, ankle stability, and the presence of associated ligamentous injuries.⁵

Tears of the deltoid ligament, especially the deep component, are frequently associated with medial malleolus fractures. The deep deltoid plays a vital role in restricting lateral displacement and external rotation of the talus. Its disruption can lead to a pathological widening of the medial clear space, resulting in significant ankle instability. Such instability, if left untreated, may predispose the patient to chronic pain, functional limitations, and post-traumatic osteoarthritis, underscoring the need for timely and appropriate surgical intervention.⁶ Therefore, identifying the optimal fixation technique for medial malleolus fractures remains a key priority to restore joint congruency, promote early weight-bearing, and minimize long-term complications. Traditionally, tension band wiring (TBW) has been widely employed for displaced or comminuted medial malleolus fractures, particularly when the distal fragment is small or osteoporotic. TBW converts tensile forces into compression at the fracture site, providing stable fixation that supports early mobilization and reliable healing.⁷

On the other hand, partially threaded cancellous screws—with or without washers—have long been considered the standard method for fixation of larger, non-comminuted fragments. More recently, the use of fully threaded cannulated cancellous screws has gained interest due to their ability to provide uniform compression across the fracture line, better purchase in osteoporotic bone, and potential to enhance rotational stability. These screws may also reduce the risk of fragment toggling or loss of reduction, problems occasionally encountered with traditional partially threaded screws.⁸

Furthermore, reported outcomes for medial malleolus fracture fixation vary across the literature, with differences noted in stability, union time, and complication rates among the available techniques. Conventional partially threaded or lag screws provide adequate compression and promote satisfactory healing in many cases; however, fully threaded

cannulated screws offer better bony purchase and more uniform stability at the fracture site.⁹ Similarly, tension band wiring has demonstrated favorable biomechanical performance, particularly in small or comminuted fragments, though concerns regarding hardware irritation and soft-tissue discomfort have also been documented.¹⁰

Despite the availability of multiple fixation techniques for medial malleolus fractures, existing studies report variable outcomes regarding stability, time to union, and complication rates. These inconsistencies underscore the need for a more comprehensive comparison between commonly used methods, particularly in terms of radiological union, which remains a key indicator of healing. Emerging evidence suggests that fully threaded cannulated cancellous screws may achieve earlier radiological union compared to tension band wiring (TBW), offering potential advantages in postoperative recovery and early mobilization. However, in our clinical setting, TBW continues to be the predominant method for managing these fractures, raising the question of whether a shift toward alternative fixation techniques may yield better outcomes. Therefore, evaluating and comparing the mean time to radiological union between these two fixation methods is essential to guide evidence-based decision-making and optimize future orthopedic practice.

MATERIALS AND METHODS

After approval from the Hospital's Ethical Review Board (IRB/98/GMC) & CPSP this study was conducted in the Department of Orthopaedic Surgery, DHQ Hospital Gujranwala from 2-06-2025 to 2-9-2025. A total sample size of 60 patients (30 in each group) was calculated with 80% power of the test and a 95% confidence interval, using an expected mean time to radiological union of 8.32 ± 1.61 weeks in the TBW group and 10.69 ± 3.35 weeks in the malleolar screw fixation group, as reported in patients with lateral humeral condyle fractures.¹¹ The sampling technique was non-probability, consecutive sampling. The study design was non-randomized controlled study.

Patients of both genders over 18 years of age presenting with bimalleolar fractures, as per operational definition, were included in the study, and only those who gave written informed consent were enrolled. Patients with pathological fractures, associated neurovascular injuries including crush injuries, or complications such as wound issues or infection—identified clinically as red, hot areas with or without discharge—were excluded. Additionally, patients with metabolic conditions like rickets or osteogenesis imperfecta, based on history and clinical records, were also excluded.

Patients who fulfilled the inclusion criteria were

included in the study. Written informed consent and a detailed clinical history were obtained from each patient. These patients were then allocated into two groups using the lottery method: Group A, treated with tension band wiring (n = 30), and Group B, treated with fully threaded cancellous cannulated screws (n = 30). Patients in both groups underwent open reduction and internal fixation under spinal anesthesia in the supine position. Under aseptic precautions, the operative limb was prepared and draped. A standard direct medial approach was used, beginning approximately 2 cm distal to the anterior edge of the medial malleolus. Deep dissection was performed carefully to avoid injury to the saphenous vein and nerve. The fracture site was exposed, reduced with traction, and temporarily stabilized using a pointed reduction clamp. For fractures treated with cancellous screws, two 4 mm screws were inserted. Two guide wires were passed perpendicular to the fracture site, followed by screw insertion under fluoroscopic guidance. In cases with small fracture fragments where screw fixation was not feasible, tension band wiring was applied. Two 2 mm K-wires were inserted, and 20-gauge stainless steel cerclage wire was placed in a figure-of-eight configuration to provide stable fixation. All patients received routine postoperative antibiotic coverage and were discharged the next day if there was no ankle swelling and oral analgesics adequately controlled pain. Stitches were removed on postoperative day 12. Patients were followed weekly in the outpatient department, where serial X-rays were obtained until radiological union occurred. Physiotherapy was initiated according to departmental protocol. Time to radiological union was recorded for each patient. Medial malleolus fractures were defined as breaks occurring at the

medial malleolus, characterized by a fracture line visible on X-ray imaging in anteroposterior (AP) and lateral views. The diagnosis was confirmed by the presence of this fracture line, with measurements taken to assess the fracture displacement in millimeters. Only fractures diagnosed within the preceding 4-week period were included in the study, ensuring timely intervention and evaluation. Radiological union was assessed by monitoring patients weekly after surgery, with X-rays obtained at each visit. Radiological union was classified as the absence of a visible fracture line, together with the presence of callus bridging the fracture ends (appearing radiodense on X-ray) in follow-up images. All surgeries were performed by a single resident (the principal investigator) under supervision, and all preoperative and postoperative assessments, as well as radiological evaluations, were conducted by the same resident to minimize bias. Confounding variables were controlled through strict adherence to the exclusion criteria.

All collected data were entered and analyzed using SPSS version 26.0. Numerical variables such as age, duration since injury, and time to radiological union were presented as mean $\pm$ standard deviation. An independent sample t-test was applied to compare the mean time to radiological union between the two groups, taking a p-value ≤ 0.05 as statistically significant. Categorical variables, including gender and anatomical side (right/left), were described as frequencies and percentages. Data were stratified for age, gender, duration since injury, and anatomical side to control effect modifiers. After stratification, the independent sample t-test was applied, with a p-value ≤ 0.05 considered significant.

RESULTS

The study included a total of 60 patients, equally divided between Group A (TBW) and Group B (Cannulated Screws). In Group A, 18 patients (60.0%) were aged 18–40 years, while 12 patients (40.0%) were older than 40 years. Similarly, in Group B, 19 patients (63.3%) were aged 18–40 years and 11 patients (36.7%) were above 40 years. Regarding gender distribution, Group A had 18 males (60.0%) and 12 females (40.0%), whereas Group B included 17 males (56.7%) and 13 females (43.3%). The side of fracture was almost equally distributed in both groups, with 16 patients (53.3%) in Group A and 15 patients (50.0%) in Group B presenting with right-sided fractures, while the remaining had left-sided fractures. The mechanism of injury was predominantly road traffic accidents in both groups, accounting for 46.7% in Group A and 43.3% in Group B, followed by falls and other causes. Most patients presented within two weeks of injury, with 20 patients (66.7%) in Group A and 21 patients (70.0%) in Group B, while the rest had injuries older than two weeks. These demographic and baseline characteristics were comparable between the two groups, ensuring homogeneity of the study sample, as given in Table 1.

The mean time to radiological union was shorter in Group B (Cannulated Screws), with an average of 8.7 ± 1.9 weeks, compared to 10.9 ± 2.4 weeks in Group A (TBW). This difference was statistically significant ($p = 0.001$), indicating that patients treated with cannulated screws achieved radiological union earlier than those treated with tension band wiring, as given in Table 2.

Table 2: Comparison of Radiological Union Time Between the Two Groups

Variable	Group A (TBW) (n=30)	Group B (Cannulated Screws) (n=30)	p-value
Mean Radiological Union Time (weeks) $\pm$ SD	10.52 $\pm$ 2.12	8.41 $\pm$ 1.72	0.001

Table 1: Demographic Characteristics of Patients (n = 60)

Variable	Group A (TBW) n = 30	Group B (Cannulated Screws) n = 30
Age (years)		
18–40	18 (60.0%)	19 (63.3%)
>40	12 (40.0%)	11 (36.7%)
Gender		
Male	18 (60.0%)	17 (56.7%)
Female	12 (40.0%)	13 (43.3%)
Side of Fracture		
Right	16 (53.3%)	15 (50.0%)
Left	14 (46.7%)	15 (50.0%)
Mechanism of Injury		
Road Traffic Accident	14 (46.7%)	13 (43.3%)
Fall	12 (40.0%)	11 (36.7%)
Other	4 (13.3%)	6 (20.0%)
Duration of Injury (weeks)		
≤2 weeks	20 (66.7%)	21 (70.0%)
>2 weeks	10 (33.3%)	9 (30.0%)

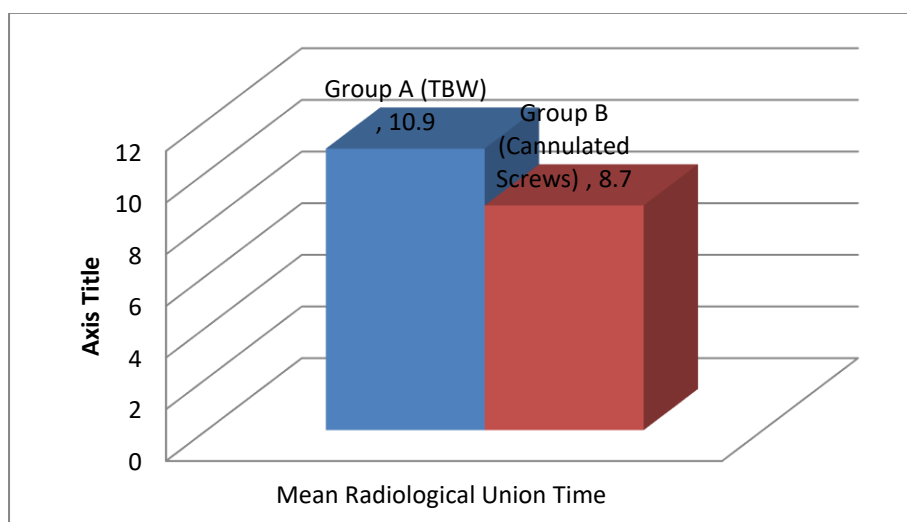


Figure 1: Comparison of Radiological Union Time Between the Two Groups

When radiological union was categorized, 6 patients (20.0%) in Group A (TBW) achieved union within 8 weeks, compared to 18 patients (60.0%) in Group B (Cannulated Screws). The majority of patients in Group A (18; 60.0%) united between 9–12 weeks, whereas only 11 patients (36.7%) in Group B fell in this category. Delayed union beyond 12 weeks occurred in 6 patients (20.0%) in Group A and in only 1 patient (3.3%) in Group B. These findings indicate that a higher proportion of patients in the cannulated screws group experienced earlier radiological union compared to the TBW group, as given in Table 3.

Table 3: Distribution of Radiological Union in Categories

Union Time Category	Group A (TBW)	Group B (Cannulated Screws)
≤ 8 weeks	6 (20.0%)	18 (60.0%)
9–12 weeks	18 (60.0%)	11 (36.7%)
> 12 weeks	6 (20.0%)	1 (3.3%)

Stratified analysis of mean time to radiological union showed consistent findings across all subgroups. Patients aged 18–40 years had a mean union time of 10.5 ± 2.3 weeks in Group A (TBW) and 8.4 ± 1.8 weeks in Group B (Cannulated Screws) ($p = 0.002$), while those over 40 years had union times of 11.5 ± 2.5 weeks and 9.1 ± 2.0 weeks, respectively ($p = 0.003$). Among males, mean union time was 10.8 ± 2.2 weeks in Group A and 8.5 ± 1.7 weeks in Group B ($p = 0.001$); in females, it was 11.2 ± 2.6 weeks versus 8.9 ± 2.1 weeks ($p = 0.004$). Patients presenting within 2 weeks of injury achieved union in 10.3 ± 2.1 weeks (Group A) and 8.2 ± 1.6 weeks (Group B) ($p = 0.001$), whereas those presenting after 2 weeks had union times of 11.8 ± 2.5 weeks and 9.5 ± 2.0 weeks, respectively ($p = 0.003$). For fracture side, right-sided fractures

united in 10.7 ± 2.3 weeks (Group A) versus 8.6 ± 1.8 weeks (Group B) ($p = 0.002$), and left-sided fractures united in 11.3 ± 2.5 weeks versus 8.9 ± 2.0 weeks ($p = 0.003$). These results indicate that cannulated screws consistently achieved faster radiological union than TBW across all stratified subgroups, as given in Table 4.

Table 4: Stratified Analysis of Mean Time to Radiological Union (weeks)

Variable	Category	Group A (TBW) Mean $\pm$ SD	Group B (Cannulated Screws) Mean $\pm$ SD	p-value
Age (years)	18–40	10.5 ± 2.3	8.4 ± 1.8	0.002
	>40	11.5 ± 2.5	9.1 ± 2.0	0.003
Gender	Male	10.8 ± 2.2	8.5 ± 1.7	0.001
	Female	11.2 ± 2.6	8.9 ± 2.1	0.004
Duration Since Injury	≤ 2 weeks	10.3 ± 2.1	8.2 ± 1.6	0.001
	>2 weeks	11.8 ± 2.5	9.5 ± 2.0	0.003
Side of Fracture	Right	10.7 ± 2.3	8.6 ± 1.8	0.002
	Left	11.3 ± 2.5	8.9 ± 2.0	0.003

DISCUSSION

Displaced medial malleolus fractures can impair ankle stability, particularly when associated with deltoid ligament injuries, increasing the risk of post-traumatic osteoarthritis. Surgical fixation is preferred for unstable fractures, with tension band wiring (TBW) and fully threaded cannulated screws being commonly used techniques. Optimal fixation methods are essential to ensure early radiological union and better clinical outcomes.¹²

In the present study, fully threaded cancellous cannulated screws demonstrated a significantly shorter mean radiological union time (8.41 ± 1.72 weeks) compared with tension band wiring (10.52 ± 2.12 weeks), indicating the superiority of screw fixation in achieving faster healing. These findings closely align with Borkar et al., who reported fewer implant-related complications and excellent to good outcomes in 97% of cases treated with cannulated screws, compared with 84.8% in TBW cases.¹³ Similarly, Agarwal et al. noted earlier union in the screw group (12.6 weeks) than TBW (14.4 weeks), with union success rates of 96.66% and 100%, respectively.¹⁴ Singh et al. reported consistent results, also demonstrating faster union in screw fixation (12.6 weeks) compared to TBW (14.4 weeks).¹⁵

Functional outcome data from other studies, such as Nikhilesh et al., who reported 78.7% excellent AOFAS scores and 38.2% excellent BJS scores in surgically treated medial malleolus fractures, supports the notion that stable fixation—regardless of technique—can achieve favorable long-term results.¹⁶ Our findings further correspond with Mohan et al., who observed significantly faster bony union in the cannulated screw group (8.32 ± 1.61 weeks) compared with TBW (10.69 ± 3.35 weeks, $p = 0.008$).¹⁷ However, Aakash et al. reported that both techniques produced satisfactory outcomes, with all screw-treated patients showing signs of healing by 8

weeks and TBW achieving union by 7 weeks, though functional outcomes varied between groups.¹⁸ In contrast, Mizhir et al. reported faster union with TBW (10.5 weeks) compared to cannulated screws (12 weeks, $p = 0.045$), suggesting TBW as the preferred option in their population.¹⁹ Swamy et al. also found shorter union time with screws (10.4 weeks) versus TBW (11.53 weeks, $p = 0.003$), reinforcing our results.²⁰ Mahmood also found excellent/good functional outcomes in 90% of TBW patients and 80% of screw-treated patients, though radiological union was slower in the screw group in their study.²¹

Overall, while a few studies favor TBW, the majority—including our findings—consistently demonstrate earlier radiological union, fewer complications, and better implant tolerance with cannulated screws, supporting their use as the preferred fixation method for medial malleolus fractures. All surgeries and radiological evaluations were performed by a single investigator to standardize procedures. Weekly follow-up with radiographs allowed precise assessment of time to union. However, the sample size was limited to 60 patients, which may reduce generalizability. The study was conducted at a single center, potentially limiting external validity. Longer-term functional outcomes beyond 12 weeks were not assessed, which is a further limitation.

CONCLUSION

Fully threaded cannulated screws achieved faster radiological union compared to tension band wiring in medial malleolus fractures. Both techniques were effective, but cannulated screws demonstrated superior early healing. These findings support the use of cannulated screws for optimal fracture stabilization and recovery.

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