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Original Research Article

A study of functional outcome of bimalleolar fracture with syndesmotic injury after open reduction and internal fixation in young adults

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ABSTRACT

Background: Malleolar injuries when combined with syndesmotic injuries are widely regarded as some of the most common and severe fractures that affect the lower extremities. These injuries are of great significance because the ankle joint bears the weight of the body, making it prone to instability and difficulty in locomotion. Open reduction and internal fixation have become the preferred treatment option for the majority of unstable bimalleolar fractures, as this surgical method restores the ankle's anatomy, biomechanics, and contact loading characteristics.

Materials and Methods: Prospective study of 20 patients of bimalleolar fracture was done in MMIMSR, Mullana, Ambala who were surgically managed by TBW/screw for medial malleolus fixation and plating for fibula.

Results: According to Baird and Jackson scores, out of 20 cases 65% had good to excellent result, 55% had fair result and 10% had poor functional outcome

Conclusion: Achieving accurate anatomical reduction, restoring articular congruity, and timely surgical fixation using appropriate implants can lead to favourable functional outcomes.

1. Introduction

The malleolar fractures in the ankle is one of the commonest fractures in day to day orthopaedic practices. Like the other intra articular fractures, malleolar fracture requires appropriate reduction and a proper stable fixation. When the malleolar fractures are not accurately reduced, they can lead to post injury painful movement restrictions of the ankle, osteoarthritis, or both.[1]

Approximately around 3 centuries ago, scientific studies had begun with Sir Percival Pott, who in his paper in the year 1768 stated some of the remarks on dislocations and fractures that had discussed the fracture complex happening at the ankle joint. Dupuytren, Tillaux Chaput, Maisonneuve, Leforte-wagstaffe and others analysed ankle joint injuries.

After examining numerous cases thoroughly in the year 1922, Ashhurt and Bromer categorized and assessed injuries around the ankle by taking into account the forces direction acting upon them. In the years 1948-1954, Lauge-Hansen identified four distinct categories by analyzing pure injury sequences and considered factors such as the timing of injury, the deforming force direction, and the position of the foot.[2]

Ankle injuries are significant because they involve the transmission of body weight through joints, which is crucial for mobility. These injuries are typically a combination of ligamentous and bony damage, and each injury results from a sequence of failures due to deforming forces. Malleolar fractures, in particular, have different presentations that have led to the development of various classification systems.

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Two such systems that are commonly used are the Lauge Hansen and Danis-Weber classification systems.[1]

The ankle joint are highly susceptible to injuries. This is due to its relatively mobile nature and it bears much of the stresses associated while weight bearing. The ankle joint supports more weight per unit area in comparison with any other joint in our body. The ankle joint can bear upto five times our body weight.[3] Sir Robert Jones mention that the ankle joint is the most injured joint of our body but it is the least well treated. Ankle injuries are very significant because body weight transmission occurs through them, and the locomotion depends upon the joint stability. Many of the ankle joint injuries are both ligamentous components and bony components. Magnetic resonance imaging (MRI) is a useful diagnostic tool to determine ligamentus injury. During the year 1948-1954, four patterns based on pure injury sequences were recognized by Lauge-Hansen and were taken into account at the time of ankle injury, it showed deforming force direction and position of the foot. To prevent complications, like other intra articular fractures, it is crucial to achieve anatomical reduction by using the open reduction and internal fixation for bimalleolar ankle fracture. The results of bimalleolar ankle injuries are improved with emphasis given on the anatomical reduction of the fracture and stable fixation and regaining full fibular length, and early active painless mobilization since the advent of AO principles of management.

As for the management of malleolar fractures, the stable fractures are treated by conservative management and have provided great results. Whereas the unstable fractures , displaced and the open fractures requires open reduction internal fixation of the fracture. The superiority of the ORIF over conservative management have been thoroughly demonstrated in the literature. The operative method restores the joint anatomy and contact-loading characteristic of the ankle. The add on advantages are earlier rehabilitation and recovery without cast, and earlier weight bearing.[1]

2. Materials and Methods

This was a prospective study, which included 20 cases of closed bimalleolar fractures, who were treated surgically at Maharishi Markandeshwar Institute of Medical Sciences and Research, Mullana, Ambala from June 2022 to June 2024.

2.1. Inclusion criteria

1. Patient with displaced unstable bimalleolar fracture.
2. Closed bimalleolar fracture.
3. Bimalleolar fracture with syndesmotic injury.
4. Patient above 18 years and below 30 years.

2.2. Exclusion criteria

1. Patient below 18 years, and above 30 years of age.
2. Patient with medical contraindications to the surgery.
3. Paralytic limb.
4. Others associated fractures in the ipsilateral limb.
5. Patients who have not give consent for the study.

All patients were all evaluated pre-operatively in context to general information like name, sex, age, occupation and address. A detailed history to find out the mode and mechanism of injury was taken. Clinical examination was done in detail to rule out other associated injuries. Anteroposterior, mortise and lateral radiograph of the ankle joints were obtained with other relevant x-rays if needed. Initially patients was supplemented with analgesics and the affected lower limb splinted with below knee slab. Consent was taken from the patient.. All patients of ankle fractures underwent surgery as soon as patients were fit . A dose of intravenous cefuroxime injection (antibiotic) was given after checking the sensitivity on the previous night of surgery and on OT table before beginning the surgery. Antibiotic coverage was continued in post-operative period.

Post-operatively Intravenous cefuroxime antibiotic coverage with adequate analgesia were given. The intravenous antibiotic was administered for 5 days followed up oral antibiotics till suture removal.

X-rays of the Ankle- AP, Lateral and Mortise view was taken on 1^{st} post-operative day. First wound examination on post op day 2 and then on post op day 5 and surgical wound dressings were done. Intermittent Ankle movements was started within 3 to 4 days. Sutures removal were done on the 14^{th} post operative day after assessing the wound status. Use of the slab was discontinued after 3 weeks after looking at the wound status, initial partial- weight bearing was allowed after 4-6 weeks but full weight bearing was started on 10 to 12 weeks which will depend on clinical examination and x-ray.

2.3. Assessment of results

The radiological and functional results were given analysis using the ankle scoring system of Baird and Jackson. The evaluation was based on a questionnaire, physical and radiological examinations. The physical examinations were measurements of active dorsi-flexion and plantar -flexion of the injured ankle in comparison with the uninjured ankle, with forepart of foot in neutral position. Radiologically, the medial clear space, the superior joint space and talar tilt were measured.

2.4. Illustration case (Figures 1, 2, 3, 4 and 5)

1. Age: 30
2. Sex: Male
3. Injury surgery interval: 2 days

Table 1: The Baird and Jackson scoring system are given below:

Parameters		Score
1. Pain	No pain.	15
	Mild pain while patient performed strenuous activity	12
	Mild pain while patient performed daily living.	8
	Pain while patient performed weight bearing	4
	Pain at rest	0
2. Stability of ankle	No clinical noticed instability	15
	Instability while patient performed sports activities	5
	Instability while patient performed activites of daily living ability to walk	0
3. Ability to walk	Patient's ability to walk the desired distances without limp or pain.	15
	Patient's ability to walk the desired distances with some mild limp or pain.	12
	Moderate restriction while walking.	8
	Patient's ability to walk short distance only.	4
	Pateint is inable to walk	0
4. Ability to run	Patient's Ability to run the desired distance without pain.	10
	Patient's ability to run desired distances with some slight pain.	8
	Moderate restriction on running with mild pain	6
	Patient's ability to run short distance only.	3
	Patient's inability to run	0
5. Ability to work	Patient's ability to perform the usual occupation without restriction.	10
	Patient's ability to perform the usual occupation with restrictions in strenuous activities	8
	Patient's ability to perform the usual occupation with little substantial restrictions.	6
	Partially disabled, can do only selected jobs.	3
	Patient's inability to work	0
6. Motion of the ankle	Less than 10% of the uninjured ankle.	10
	Less than 15% of the uninjured ankle.	7
	Less than 20% of the uninjured ankle	4
	Less than <50% of the uninjured ankle, or dorsiflexion <5	0
7. Radiographic result	Intact mortise which is normal medial clear space, normal- 2mm superior joint space and no talar tilt seen.	25
	Same like the above with some mild reactive changes at the joint margins .	15
	Narrowed superior joint space, superior joint space of 2mm and talar tilt more than >2mm	10
	Moderate narrowing of superior joint space, with superior space of between 2 and 1mm.	5
	Severe narrowed superior joint space with superior joint space	0

Baird and Jackson scoring sytem:
Excellent results: 96 -100
Good results: 91 - 95
Fair results: 81 - 90
Poor results: 0 – 80
Maximum possible score - 100

4. Classification: Lauge-Hansen- SER
5. Complications: Nil

3. Observation and Results

It was a prospective study including 20 patients who had bimalleolar fracture. They were all treated surgically at MMIMSR, Mullana, Ambala from June 2022 to June 2024.

The maximum occurence of the injury occured in the third decade of life, with injury which were more common in males- 15 cases (75%) than females- 5 cases (25%). The side more commonly involved was left- 11 cases (55%) as compared to right- 9 cases (45%). Road traffic accidents accounted to majority of the injuries (65%) with second being self fall and twisting accounting to 35%. Out of the 20 patients, 8 are PER pattern, 7 are SER pattern, 3 are PA pattern and SA pattern accounting to 3 patients. Commonest injury pattern observed in my study was Pronation- External rotation type, followed by Supination External Rotation type. According to Baird and Jackson scoring system , out of 20 cases 65% had good to excelent result, 55% had fair result and 10% had poor functional outcome. In our study, mean for radiological union in 6 months period was 13.45 weeks.

On the basis of positioning of foot while injury and the direction of the force applied to the foot, four types of injury patterns which was described by Lauge-Hansen and their incidences.(Graph 1) The results are the following:

Figure 1: Pre-op x-ray

Figure 2: Approach to the lateral malleolus

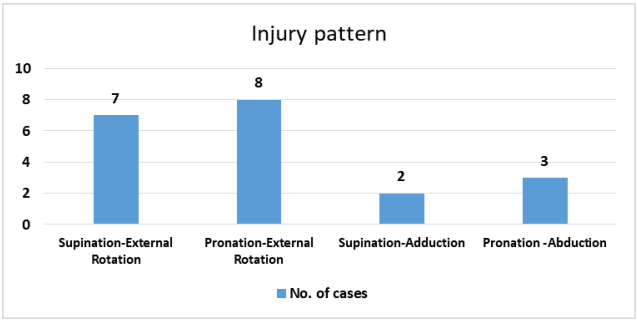
Figure 3: Approach to the medial malleolus

Table 2: The various results are displayed

Sex ratio	
Sex ratio	**No. of patients**
Male	15
Female	5
Side involved	
Side involved	**Number of patients**
Left	11
Right	9
Mode of injury	
Mode of injury	**Number of patients**
Self fall, twisting.	7
Road traffic accidents.	13

Figure 4: Immediate post op x-ray

Figure 5: Range of motion after 6 months of follow up



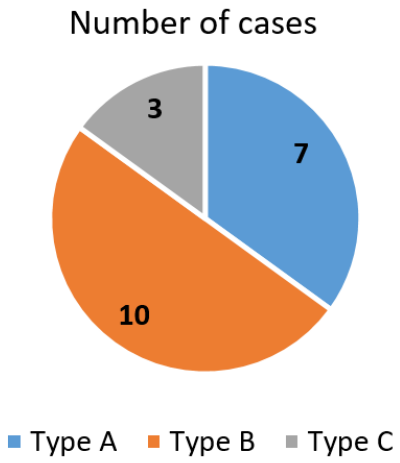
Graph 1: Injury pattern

Based on the fibula fracture level, the AO classification expands on Danis-Weber, the following distributions were seen.(Graph 2)

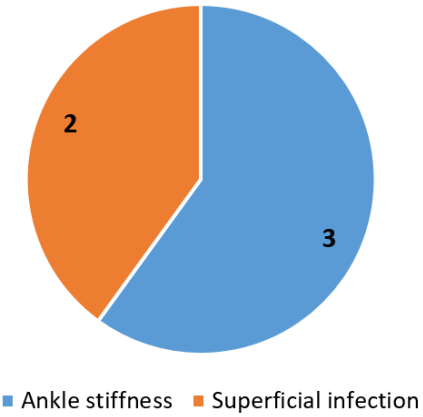
According to Baird and Jackson, following functional outcomes were observed.

Table 3:

Results	No. of patients	Percentage
Excellent	2	10%
Fair	5	25%
Good	11	55%
Poor	2	10%



Graph 2: Danis- Weber classification



Graph 3: Management of complications

Table 4: Based on the fracture pattern, the following functional outcome were observed

Subjective scoring	Fracture pattern SER	PER	SA	PA
Excellent	2	0	0	0
Good	2	6	0	3
Fair	2	2	1	0
Poor	1	0	1	0

Table 5: Functional outcome according to sex distribution

Sex	Excellent	Good	Fair	Poor
Male	1	8	4	2
Female	1	3	1	0

3.1. Complications

The following postoperative complications were observed

1. Superficial infections with or without skin necrosis: 2
2. Ankle stiffness: 3

Patients who encountered superficial infections, were all treated with repeated saline aseptic dressings and appropriate antibiotics. They responded well to this mode of treatment.

4. Discussion

Our study consist of 20 cases of closed bimalleolar ankle fractures. Injury were more common in males - 15 cases (75%) than females- 5 cases (25%). The side more commonly involved was left- 11 cases (55%) as compared to right- 9 cases (45%).

Road traffic accidents (RTA) accounted to to majority of the injuries (65%) followed by self fall and twisting injury accounting to 35% of total injury. Out of the 20 patients, 8 are PER pattern, 7 are SER pattern, 3 are PA pattern and SA pattern accounting to 3 patients.

Most common pattern of injury seen in my study was Pronation and External Rotation type. Stress radiograph is useful to assess the ankle stability.

In PER pattern, 6 out of 8 had good functional outcome, with no poor functional outcome, although 1 patient had developed complication of ankle stiffness which were managed with malleolar screws for medial malleolus fracture and plate for lateral malleolus fracture. In pronation and external rotation injury restoration of the fibular length and rotation, ankle mortise and syndesmotic stability is important factoras noted by maverick et al.[4]

Displacement is the talus position in a mortise of the ankle joint and it depends on the intact deep deltoid ligaments.[5] Fixing of the malleolar fragments will not likely restore the ankle stability and will need to repair the deep deltoid if torn.[6] Stable fractures does not displace with axial pressure.[7] Treatment management are based on the fracture stability. Prognosis will be determined by the injury energy.[8] Even though the Lauge and Hansen classification does describe in detail regarding the pattern of ankle injuries, however it do not deal much with syndesmotic injury pattern.

In S-ER pattern, 4 out of total 7 patients were observed to have good to excellent result, with 2 cases having complications of superficial infections, out of which a single case was treated with medial malleolus screw fixation and fixation with plate for the lateral malleolus and the second case was treated with kwire fixation of medial malleolus and plate fixation of lateral malleolus. SER4 fracture pattern are unstable kind of fractures and needs ligament reconstruction.[9]

As compared to other fracture pattern, Supination-Adduction pattern had fair to poor prognosis. One out of the two patients developed ankle stiffness.

The three patients with pronation and abduction injury, we fixed medial malleolus first then followed by extra periosteal plate for fibula.

Bimalleolar fractures had a good male dominance with 75% and male to female ratio of 15:5 which we compared with the study done by Motwani G N[10] and Maruthi C V.[11] (Table 6)

Table 6: Sex distribution seen in various studies

Study	Number of patients	Male to Female ratio	Percentage of males
Motwani GN[10]	40	5:1	82.5
Maruthi CV[11]	40	28:12	70
Present study	20	15:5	75

The commonest injury pattern was RTA - 13 patients (65%) which were compared with the study by Raj K[12] and Lee et al.[13] and Mohapatra A.[12] (Table 7)

Table 7: Mode of injury in various studies are shown below

Study	Number of patients	Common mode of Injury
Lee et al[13]	168(98)	RTA
Mohapatra A, Raj K[12]	84(43)	RTA
Present study	20(13)	RTA

From the 20 patients, 8(40%) are PER pattern, 7 (35%) are SER pattern, 3 patients (15%) are PA pattern and 2 patients (10%) are SA pattern. Parvataneni Prathap D A,[14] Roberts RS.[15]

Beris et al[16] all had SER as the commonest pattern, whereas in our study, PER pattern was the commonest injury.(Table 8)

Table 8: Common type of injury seen in various studies

Study	Total Number of patients	Most common type of injury	Percentage
Parvataneni Prathap[14]	(30)	SER	(46.6)
Roberts RS[15]	(25)	SER	(34)
Beris et al[16]	(144)	SER	(45)
Our study	(20)	PER	(40)

Average time which was required for union seen radiologically was (13.45) weeks which were in compared with study by Parvataneni Prathap D A[14] and Maruthi C V[11] (Table 9)

Baird and Jackson scores - at the end of 6 months, out of the 20 patients, 2 patients (10%) had excellent score, 11 patients (55%) had good score, 5 patients(25%) had fair score and 2 patients(10%) had poor functional outcome. Similar results were also seen in other study like Shah Z A, Arif U,[17] De souza et al.,[18] Beris et al.,[16] Motwani GN.[10] The comparative results is shown below (Table 10).

Table 9: Radiological union in various studies

Study	Follow up period.	Mean for radiological union
Parvataneni Prathap D A[14]	6 months	(10.6) weeks
Maruthi CV[11]	6 months	(8) weeks
Our study	6 months	(13.45) weeks

Table 10: Comparative results in various studies are shown below

Study	Good to Excellent	Fair	Poor
Shah ZA, Arif U[17]	82.5%	12.5%	5%
Beris et al[16]	74.3%	14.6%	11.1%
De souza et al[18]	90%	6%	4%
Motwani GN[10]	82.5%	12.5%	5%
Present study	65%	25%	10%

In our research, the factors of gender, age of patients, and mechanism of injury (classified according to Lauge-Hansen) did not prove to be statistically significant in determining functional outcomes. Within our sample of 20 patients, only 2 cases (10%) experienced complications such as superficial wound infections, as opposed to a study by Shah ZA and Arif U (17), in which 4 out of 20 patients developed superficial infections.

5. Conclusion

The goal of surgery is to obtain anatomical reduction, ankle mortise congruence, fibular length restoration, and maintain integrity of the syndesmosis. Soft tissue dissection should be kept minimal as possible to avoid further compromise in an already swollen ankle so as to avoid vascular compromise. Achieving accurate anatomical reduction, restoring articular congruity, and timely surgical fixation using appropriate implants can lead to favourable functional outcomes. It was observed that the Pronation-External Rotation pattern of injury was the most prevalent pattern in our study. We observed that plating of fibula is a better method of fixation in B2, B3, and C2 fractures of AO pattern. If a ligament injury is properly treated and fixed with anatomical soundness, functional outcomes are improved.

6. Sources of Funding

None.

7. Conflict of Interest

None.

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