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# COMPARATIVE ANALYSIS OF THE MODALITIES OF INTERNAL FIXATION IN BIMALLEOLAR ANKLE FRACTURE

**Orthopaedics**

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## ABSTRACT

**Introduction:** Ankle fractures are prevalent, constituting a significant proportion of all fractures. Proper management is crucial to prevent long-term complications such as pain, instability, and arthritis. Surgical interventions aim to restore load-bearing capacity and stability. The increasing incidence of diabetes and its associated complications further stresses the need for effective treatment strategies. This study aimed to identify the optimal internal fixation method for bimalleolar ankle fractures. **Methodology:** This comparative analytical study included 40 patients with fresh bimalleolar ankle fractures and divided them into groups based on the fixation method: cannulated cancellous (CC) screws, tension band wiring (TBW), plate fixation, and K-wire fixation. Data were collected using a pre-designed Performa, and outcomes were assessed using the Baird and Jackson's Ankle Scoring System over a 6-month follow-up period. **Results:** No substantial difference was recorded in age and gender. Superficial infection was seen in 10% of CC screw and plate fixation cases. Falls were most common in the CC screw group, while RTAs were prevalent in the TBW group. The most common fracture type was SER. Mean union time was the shortest for CC screws. Overall, postoperative outcomes were comparable across groups. **Conclusion:** The study highlights that despite variations in pain levels and complications among different fixation methods, overall functional recovery and radiographic outcomes were comparable. These findings emphasize the need for individualized treatment approaches, considering patient preferences and specific factors when selecting the fixation modality for bimalleolar ankle fractures.

## KEYWORDS

Bimalleolar ankle fractures, Cannulated cancellous screws, tension band wiring, Functional recovery, Ankle Scoring System

## INTRODUCTION

Ankle joints function as uniaxial hinges, with a mortise being a deep groove in the talus body that includes the lower tibia, medial malleolus, lateral malleolus, and inferior transverse tibiofibular tendon. [1] Ankle fractures are common, occurring in about 137 out of every 1,000,000 people annually, accounting for 10% of all fractures and being the second most common in the lower limbs after hip fractures. [2] These fractures have increased over the past 20 years, particularly among young, active individuals and the elderly. [3] Experimental data by Paul L. Ramsey show that a lateral displacement of the talus by one millimeter decreases the tibia-talus contact area by approximately 42%, highlighting the complexity of these injuries. [4] Given that the entire body weight is transmitted through the ankle, these fractures necessitate prompt and appropriate management to avoid serious long-term complications such as pain, instability, and early degenerative arthritis. [5] Surgical intervention aims to restore the ankle's load-bearing capacity and structural stability, facilitating early mobility and weight-bearing without the need for a cast. The A.O. principles of anatomical fracture reduction, stable internal fixation, and early active pain-free movement have significantly improved outcomes for bimalleolar ankle fractures. The primary goals of treatment are achieving proper fracture healing and restoring pain-free function. Ankle fractures constitute 9% of all fractures and their increasing incidence has added to the financial burden on healthcare systems. [6] The association between diabetes and complications such as Charcot neuroarthropathy, impaired wound healing, and delayed fracture healing is well documented. [7,8] With the rising incidence of diabetes, complications related to diabetic ankle fractures are expected to increase, further stressing the need for effective management strategies. [9] Diabetic patients often experience balance impairments due to neuropathy, increasing the risk of early weight bearing and subsequent complications like malunion and infections. [10,11] Alternative fixation methods, such as minimally invasive percutaneous osteosynthesis (MIPO) and intramedullary fixation, have been proposed to improve outcomes by preserving the soft tissue envelope and reducing the risk of complications. [12] Techniques like tibiotalocalcaneal (TTC) nailing and locked fibular nailing require minimal incisions, aiming to improve limb salvage rates. [13,14] However, some studies report less favourable outcomes than initially suggested, highlighting the need for continued research. [15] Therefore, this study aimed to identify the optimal internal fixation method for bimalleolar ankle fractures, highlighting the need for thorough, standardized research in the field.

## MATERIAL AND METHODS

The research took place over an 18-month period within the Orthopaedics departments at the Hind Institute of Medical Sciences, a tertiary care center located in Safedabad, Barabanki, UP. Utilizing a comparative analytical study design, the study aimed to assess the treatment outcomes for bimalleolar ankle fractures. A total of 40 patients, sourced from both the regular outpatient department and the emergency department, were included. These participants were selected through consecutive sampling, encompassing all consenting individuals with fresh bimalleolar ankle fractures who met the inclusion criteria. Inclusion criteria comprised patients aged 18 years and above with fresh bimalleolar ankle fractures. Exclusion criteria excluded individuals < 18 years, those with compound fractures, those unfit for surgery or anaesthesia, polytrauma cases, and those not providing informed consent. Additionally, patients classified under specific Lauge Hansen stages were excluded. Data collection utilized a pre-designed Performa to record patient details, clinical findings, and investigation reports based on the established criteria. Ethical approval was obtained from the HIMS Institutional Ethics Committee, and written informed consent was obtained from each participant prior to enrolment. The patients were divided into four groups, each undergoing a different surgical procedure to fix the fracture. Cannulated cancellous (CC) screws were used for 20 patients, with plate fixation and K-wire fixation each performed on 10 patients. Another 20 patients underwent tension band wiring (TBW) fixation, with plate fixation and K-wire fixation each performed on 10 patients.

After surgery, the operated limb was elevated on a pillow, and active toe movements were encouraged. The first wound inspection was done on the second postoperative day, followed by an X-ray. On the 5th postoperative day, the second wound inspection and dressing was done. Depending on the condition of the wound, further wound inspections and dressing changes were performed as needed. Suture removal was done on the 14th day. Patients were assessed at regular intervals for up to 6 months using the Baird and Jackson's Ankle Scoring System to evaluate the outcomes. Complications assessed during follow-up visits included non-union, malunion, wound problems, infection, post-traumatic arthritis, and ankle stiffness.

***Statistical Analysis:***

The data was put into Microsoft Excel and evaluated with SPSS version 26 software from SPSS Inc. in Chicago, Illinois, USA. When needed, the range value or mean (standard deviation) value was used to look at the continuous factors. The dichotomous variables were shown as numbers or frequencies, and Chi-square was used to examine them. This test was used to see how the means of two or more groups compared to each other.

## RESULTS

Among the enrolled patients, the mean ages for CC screws, TBW, plate fixation, and K-wire fixation were 34.00±6.82, 39.30±11.21, 46.50±20.36, and 48.10±15.97 years, respectively. Most patients were males in each group, but this difference was not statistically significant. [Table-1] Skin irritation occurred in 20% of cases with TBW fixation, but not in other groups. Superficial infection was observed in 10% of cases with CC screw and plate fixations, but not with TBW or K-wire fixations (p=0.1353). [Figure-1]. Across all fixation methods, the most common Lauge Hansen type was SER, followed by PER depicted in table-2. The time to surgery was 3.20±1.23 days for CC screw with plate fixation, 4.50±2.55 days for CC screw with K-wire fixation, 4.70±2.16 days for TBW with plate fixation, and 3.80±1.75 days for TBW with K-wire fixation. Patients treated with CC screws had a mean union time shorter than those with TBW. Postoperative outcomes were comparable among all the groups. [Table-3] Regarding radiographic outcomes, patients treated with plate fixation had a mean radiographic score of 25.00 (SD=0.00), while those with K-wire fixation had a slightly lower mean score of 24.00±3.16. [Figure-2] Baird and Jackson's ankle scoring system yielded comparable outcomes across different fixation methods for bimalleolar ankle fractures. [Table-4]

## DISCUSSION

The mean ages for patients undergoing CC screw fixation, TBW, plate fixation, and K-wire fixation were 34.00±6.82, 39.30±11.21, 46.50±20.36, and 48.10±15.97 years, respectively. Statistical analysis revealed a non-significant difference in age distribution among fixation groups (p=0.1257), indicating age did not significantly influence fixation method choice. These results are consistent with John R et al. (mean age 40 years) and Beris A et al. (mean age 43.8 years). [16,17] Despite variations in fixation modalities between genders, no significant difference in distribution based on gender (p=0.3359) was recorded.

The distribution of weight-bearing status among patients with bimalleolar ankle fractures shows a uniform distribution of both partial and full weight-bearing across all fixation modalities. This suggests that patients can achieve weight-bearing postoperatively regardless of the fixation method used—CC screw fixation, TBW, plate fixation, or K-wire fixation. Statistical analysis (p>0.9999) indicates no significant differences in weight-bearing status among the methods, supporting their equal effectiveness in facilitating postoperative weight-bearing. This aligns with previous literature showing comparable functional outcomes among different fixation techniques for ankle fractures. [18,19] All fixation methods achieved 100% partial and full weight-bearing, highlighting their success in promoting early mobilization and rehabilitation of post-bimalleolar ankle fractures. Despite variations in dorsiflexion and plantarflexion outcomes, statistical analysis showed no significant differences in dorsiflexion among fixation methods (p=0.2898 and p=0.2267), indicating similar efficacy across groups. At 1.5 months post-surgery, all CC screw fixation patients reported pain levels of 4, while TBW, plate fixation, and K-wire fixation patients showed varied pain levels, with some reporting pain levels of 0. By 3 months, pain levels of 4 were reported by 60% of CC screw patients, 40% of TBW, and 40% of plate fixation patients. Statistical analysis indicated significant differences in pain levels among fixation methods at 1.5 and 3 months (p=0.2654 and p=0.1840), highlighting variability in postoperative pain experiences. The present study examined complications like skin irritation and superficial infection among different fixation methods for bimalleolar ankle fractures. No skin irritation was reported in the CC screw fixation with K-wire and TBW group with K-wire, although there was one case of superficial infection in the CC group. In contrast, 20% of patients with plate fixation with TBW and K-wire with TBW reported skin irritation. Another study found complications in 15% of 75 ankle injury patients. [20] Injury mechanisms (falls, road traffic accidents, twisting injuries) showed no significant differences across fixation methods, suggesting fixation choice does not influence injury mechanism. Comprehensive patient assessment remains crucial in treatment planning. [21,22]

Fracture distribution between the left and right sides was similar across all fixation methods. In CC screw and TBW groups, 50-60% had left-side fractures and 40-50% had right-side fractures. Plate and K-wire fixation groups showed predominantly right-side fractures (80%), with 20% having left-side fractures. Statistical analysis found no significant variation in fracture distribution among methods (p=0.1423), suggesting fixation choice does not influence the fracture side. The most common Lauge Hansen type across all methods was SER (supination-external rotation), with 50% in CC screw and TBW groups, and lower incidences in the plate (40%) and K-wire (20%) groups. PER (pronation-external rotation) type followed, reported by 30% of CC screw, 20% of TBW, 40% of the plate, and 50% of K-wire patients. Statistical analysis showed no significant differences in Lauge Hansen type distribution (p=0.2806), indicating the minimal impact of the fixation method on fracture classification. The mean time to surgery for bimalleolar ankle fractures varied slightly among CC screw, TBW, plate fixation, and K-wire fixation methods, with no significant differences found (p>0.05). This suggests that the choice of fixation modality may not significantly impact surgical timing, supported by recent studies. [23,24] emphasizing patient-specific factors in decision-making. Comprehensive data analysis across outcomes including pain levels, stability, patient-reported outcomes, radiographic outcomes, and ankle scoring showed consistent findings: no significant differences in pain levels or stability among fixation methods were observed, underscoring the multifactorial nature of post-operative outcomes. [25,26] Scores for walking, running, work, and motion did not differ significantly among fixation methods post-surgery for bimalleolar ankle fractures, suggesting minimal impact on functional outcomes. Individualized treatment approaches and comprehensive rehabilitation are increasingly recognized for optimizing functional recovery. [27] Radiographic outcomes, including fracture reduction and alignment, also showed no significant differences among fixation methods, though they should be considered alongside clinical outcomes for overall treatment assessment. [28] Baird and Jackson's ankle scoring system provided consistent results across fixation methods, indicating its reliability in evaluating treatment outcomes for these fractures. [29] Thus, this study indicates that while there may be variations in specific outcome measures among different fixation methods for bimalleolar ankle fractures, overall, the choice of fixation modality may not significantly impact key clinical outcomes.

## CONCLUSION

This study provides valuable insights into the outcomes associated with different fixation modalities. While age, gender, occupation and several other factors did not significantly influence the choice of fixation method or treatment outcomes, variations in pain levels and complications were observed among the different modalities. However, overall functional recovery, radiographic outcomes, and patient-reported outcomes remained comparable across all fixation methods. These findings underscore the importance of individualized treatment approaches and careful consideration of patient preferences and factors when selecting the most appropriate fixation modality for Bimalleolar Ankle Fractures. The study's limitations include small sample size, single-centre design, retrospective nature, short follow-up period, and lack of blinding during outcome assessment. These factors may introduce biases, limit generalizability, and reduce the strength of the evidence. Larger, multi-centre, prospective, randomized controlled trials with longer follow-ups and blinding procedures are needed for more robust findings. Furthermore, treatment for ankle fractures should consider bone quality, soft tissue condition, and overall health rather than age alone. Tailored postoperative pain management and vigilant monitoring for complications are essential. Surgeons should assess the patient's overall condition and ensure patient readiness and fracture stability, as

surgery timing is similar across treatments.

**Tables And Figures**

**Table-1: Demographic Characteristics Of Patients With Different Fixation Modalities For Bimalleolar Ankle Fractures.**

| Demographic characteristics | | CC SCREW [n=20] | | | | TBW [n=20] | | | | P-VALUE |
|---|---|---|---|---|---|---|---|---|---|---|
| | | PLATE [n=10] | | K-WIRE [n=10] | | PLATE [n=10] | | K-WIRE [n=10] | | |
| | | N | % | N | % | N | % | N | % | |
| AGE (Years) | 18-30 | 3 | 30.00 % | 4 | 40.00 % | 2 | 20.00% | 3 | 30.00 % | X=17.73 p=0.1241 |
| | 31-40 | 2 | 20.00 % | 5 | 50.00 % | 1 | 10.00% | 1 | 10.00 % | |
| | 41-50 | 3 | 30.00 % | 1 | 10.00 % | 2 | 20.00% | 2 | 20.00 % | |
| | 51-60 | 2 | 20.00 % | 0 | 0.00 % | 2 | 20.00% | 0 | 0.00 % | |
| | >60 | 0 | 0.00% | 0 | 0.00 % | 3 | 30.00% | 4 | 40.00 % | |
| GENDER | Female | 4 | 40.00 % | 2 | 20.00 % | 1 | 10.00% | 4 | 40.00 % | X=3.386 p=0.3359 |
| | Male | 6 | 60.00 % | 8 | 80.00 % | 9 | 90.00% | 6 | 60.00 % | |

**Table-2: Lauge-hansen Type In Patients With Different Fixation Modalities For Bimalleolar Ankle Fractures.**

| LAUGE-HANSEN TYPE | CC SCREW [n=20] | | | | TBW [n=20] | | | | P-VALUE |
|---|---|---|---|---|---|---|---|---|---|
| | PLATE [n=10] | | K-WIRE [n=10] | | PLATE [n=10] | | K-WIRE [n=10] | | |
| | N | % | N | % | N | % | N | % | |
| PA | 2 | 20.00% | 2 | 20.00% | 2 | 20.00% | 0 | 0.00% | X=10.93 p=0.0286 |
| PER | 3 | 30.00% | 2 | 20.00% | 4 | 40.00% | 5 | 50.00% | |
| SA | 0 | 0.00% | 1 | 10.00% | 0 | 0.00% | 3 | 30.00% | |
| SER | 5 | 50.00% | 5 | 50.00% | 4 | 40.00% | 2 | 20.00% | |

PA (pronation-abduction), PER (pronation-external rotation), SA (supination-abduction), SER (supination-external rotation).

**Table-3: Comparative Outcomes Of Different Fixation Methods For Bimalleolar Ankle Fractures.**

| | CC SCREW [n=20] | | | | TBW [n=20] | | | | P-VALUE |
|---|---|---|---|---|---|---|---|---|---|
| | PLATE [n=10] | | K-WIRE [n=10] | | PLATE [n=10] | | K-WIRE [n=10] | | |
| | MEAN | SD | MEAN | SD | MEAN | SD | MEAN | SD | |
| TIME (DAY) TO SURGERY | 3.20 | 1.23 | 4.50 | 2.55 | 4.70 | 2.16 | 3.80 | 1.75 | F=1.194 p=0.3258 |
| UNION (WEEKS) | 8.80 | 1.69 | 10.80 | 3.01 | 10.00 | 1.63 | 10.90 | 2.77 | F=1.695 p=0.1854 |
| PAIN | 14.10 | 1.45 | 11.80 | 2.35 | 13.50 | 1.58 | 13.10 | 2.33 | F=2.442 p=0.0800 |
| STABILITY | 15.00 | 0.00 | 15.00 | 0.00 | 15.00 | 0.00 | 15.00 | 0.00 | -- |
| WALKING | 14.70 | 0.95 | 13.40 | 2.37 | 14.10 | 1.45 | 14.00 | 2.31 | F=0.8120 p=0.4956 |
| RUNNING | 8.60 | 0.97 | 8.20 | 1.14 | 9.00 | 1.05 | 8.60 | 1.35 | F=0.8260 p=0.4482 |
| WORK | 9.80 | 0.63 | 9.00 | 1.05 | 9.20 | 1.03 | 9.20 | 1.03 | F=1.326 p=0.2812 |
| MOTION | 10.00 | 0.00 | 9.10 | 1.45 | 9.10 | 1.45 | 9.70 | 0.95 | F=1.586 p=0.2097 |

**Table-4: Baird And Jackson's Ankle Scoring In Patients With Different Fixation Modalities For Bimalleolar Ankle Fractures.**

| BAIRD AND JACKSON'S ANKLE SCORING | CC SCREW [n=20] | | | | TBW [n=20] | | | | P-VALUE |
|---|---|---|---|---|---|---|---|---|---|
| | PLATE [n=10] | | K-WIRE [n=10] | | PLATE [n=10] | | K-WIRE [n=10] | | |
| | N | % | N | % | N | % | N | % | |
| Poor | 0 | 0.00 % | 1 | 10.00% | 0 | 0.00 % | 1 | 10.00 % | X=7.617 p=0.5731 |
| Fair | 0 | 0.00 % | 2 | 20.00% | 2 | 20.00% | 1 | 10.00 % | |
| Good | 2 | 20.00% | 4 | 40.00% | 2 | 20.00% | 2 | 20.00 % | |
| Excellent | 8 | 80.00% | 3 | 30.00% | 6 | 60.00% | 6 | 60.00 % | |
| MEAN±SD | 97.20±2.20 | | 91.80±7.11 | | 95.60±4.09 | | 94.70±6.82 | | F=1.732 p=0.1779 |

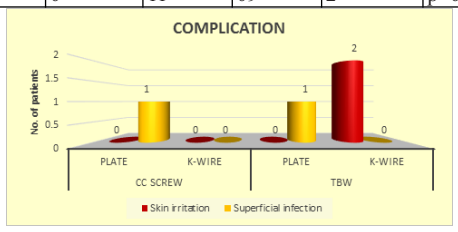


**Figure-1:** Complications in patients with different fixation modalities for bimalleolar ankle fractures.

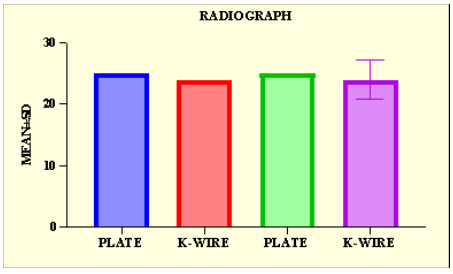


**Figure-2:** Radiographic outcomes in patients with different fixation modalities for bimalleolar ankle fractures.

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