



A Prospective Cohort Study on Functional Outcome in Surgically Managed Bimalleolar Fractures in Adults

1. **Dr Mohammad Shariq** (Junior Resident), Department Of Orthopaedics , Imsr , Integral University , Lucknow.
2. **Dr Ashutosh Singh** (Associate Professor), Department Of Orthopaedics , Imsr , Integral University , Lucknow.
3. **Dr Farid Mohammad** (Professor), Department Of Orthopaedics , Imsr , Integral University , Lucknow.
4. **Dr Anand Srivastav** (Assistant Professor), Department Of Orthopaedics , Imsr , Integral University , Lucknow.

Corresponding Author - Dr Farid Mohammad

(Received: 16 June 2025

Revised: 20 July 2025

Accepted: 07 August 2025)

KEYWORDS

Ankle fractures,
Bimalleolar
fractures, Surgical
management,
Functional outcome,
Radiological union..

ABSTRACT:

Introduction: Bimalleolar fractures are complex and their conservative management is difficult and often require surgical intervention.

Objective: To study the functional outcome and determinants of surgically managed bimalleolar fractures.

Methods: Fifty adults with bimalleolar fracture (aged 22-63 years; mean age 37.48 years; 62% 21-40 years; 66% males; 54% right ankle; 52% Road traffic accident) were enrolled. Fractures were classified according to AO and Lauge-Hansen classification. Surgical management of the fractures was done under spinal anesthesia. All the patients were followed up for a minimum of six months. At each follow-up, clinical and radiological assessment was done. Time for radiological union was noted. Functional outcomes were assessed at six months using Baird and Jackson scoring system. Association of functional outcome with clinicodemographic profile of patients was assessed using Chi-square test. Data analysis was done using SPSS 25.0 software.

Results: According to AO classification, maximum fractures were Class B (48%) followed by Class C (40%) and Class A (12%) respectively. According to Lauge-Hansen classification, 17 (34% each) were identified as Supination-External rotation (SER) and Pronation-External Rotation (PER) respectively. Mean union time was 10.88±2.27 weeks. Excellent, good, fair and poor functional outcomes were seen in 52%, 34%, 12% and 2% cases. Older age, fall or sports as mode of injury, Class B and C fractures, and PER or SER L-H class were significantly associated with poor/fair outcome.

Conclusion: Surgical management of bimalleolar fractures was highly successful with 100% union rate and high prevalence of good to excellent functional outcomes.

INTRODUCTION

Bimalleolar fractures comprise nearly 60% of the total ankle fractures [1]. Bimalleolar fractures often also have ligament injuries. Even when one of the two malleoli is fractured along with ligament injury, the resultant fracture is unstable one and is difficult to manage conservatively. The situation becomes more

complicated in patients with poor bone quality. The most common reason for occurrence of these fractures is exposure to excessive rotational forces that leads to subluxation or dislocation of talus out of ankle mortise [2-4]. Owing to these complexities, bimalleolar fractures often require surgical intervention. Functional outcomes hold a high relevance while managing these fractures as these fractures disrupt the stability of the



ankle joint, an essential structure for mobility, balance, and weight-bearing. Without proper functional evaluation, even anatomically restored fractures may result in unsatisfactory patient outcomes due to lingering pain, reduced range of motion, or impaired gait mechanics [5-7].

Functional outcomes are commonly assessed using patient-reported outcome measures (PROMs) and clinician-evaluated metrics. PROMs, such as the Foot and Ankle Outcome Score (FAOS) and the American Orthopaedic Foot & Ankle Society (AOFAS) score, provide subjective insights into pain, functional limitations, and patient satisfaction. These scores are particularly useful in capturing the patient's perspective, which may differ from clinical evaluations [8,9].

The **Baird and Jackson scoring system** is a widely used functional assessment tool for evaluating the outcome of patients following ankle fractures. It incorporates subjective and objective parameters to comprehensively assess the recovery and functionality of the ankle. The scoring system evaluates six key categories, *viz.* Pain, Stability, Walking ability, Running ability, work and activity and ankle & subtalar motion. For each domain maximum scores range from 10 to 25 with total maximum possible score of 100. The scores can also be interpreted categorically as poor (<70), fair (70-79), good (80-89) and excellent (90-100). This system provides a quantitative and qualitative evaluation of ankle function, offering insight into both the patient's recovery and the effectiveness of treatment. Its comprehensive nature makes it a valuable tool for both clinical and research applications in orthopedic and rehabilitation medicine [10]. Although, surgical management is currently the preferred management modality yet functional outcomes may vary from patient to patient, thus indicating the role of individual factors affecting them.

In the present study, we describe the functional outcomes of surgically managed patients with bimalleolar fractures and correlate the same with various demographic and clinical factors as determinants.

MATERIAL AND METHOD

A total of 50 patients with closed bimalleolar fractures aged >18 years fit for surgery were enrolled in

the study after obtaining informed consent and approval from the Institutional Ethics Committee (IED Letter No. IEC/IIMSR/2023/38 dated 16th May 2023). Patients having pilon fractures, old neglected fractures, pathological fractures, multiple Trauma/Neurovascular injuries, medically unfit for surgery and/or anesthesia patients and those who failed to comply with regular follow up for a period of at least 6 months were excluded from the study.

Sample size calculation was done at 9% prevalence, 90% confidence level and 7% margin of error. The calculated sample size was 45. However, a total of 50 patients were enrolled in the study.

Method

A detailed history was taken and the mode, type of injury was inquired. Patients were examined for other bony injuries and visceral injuries. All the patients included in the study were investigated thoroughly with:

- a) Routine blood investigations (complete blood count, Random blood sugar, serum creatinine, HIV, HbSag, HCV, Thyroid Profile, LFT)
- b) Urine routine (albumin, sugar and microscopy)
- c) Radiological examination - AP view, Lateral view, Mortise view, Chest X ray PA view
- d) E.C.G: To assess the myocardial status.

The fractures were then classified as per the Lauge-Hansen's and Weber's classification both. Patients were given below knee POP slab with strict limb elevation till the time of surgery.

Preoperative planning

Following the radiological evaluation, patients were briefed regarding the need for operative treatment and were investigated with routine investigations for the surgical procedure. Patients with comorbid medical illnesses were treated appropriately with the help of general Physicians. Evaluation by anesthesiologists was done. Consent for the surgical procedure was obtained. Antibiotics were administered at the time of induction of anesthesia. The antibiotics used were second generation Cephalosporins.



Operative Procedure

Spinal anesthesia was administered to all patients. The patient was placed in supine position with a sandbag under the ipsilateral buttock in cases of lateral malleolar fracture. Following exsanguinations, tourniquet was inflated with time being noted. The affected limb was prepared with a primary scrub with Betadine. The parts were then painted with Betadine and Spirit. Surgical draping was done using the standard methods and the foot was covered with a hand towel or a glove.

The operative approach for the fixation of the lateral malleolus was done as per the standard approaches, depending on the mode of fixation planned. The lateral malleolar fracture was exposed first.

Medial malleolus was approached according to the mode of fixation planned using the standard approaches. Almost in all the cases we found that there was soft tissue interposition between fracture fragments.

All the patients were operated under tourniquet control. The duration of surgery varied from 30 mins to 80 minutes. The implants used for the fixation of fractures were as follows:

The medial malleolus was fixed with Tension band wiring

The lateral malleolus was fixed with, One third tubular plate or Semi tubular plate and Syndesmotic screw. The wound was washed with normal saline and subcutaneous sutures applied using 2-0 Vicryl. Skin was closed with 3-0 Ethilon or Staple. Dressing was done with adequate padding and a below knee plaster of Paris slab was applied.

Postoperative regimen

Patients were administered adequate analgesics. IV Antibiotics were administered for 2 days postoperatively. The foot was kept elevated over pillows. Radiological evaluation was done in the postoperative period which included both Anteroposterior and Lateral views.

First dressing done on the second postoperative day. Patient was mobilized on the first postoperative day, non-weight bearing on the affected

leg with the help of walker. Patients were discharged on the fifth day on an average.

Follow up

The patients were followed up at 2nd week, 4th week, 6th week, 3rd Month and 6th month. Sutures were removed at follow up in the outpatient clinic at the end of two weeks. Posterior slab removed same day, crepe bandage applied and range of motion of ankle started but patients were advised to continue non weight bearing ambulation with a walker for a period of four weeks. Check x rays were done. Signs of healing and status of the joint was noted. Partial weight bearing was started with support. Full weight bearing was decided on the basis of the X-ray picture.

At the end of 6 months, patients were evaluated as per the rating of the Baird and Jackson criteria which included objective criteria, subjective criteria and Radiological evaluation.

Data Analysis: Data analysis was done using IBM SPSS latest version software. Data has been represented as numbers and percentage for qualitative data and mean±standard deviation for continuous data. Chi-square test was used to compare the outcomes against different clinicodemographic variables.

RESULTS

Age of patients ranged from 22 to 63 years. Mean age of patients was 37.48±10.27 years. Majority of patients were males (66%). Left side (54%) was more commonly involved than the right side. Road traffic accident (52%) was the most common cause of injury. Class A, B and C fractures accounted for 12%, 48% and 48% injuries respectively. According to Lauge-Hansen classification, 17 (34% each) were identified as Supination-External rotation (SER) and Pronation-External Rotation (PER) respectively while Superior adduction (SA) was responsible for 24%. Only 8% were other types (Table 1).

Fracture union time ranged from 8 to 16 weeks with a mean of 10.88±2.27 weeks. Mean Baird and Jackson functional scores for domains pain, stability of ankle, ability to walk, ability to run, ability to work, motion of ankle and radiographic results were 12.68±1.88, 15.00±0.00, 14.46±1.46, 8.20±0.73, 9.40±0.93, 9.58±1.05 and 25±0.00 respectively. Overall



total functional score was 94.46±4.63 out of a maximum possible of 100 (Table 2).

Functional outcomes were rated as excellent, good, fair and poor in 52%, 34%, 12% and 2% cases respectively (Fig. 1).

Poor/fair outcome showed a significant association with older age, fall as the cause of injury, AO class C and fracture type PER (p<0.05) (Table 3).

Table 1: General Characteristics and baseline profile of study population

SN	Characteristic	Statistic
1.	Mean age±SD (Range) in years	37.48±10.27 (22-63)
2.	Male:Female	33 (66%): 17 (34%)
3.	Side: Right:Left	23 (46%): 27 (54%)
4.	Mode of injury	
	Fall from height	16 (32%)
	Road traffic accident	26 (52%)
	Sports	8 (16%)
5.	Class of Fracture (AO Classification)	
	A	6 (12%)
	B	24 (48%)
	C	20 (40%)
6.	Type of Fracture (Lauge-Hansen)	
	PA/PD	4 (8%)
		17 (34%)

PER	12 (24%)
SA	17 (34%)
SER	

Table 2: Union Time and Functional Outcome

SN	Characteristic	Mean±SD (Range)
1.	Mean union time±SD (Range) weeks	10.88±2.27 (8-16)
2.	Domainwise functional scores (Defined range)	
	Pain (0-15)	12.68±1.88 (8-15)
	Stability of ankle (0-15)	15.00±0.00 (15-15)
	Ability to walk (0-15)	14.46±1.46 (8-15)
	Ability to run (0-10)	8.20±0.73 (6-10)
	Ability to work (0-10)	9.40±0.93 (8-10)
	Motion of ankle (0-10)	9.58±1.05 (7-10)
	Radiographic results (0-25)	25.00±0.00 (25-25)
3.	Total functional score±SD (Range)	94.46±4.63 (77-100)

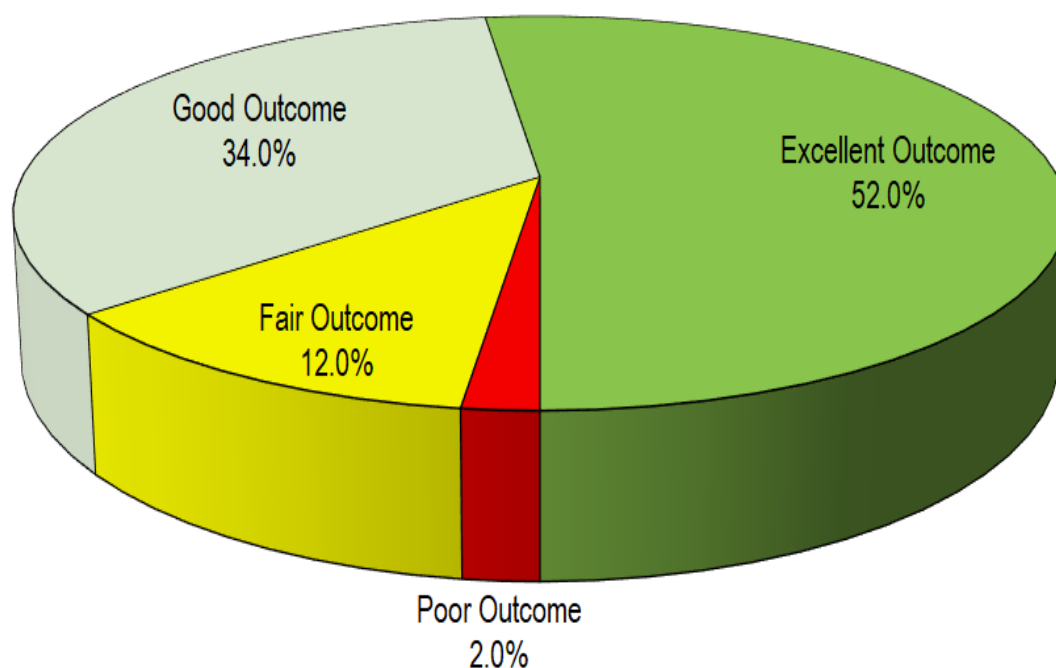
Table 3: Association of Functional Outcome with Demographic Profile of Study Population

SN	Characteristic	Poor/Fair outcome (n=7)		Good outcome (n=26)		Excellent outcome (n=17)		Statistical significance	
		No.	%	No.	%	No.	%	χ ²	'p'
1.	Age (yrs)								
	21-30 yrs	0	0.0	12	46.2	4	23.5	20.99	0.002



	31-40 yrs	2	28.6	4	15.4	9	52.9		
	41-50 yrs	1	14.3	8	30.8	3	17.6		
	≥51 yrs	4	57.1	2	7.7	1	5.9		
2.	Gender								
	Male	5	71.4	19	73.1	9	52.9	1.964	0.375
	Female	2	28.6	7	26.9	8	47.1		
3.	Laterality								
	Left ankle	5	71.4	9	34.6	9	52.9	3.509	0.173
	Right ankle	2	28.6	17	65.4	8	47.1		
4.	Mode of injury								
	Fall	4	57.1	9	34.6	3	17.6	12.938	0.012
	Road traffic	0	0.0	16	61.5	10	58.8		
	Sports	3	42.9	1	3.8	4	23.5		
5.	AO Class								
	Class A	0	0.0	6	23.1	0	0.0	12.801	0.012
	Class B	2	28.6	15	57.7	7	41.2		
	Class C	5	71.4	5	19.2	10	58.8		
6.	L-H Class								
	PA/PD	0	0.0	4	15.4	0	0.0	16.878	0.010
	PER	4	57.1	5	19.2	8	47.1		
	SA	0	0.0	11	42.3	1	5.9		
	SER	3	42.9	6	23.1	8	47.1		

Fig. 1: Grading of Overall Functional Outcome





PRE-OPERATIVE X RAY



POST-OPERATIVE X RAY



Fig. 2: Radiological outcome of a representative case achieving excellent functional outcome

**DORSIFLEXION OF ANKLE****PLANTARFLEXION OF ANKLE****SQUATTING POSITION****STANDING ON TOETIPS**

Fig. 3: Clinical photographs showing functional outcome assessment of a representative case achieving excellent functional outcome

DISCUSSION

In the present study, final assessment for functional outcomes was made at 6 months, mean functional scores for pain, stability of ankle, ability to walk, ability to run, ability to work, motion of ankle and radiological outcome domains were 12.68 (out of 15), 15 (out of 15), 14.46 (out of 15), 8.20 (out of 10), 9.40 (out of 10), 9.58 (out of 10) and 25 (out of 25) respectively. Excellent, good, fair and poor functional outcomes were seen in 52%, 34%, 12% and 2% cases. Overall percentage of patients achieving good/excellent

outcome was 86%. These findings are in agreement with the observation of Kakkar *et al.* who reported good/excellent functional outcomes in 84.6% cases [10]. Though in their study, poor outcomes were achieved in 7.6% cases as compared to only 2% in the present study. However, this difference could be attributed mainly to fewer number of cases (n=26) in their study. As far as number of cases with poor outcome is concerned, it was two cases in both the studies. Using different criteria for functional assessment, Dhoju *et al.* also found excellent result in



majority of their cases [3]. However, Suhas *et al.* in their study not only had a total of 83.3% cases with good/excellent outcome but they also had no case with poor outcome [11]. In other studies too, good/excellent functional outcomes have been reported in more than three-fourth cases while poor outcomes have remained in less than 10% cases only [12-18]. In remaining studies too, majority of cases had good to excellent outcomes irrespective of the sample size or surgical technique used [19,20]. Thus despite differences in studies, surgical management of bimalleolar fractures promises a good functional outcome as also endorsed by present study.

In the present study, we did not find an association of functional outcomes with sex and laterality. However, older age, fall or sports as mode of injury, Class B and C fractures, and PER or SER L-H class were significantly associated with poor/fair outcome. All these factors were non-modifiable in nature. As far as modifiable factors like surgical technique or type of anesthesia is concerned, none of the prior studies had shown a significant difference in terms of functional outcome. In the present study, though we found a significant association of fracture type with functional outcome, however, some workers like Dhoju did not even find them to have an interference with functional outcome [3]. In another study, with a larger series (n=68) Balaji *et al.* however found significant association of outcomes with sex, age, fracture type (closed/open or dislocated/undislocated), comorbidities (diabetes), alcohol use, redressal of syndesmotom injury and preoperative TCA, thereby showing the role of both demographic as well as clinical factors in determining the outcome [16]. In the present study, we also noticed the impact of both clinical as well as demographic factors, however, these need further evaluation in a larger sample size with inclusion of more variables focused on to assess their role in multivariate terms.

The present study had a limitation of sample size like most of the other studies owing to a relatively rare occurrence of these fractures. Another limitation was a short follow-up and absence of multiple surgical techniques for comparison. All the surgeries were performed using standard approach under spinal anesthesia, thus role of surgical approach and anesthetic

alternative was not evaluated. Lack of focus on complications during hospitalization, time gap between occurrence of fracture and surgery were some of the other unrecorded variables that could have affected the radiological as well as functional outcome.

CONCLUSION

The present study showed that surgical management of bimalleolar fractures using a standard surgical approach is not only successful but provides promising radiological as well as functional outcomes, hence surgical management using standard surgical approach of open reduction and internal fixation under spinal anesthesia is highly recommended for management of these fractures. Further studies with inclusion of more variables, larger sample size and longer follow-up duration are also recommended. Meta-analytical and multicentric studies to lend more statistical credence to the research work are also recommended.

We are grateful to all the patients who participated in the research for their cooperation and trust. Special thanks to the medical and technical staff for their assistance in data collection and patient care. MCN: IU/R&D/2025-MCN0003830

REFERENCES

1. Koujan K, Saber AY. Bimalleolar Ankle Fractures. [Updated 2023 Feb 11]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK562254/>
2. Bugler KE, White TO, Thordarson DB. Focus on Ankle Fracture. *J Bone Joint Surg Br* 2012;94:1107-12.
3. Dhoju D. Operative outcome of bimalleolar fractures. *Kathmandu Univ Med J* 2019;17(66):131-5.
4. Anghong C. Ankle fracture configuration following treatment with and without arthroscopic-assisted reduction and fixation. *World J Orthop* 2016;7(4):258-64.
5. Court-Brown CM, Heckman JD, McQueen MM, Ricci WM, Tornetta P, 3rd, McKee MD.



- Rockwood and Green's Fractures in Adults. Philadelphia, PA, USA: Wolters Kluwer Health; 2015.
6. Shibuya N, Davis ML, Jupiter DC. Epidemiology of foot and ankle fractures in the United States: an analysis of the National Trauma Data Bank (2007 to 2011). *J Foot Ankle Surg*. 2014;53(5):606-8.
 7. Hermena S, Slane VH. Ankle Fractures. 2023 Aug 8. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. PMID: 31194464.
 8. Larsen P, Rathleff MS, Roos EM, Elsoe R. Foot and Ankle Outcome Score (FAOS): Reference Values From a National Representative Sample. *Foot Ankle Orthop*. 2023;8(4):24730114231213369.
 9. Van Lieshout EM, De Boer AS, Meuffels DE, Den Hoed PT, Van der Vlies CH, Tuinebreijer WE, Verhofstad MH. American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Score: a study protocol for the translation and validation of the Dutch language version. *BMJ Open*. 2017;7(2):e012884.
 10. Kakkar RS, Mehta D, Sisodia A. Radiological and Functional Outcome of Unstable Bimalleolar Fractures Through Surgical Treatment Using Baird-Jackson Scoring System. *Int J Sci Res*. 2019;8(10): 15-20.
 11. Suhas D, Kumar MP, Sriram V. Functional outcome following surgical management of ankle fractures. *International Journal of Orthopaedics Sciences* 2019; 5(4): 762-767.
 12. Patil NS, Gaonkar NK, Dalal SK, Shivaji A. A Study of Functional Outcome of Bimalleolar Fracture. *Journal of Pharmaceutical Research International*, 2020; 32(30): 62-68.
 13. 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. *Surgical Review Int J Surg Trauma Orthoped*. 2020; 6(2):72-78.
 14. Dwivedi R, Karki A, Bhattarai R, Rijal B. Functional Outcome Estimation of Bimalleolar Ankle Fractures Treated by Open Reduction and Internal Fixation at a Tertiary Care Center: A Descriptive Cross-sectional Study. *JNMA J Nepal Med Assoc*. 2020;58(230):740-743.
 15. Kale S, Tank P, Ghodke R, Singh P, Patel A. Functional outcome of bimalleolar ankle fractures treated with fibular plate for lateral malleolus and C.C. screws for medial malleolus. *IJOS* 2020; 6(1): 1126-1132.
 16. Balaji G, Bhukya R, Nema S, Rajeswari M, Vellaipandi V. Predictors of Functional Outcome in Unstable Ankle Fractures Treated Surgically – A Prospective Cohort Study. *Malaysian Orthopaedic Journal* 2021; 15(1): 85-92.
 17. Patel DB, Patel D, Singh A, Vohra R, Chauhan S. The Radiographic and Functional Outcome of Bimalleolar Fractures Treated by Open Reduction and Internal Fixation with Screws/Tbw and Plates: A Prospective Study. *Orthop & Spo Med Op Acc J* 2021; 5(1): 492-96.
 18. Shyam Kumar, Das J. Functional outcome of Bimalleolar Ankle Fractures treated with internal fixation. *International Journal Dental and Medical Sciences Research* 2022; 4(5): 444-452.
 19. Sharma Y, Thoudam S, Garg R, Das S, Kevadiya M, Gupta A. A study of functional outcome of bimalleolar fracture with syndesmotic injury after open reduction and internal fixation in young adults. *Indian J Orthop Surg* 2024;10(3):231-237.
 20. Gangadhran N, Pillai MG. Study on functional outcome of bimalleolar ankle fractures treated by open reduction and internal fixation. *Int J Res Orthop* 2021;7:518-25.