

COMPARATIVE STUDY OF TENSION BAND WIRING, MODIFIED TENSION BAND WIRING AND FULLY THREADED CANNULATED CANCELLOUS SCREWS FOR FIXATION OF MEDIAL MALLEOLUS FRACTURES**SANTOSH S BORKAR^{ID}, SHIVRAJ S KONDE^{ID}, RAJIV MUNDE^{ID}, SHANTANU PATIL^{ID}, SHUBHAM CHAUDHARI^{ID},
MANAS PUSALKAR*^{ID}**

Department of Orthopaedics, M.I.M.E.R Medical College and Dr BSTR Hospital, Pune, Maharashtra, India.

*Corresponding Author: Dr. Manas Pusalkar; Email: manaspusalkar@yahoo.com

Received: 02 January 2024, Revised and Accepted: 18 February 2024

ABSTRACT**Objective:** To compare the three most commonly used fixation techniques: "Tension band wiring, modified tension band wiring, and fully threaded cannulated cancellous screws for fixation of medial malleolus fractures."**Methods:** A prospective comparative cohort study was carried out at a tertiary care hospital in rural Maharashtra. Patients were allocated into three groups, with 33 patients in each group. The internal fixation was done by tension band wiring, modified tension band wiring, or fully threaded cannulated cancellous screws, depending on the group to which a patient belonged. Patients were assessed using the Baird and Jackson scoring system at each follow-up at immediate post-operative period, at 3, 6, 12, 24 weeks, and 1 year. For statistical purposes, $p < 0.05$ was considered statistically significant.**Results:** There was no significant difference in the three groups as regards age, body mass index, and mean time from injury to management. The most common mode of injury was road traffic accidents (51.52%), followed by falls from height (27.27%) and sports-related injuries (21.21%). The mean duration of surgery was significantly longer in cases managed by tension band wiring as compared to the other two groups. Implant-related complications were significantly less in the threaded cannulated cancellous screw group as compared to the other two groups. Overall excellent to good outcomes were observed in 97% of cases of cannulated cancellous screws as well as in modified tension band wiring and 84.8% of cases of tension band wiring, respectively.**Conclusion:** Fully threaded cannulated cancellous screws or modified tension band wiring should be used for the management of medial malleolar fractures while considering the functional outcome and complications associated with each and patient-related factors.**Keywords:** Malleolus fracture, Tension band wiring, Screws, Functional outcome.© 2024 The Authors. Published by Innovare Academic Sciences Pvt Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>) DOI: <http://dx.doi.org/10.22159/ajpcr.2024v17i3.50840>. Journal homepage: <https://innovareacademics.in/journals/index.php/ajpcr>**INTRODUCTION**

Ankle injuries may result from low-energy rotational forces sustained during sports or a missed step during routine daily activities. Young and middle-aged individuals are more prone to develop this type of injury. Population-based studies suggest that the incidence of ankle fractures has increased dramatically since the early 1960s [1]. Their incidence has increased over the last 30 years, affecting one in every 800 people each year and accounting for 9% of all fractures [2].

Several techniques have been described for the surgical fixation of medial malleolar fractures, including lag screws, tension band wiring, K-wiring, bio-absorbable implants, and buttress plating [3,4]. The tension band wiring is indicated for the fixation of small medial fragments, avulsion fractures, or osteoporotic bone. The tension band converts tensile forces into compression forces. Cleak and Dawson presented a modified technique that involved the use of a medial screw to anchor the figure-of-eight wire [5]. The principle of tension band wiring states that by applying tension band wires on the tensile side, the distractive forces are converted into compressive forces. Recent research has shown the effectiveness of tension band wiring and its modification over screws [6].

However, new studies say fully threaded cannulated cancellous screws have thrice the pullout strength as compared to partially threaded cannulated cancellous screws. Biomechanical studies have shown that

bicortical screws have up to 24% stronger pullout strength, higher torque values, greater yield strength, and maximal load at failure in 3-point bending compared to unicortical screws. Studies have shown fully threaded screws engage the physal scar better than longer, partially threaded screws. Furthermore, fully threaded screws had the additional benefit of increasing thread count in the denser paraphyseal region [7].

From this study, it was not possible to determine whether purchase within the physal scar is crucial in all medial malleolar fractures, although in osteoporotic bone, it seems to improve the purchase of the screw threads and compression at the fracture site. This study therefore recommends that fully threaded screws be used instead of long, partially threaded screws when treating medial malleolar fractures in osteoporotic bone [3]. To our knowledge, there has been no study so far comparing these three novel fixation techniques, i.e., tension band wiring, modified tension band wiring, and fully threaded cannulated cancellous screws. Hence, the present study was planned to compare three commonly used techniques of medial malleolus fixation, i.e., tension band wiring, modified tension band wiring, and fully threaded cannulated cancellous screws after open reduction and internal fixation of medial malleolus fracture.

METHODS

This was a prospective comparative cohort study carried out at a tertiary care hospital in rural Maharashtra for 2 consecutive calendar

years after Institutional Ethics Committee approval and consent from the participants. Ninety-nine patients with medial malleolus fractures were included in this study based on pre-defined inclusion and exclusion criteria. Patients were divided into three groups by the investigator after explained to them about the pros and cons of each operative procedure with 33 patients in each group. Open reduction and internal fixation were tried to achieve in all patients. The basic idea was to achieve a near-anatomical reduction. It was done as a planned and elective procedure. When the patients were seen for the first time after injury, a thorough history was taken regarding the time of injury, mechanism of injury, and any significant past or personal history. Medial malleolus fractures were classified based on Muller's classification for isolated medial malleolus fractures [8]. There were three study groups in our study. Group A included a fracture of the medial malleolus treated with tension band wiring. Group B included fractures of the medial malleolus treated with modified tension band wiring. Group C included fractures of the medial malleolus treated with a fully threaded cancellous cannulated screw.

Before patients are taken up for surgery, they are put on foot elevation, and anti-inflammatory drugs are given for a few days to reduce foot swelling. Routine investigations were done, and the diagnosis was confirmed by anterior-posterior and lateral views. Written and informed consent was taken from the patient. According to the fracture sustained, the treatment options available were explained by the surgeon, and then the patient selected the treatment he wanted to receive.

Operative procedure

The operative technique consisted of a standard medial or anteromedial approach to the ankle, usually after exposure and fixation of the lateral malleolus. In modified tension band wiring, a fully threaded screw was inserted into the cephalad to fracture without bone tapping and without completely seated. Two K-wires were then inserted to achieve reduction, and then a figure-of-eight tension band wire was applied around the screw. In tension band wiring, the cerclage was folded on itself before forming a figure-of-eight. This system was then fixed to the medial tibia metaphysis. In the fully threaded cancellous screw fixation technique, a hole was drilled in the superior posterior direction while the distal fragment was held in place with pointed clamps. Fully threaded screws were then inserted over guide wires, and then, both screws were tightened and the guide wires removed.

Postoperatively, limbs were immobilized in plaster splints, patients were put on antibiotics and analgesics, and limbs were elevated. Dressings were done regularly, and sutures were removed on average on the 14th day (decided according to the wound inspection). The below knee splint was continued until 3 weeks postoperatively and then removed. The rehabilitation protocol was started postoperatively. Patients were assessed for fracture union radiologically at the immediate post-operative period of 3 weeks, 6 weeks, 12 weeks, 6 months, and 1 year by the disappearance of the fracture and the appearance of a bridging callus on an X-ray. The functional outcome of patients was assessed using the Baird and Jackson scoring system at each follow-up [4]. If the fracture was showing signs of union, partial weight bearing was advised (approximately at 6–8 weeks), and then gradually full weight bearing was advised. Physiotherapy exercises for ankle movements were started with removal of stitches.

For statistical analysis, all the data were noted down in a pre-designed study pro forma. Qualitative data were represented in the form of frequency and percentage. The association between qualitative variables was assessed using Chi-square test. Quantitative data were represented using mean±SD. Analysis of quantitative data between the three groups was done using analysis of variance with *post-hoc* Tukey's. A $p < 0.05$ was taken as the level of significance. Results were graphically represented where deemed necessary. SPSS Version 26.0 was used for most analysis and Microsoft Excel 2021 for graphical representation.

Inclusion criteria

1. Patients with medial malleolus or bimalleolar fractures of the ankle
2. Patient presenting within 6 weeks of injury
3. Types B and C as per Muller's classification
4. Age > 18 years
5. The patient gave informed and written consent to be part of the study.

Exclusion criteria

1. Those who refused consent
2. Age < 18 years
3. Compound, pathological fractures
4. Posterior malleolar fractures and fractures associated with tibial pilon.

RESULTS

Out of the total 99 studied cases, there were 63 (63.64%) males and 36 (36.36%) females. There was a male preponderance in the studied cases with a M: F ratio of 1:0.67 (Fig. 1).

The mean age of cases with medial malleolar fractures was 39.31 years. All three treatment groups were comparable with regards to age distribution ($p > 0.05$). The mean time from injury to the respective management procedure was 3.93 days among the study group. All three groups were comparable ($p > 0.05$). All three treatment groups were also comparable with regards to mean body mass index ($p = 0.823$) (Table 1).

The most common mode of injury for medial malleolar fractures was road traffic accidents (54.5%), followed by falls (27.3%), and sports injuries (21.2%). As per Muller's classification, Type B medial malleolar fractures were more common as compared to Type C (66.7% vs. 33.3%; $p = 0.95$) (Table 2).

The mean duration of surgery was significantly more in cases managed by tension band wiring (89.56 min) as compared to modified tension

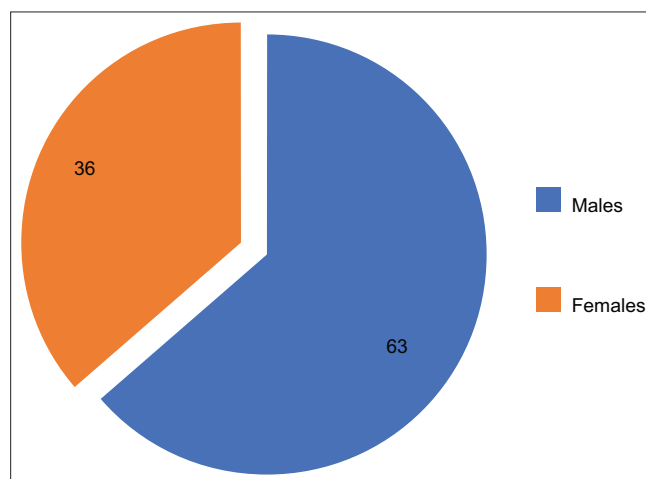


Fig. 1: Gender distribution of the studied cases

Table 1: Mean age, time from injury to management and BMI in studied cases

Parameter	Group	Value	Significance
Mean age	Group A	40.82±5.96	$p > 0.05$ (Not Significant)
	Group B	39.14±6.12	
	Group C	37.98±5.12	
Mean time from injury to management (In h)	Group A	98.4±12.34	$p > 0.05$ (Not Significant)
	Group B	91.2±10.76	
	Group C	93.6±9.96	
Mean body mass index	Group A	24.8±6.12	$p > 0.05$ (Not Significant)
	Group B	23.76±5.48	
	Group C	25.12±3.46	

band wiring (65.64 min) and cannulated cancellous screws (64.55 min). This difference was statistically significant between the tension band wiring and the other two groups ($p < 0.05$). The mean time for wound healing was 14.58 days and was comparable among the three treatment groups ($p = 0.776$). All three treatment groups were also comparable with regards to intra-operative blood loss ($p = 0.798$). The mean time required for the radiological union was significantly less in cases managed by modified tension band wiring (8.42 weeks) and cannulated cancellous screws (9.21 weeks) as compared to tension band wiring (10.09 weeks). This difference was statistically significant between tension band wiring and the other two groups ($p < 0.01$). The overall incidence of implant-related complications was 3% in cases managed by cannulated cancellous screws, as compared to 12.1% in modified tension band wiring cases and 18.2% in cases managed by tension band wiring. Implant-related complications were significantly less in cannulated cancellous screws as compared to groups treated by tension band wiring and modified tension band wiring ($p < 0.05$) (Table 3).

Common complications observed were implant prominence, wire loosening, and wire cut-out (seen in 6.1% of cases each in tension band wiring and 3% of cases in the modified tension band wiring group each, respectively). The only complication seen in the cannulated cancellous screw group was implant prominence in one case (3%). Fracture at the upper part of the medial tibial metaphysis (site of stainless-steel wire insertion) was observed in one case (3%) of the tension band wiring group. Delayed union and non-union were seen in 3 (9.1%) and 1 case (3%) of tension band wiring, respectively, as compared to none in modified tension band wiring and cannulated cancellous screws. One case each in the tension band wiring and modified tension band wiring groups, while two cases in the cannulated cancellous screw group had a surgical site infection (Fig. 2).

Functional outcome was assessed using the Baird and Jackson scores. Overall excellent to good outcomes were observed in 97% of cases of cannulated cancellous screws as well as in modified tension band wiring and 84.8% of cases of tension band wiring, respectively. Excellent results were 12 and 10 in the modified tension band wiring and cannulated cancellous group, respectively, while good results were seen in 20 and 22 in the modified tension band wiring and cannulated cancellous group,

respectively. Poor outcomes were observed in 3 cases (9.1%) of tension band wiring owing to delay and malunion as compared to none in modified tension band wiring and cannulated cancellous screw groups (Fig. 3).

DISCUSSION

Isolated fractures of the medial malleolus are relatively uncommon, occurring in about 7% of ankle fractures, but their incidence increases to 20% when combined with lateral malleolar fractures. Various surgical techniques for fixing medial malleolar fractures include lag screws, tension band wiring, K-wiring, bio-absorbable implants, and buttress plating, each with its own pros and cons. This study aimed to compare the efficacy of three common surgical approaches for medial malleolar fractures: tension band wiring, modified tension band wiring, and fully threaded cannulated cancellous screws, involving 99 cases divided into three groups of 33 each. The study sought to identify the superior method among these, as previous research, including studies by Badgire et al. [5] and Kochai et al. [9], had not conclusively done so.

The mean age of patients with medial malleolar fractures was 39.31 years, with a male predominance (63.6%). The most common cause of injury was road traffic accidents (54.5%), followed by falls (27.3%) and sports injuries (21.2%). Right-side fractures were slightly more common than left-side fractures (54.5% vs. 45.5%). Al-Azzawi et al. [10] and Khachariya et al. [11] also observed similar demographics and injury causes in their studies, reinforcing the typical profile of patients at risk for medial malleolar fractures.

The study noted significant differences in surgery duration, with tension band wiring taking the longest time compared to the other two methods. This finding aligns with observations by Singh [12], who also reported shorter operation times for cannulated screw fixation compared to tension band wiring. The meticulous approach taken for anatomical reduction and stable construct preparation, especially in

Table 2: Mode of injury and Muller's classification in studied cases

Mode of injury and Muller classification	Type	No of cases	Percentage
Mode of injury	Road traffic accidents	51	51.52
	Fall from height	27	27.27
	Sports injury	21	21.21
Muller's classification	Type B	66	66.67
	Type C	33	33.33

Table 3: Duration of surgery, time for healing, time for radiological union and complications

Parameter	Group	Value	Significance
Mean duration of surgery (Min)	Group A	89.56±13.42	$p < 0.05$ (Significant)
	Group B	65.64±12.12	
	Group C	64.55±9.98	
Mean time for wound healing (Days)	Group A	15.12±2.44	$p > 0.05$ (Not Significant)
	Group B	13.92±1.96	
	Group C	14.46±2.02	
Mean time for radiological union (weeks)	Group A	10.09	$p < 0.05$ (Significant)
	Group B	8.42	
	Group C	9.21	
Implant-related complications	Group A	6 (18.2)	$p < 0.05$ (Significant)
	Group B	4 (12.01)	
	Group C	1 (3.03)	

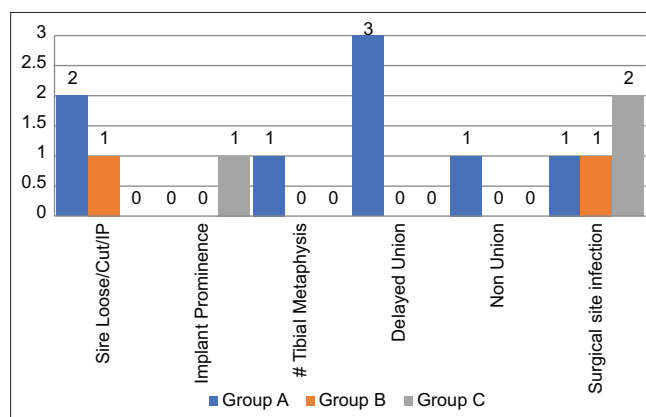


Fig. 2: Comparison of complications in studied cases

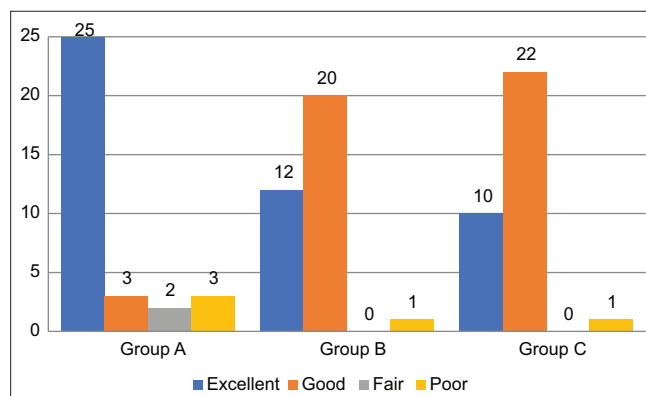


Fig. 3: Comparison of functional outcome in studied cases

a teaching institute setting, was thought to contribute to the longer surgery times. Radiological union times were significantly shorter in the modified tension band wiring and fully threaded cannulated cancellous screw groups compared to tension band wiring. This quicker union in the modified tension band wiring group could be attributed to better stability and compression at the fracture site, a conclusion supported by the studies of Kanwar *et al.* [13] and Georgiadis and White [14], who also found differences in union times based on the surgical approach.

Implant-related complications varied among the groups, with the lowest incidence in the fully threaded cannulated cancellous screw group (3%) compared to modified tension band wiring (12.1%) and tension band wiring (18.2%). This is consistent with findings from Shrestha *et al.* [8] and Vala *et al.* [15], who also reported lower complication rates with certain fixation methods. Complications included implant prominence, wire loosening, and wire cut-out, similar to issues noted by Haseeb *et al.* [16] and Rammelt [17] in their respective studies.

The Baird and Jackson score was used for clinical evaluation, showing significantly higher scores in the modified tension band wiring group compared to the other two, indicating better functional outcomes. This study's findings of excellent to good outcomes in 97% of cases for both the fully threaded cannulated cancellous screws and modified tension band wiring groups, and 84.8% for the tension band wiring group, were echoed in the results of Maruthi and Shivanna [18] and Singh *et al.* [19], who also used the Baird and Jackson scoring system in their evaluations.

Kim *et al.* also suggested that modified tension band wiring and fully threaded cannulated cancellous screws tend to offer better outcomes in terms of reduced surgery time, lower complication rates, and improved functional scores, advocating for a nuanced approach to surgical decision-making [20]. Further research, particularly direct comparisons between fully threaded and partially threaded cannulated cancellous screws, is recommended to refine these recommendations.

CONCLUSION

Modified tension band wiring resulted in better radiological outcomes than traditional tension band wiring, while fully threaded screws showed a slightly better functional outcome and fewer implant-related complications. The study suggests preferring fully threaded screws or modified tension band wiring for medial malleolar fracture management due to their advantages. However, limitations include a small sample size, a lack of a partially threaded screw comparison group, and a short follow-up, which highlights the need for further, more extensive research.

CONFLICT OF INTEREST

None.

REFERENCES

1. Elsoe R, Ostgaard SE, Larsen P. Population-based epidemiology of 9767 ankle fractures. *Foot Ankle Surg.* 2018;24(1):34-9. doi:10.1016/j.fas.2016.11.002
2. Gardner MJ, Demetrakopoulos D, Briggs SM, Helfet DL, Lorich DG. The ability of the Lauge-Hansen classification to predict ligament injury and mechanism in ankle fractures: An MRI study. *J Orthop Trauma.* 2006;20(4):267-72. doi:10.1097/00005131-200604000-00006
3. Lee KM, Chung CY, Kwon SS, Won SH, Lee SY, Chung MK, *et al.* Ankle fractures have features of an osteoporotic fracture. *Osteoporos Int.* 2013;24(11):2819-25. doi:10.1007/s00198-013-2394-6
4. Lin Z, Gao LY, Ruan KM, Guo DB, Chen YH, Liu QP. Clinical observation on the treatment of ankle fracture with buttress plate and traditional internal fixation and its effect on GQOLI-74 score and Baird-Jackson score. *Pak J Med Sci.* 2023;39(2):529-33. doi:10.12669/pjms.39.2.6876
5. Badgire K, Sharma G, Naik L. Modified tension band wiring in medial malleolus fractures: A prospective study. *Int J Res Rev.* 2016;3:103-8.
6. John R, Dhillon MS, Khurana A, Aggarwal S, Kumar P. Tension band wiring is as effective as a compression screw in a neglected, medial malleolus non-union: A case-based discussion and literature review. *J Orthop Case Rep.* 2017;7(4):72-5. doi:10.13107/jocr.2250-0685.860
7. Bulut T, Gursoy M, Ertem H. Fully threaded headless compression screw versus partially threaded cancellous lag screw in medial malleolus fractures: Clinical and radiological outcomes. *Eur J Trauma Emerg Surg.* 2021;47(1):179-85. doi:10.1007/s00068-019-01207-0
8. Shrestha P, Chalise PK, Paudel SR. Comparative study of modified tension band wiring versus tension band through parallel Cannulated Cancellous screws in patella fractures. *Birat J Health Sci.* 2020;4(3):777-81.
9. Kochai A, Türker M, Çiçekli Ö, Özdemir U, Bayram L, Erkorkmaz Ü, *et al.* A comparative study of three commonly used fixation techniques for isolated medial malleolus fracture. *Eklemler Hastalıkları Cerrahisi.* 2018;29(2):104-9.
10. Al-Azzawi I, Mohammed H. Malleolar screw versus tension-band wiring in treatment for closed fracture of medial malleolus. *Iraqi J Community Med.* 2016;29(2):8-15.
11. Khachariya J, Singh MA, Lotha WL, Maske R, Masatwar P. A comparative study of Tension band wiring and cannulated screw fixation for medial malleolar fractures. *IOSR J Dent Med Sci.* 2015;14(12):42-9.
12. Singh VK. A comparative study of tension band wiring and cannulated screw fixation for medial malleolar fractures. *Int J Orthop.* 2019;5(3):805-9.
13. Kanwar S, Gupta S, Kaushik SK. Functional outcome of surgical treatment of displaced malleolar fractures. *Int J Orthop Sci.* 2019;5(3):270-4. doi:10.22271/ortho.2019.v5.i3e.1538
14. Georgiadis GM, White DB. Modified tension band wiring of medial malleolar ankle fractures. *Foot Ankle Int.* 1995;16(2):64-8. doi:10.1177/107110079501600202
15. Vala GP, Patel N, Vora J. A study of functional outcome of bimalleolar fracture treated with fully threaded 4 mm cancellous cannulated screw in medial malleolus fracture. *Surg Rev Int J Surg Trauma Orthop.* 2020;6(2):72-8.
16. Haseeb M, Butt MF, Altaf T, Muzaffar K, Gupta A, Jallu A. Indications of implant removal: A study of 83 cases. *Int J Health Sci (Qassim).* 2017;11(1):1-7.
17. Rammelt S. Management of ankle fractures in the elderly. *EFORT Open Rev.* 2017;1(5):239-46. doi:10.1302/2058-5241.1.000023
18. Maruthi CV, Shivanna D. Management of medial malleolar fractures by tension band wiring: A prospective study. *Int J Orthop Sci.* 2017;3(1):605-7. doi:10.22271/ortho.2017.v3.i1i.90
19. Singh R, Pandey A, Sharma G. Functional results of bimalleolar ankle fractures treated by plating and tension band wiring technique: A prospective study. *Int J Orthop.* 2019;5(3):379-82.
20. 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. doi:10.1016/j.otsr.2022.103447