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## A prospective observational study of surgical management of bimalleolar fractures around ankle

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### Abstract

Ankle fractures are one of the commonest fracture of lower limb encountered by orthopaedic surgeon. Incidence of ankle fracture has increased in both young and elderly age group; which accounts for 9% of all fractures. The incidence of ankle fractures is approximately 187 per 1 lakh person each year. Sir Robert Jones said "The least well treated and most prone joint to get injured is the ankle joint. Ankle fractures most commonly caused by fall, twisting and sport injuries. Middle and older aged patients presenting with ankle fractures have co-morbidities like diabetes mellitus and obesity.

Ankle joint is most commonly injured because of its weight bearing function and role in locomotion. Ankle fracture are likely to cause lifelong complication like early degenerative arthritis, instability and pain; therefore understanding of biomechanics of ankle joint, proper fixation technique and findings of outcome studies is utmost important. Experimentally shown by Paul L. Ramsay, about 1mm lateral shift in talus, produces about 42% of decrease in tibio-talar contact area. Therefore the reduction should be ideal anatomically, which can be attained by open reduction and internal fixation. The operative procedure preserve the anatomy and weight bearing function of ankle joint and also helps in easier rehabilitation without a cast, early mobilization and weight bearing.

**Keywords:** Ankle, fracture, bimalleolar, danis weber, lauge hansen

### Introduction

Ankle fractures are one of the commonest fracture of lower limb encountered by orthopaedic surgeon. Incidence of ankle fracture has increased in both young and elderly age group; which accounts for 9% of all fractures <sup>[1]</sup>. The incidence of ankle fractures is approximately 187 per 1 lakh person each year. Sir Robert Jones said "The least well treated and most prone joint to get injured is the ankle joint <sup>[2]</sup>. Ankle fractures most commonly caused by fall, twisting and sport injuries. Middle and older aged patients presenting with ankle fractures have co-morbidities like diabetes mellitus and obesity <sup>[3]</sup>.

Ankle joint is most commonly injured because of its weight bearing function and role in locomotion. Ankle fracture are likely to cause lifelong complication like early degenerative arthritis, instability and pain <sup>[4]</sup>; therefore understanding of biomechanics of ankle joint, proper fixation technique and findings of outcome studies is utmost important. Experimentally shown by Paul L. Ramsay, about 1mm lateral shift in talus, produces about 42% of decrease in tibio-talar contact area <sup>[5]</sup>. Therefore the reduction should be ideal anatomically, which can be attained by open reduction and internal fixation. The operative procedure preserve the anatomy and weight bearing function of ankle joint and also helps in easier rehabilitation without a cast, early mobilization and weight bearing <sup>[6]</sup>.

Ankle joint is a hinge joint of synovial variety. It is a congruous joint consist of tibial plafond, medial malleolus of tibia and lateral malleolus of fibula. Ankle joint is stabilized by medial and lateral ligament complexes, the distal tibio-fibular ligament, tendons crossing the joint, the bony contour and capsular attachments.

Bimalleolar fracture is a fracture of medial malleolus and lateral malleolus. Fracture patterns are more complicated in patients with poor bone quality. These fractures are most commonly caused by excessive rotational forces which results in subluxation or dislocation of talus out of ankle mortise.

Many classifications have been proposed to describe these fractures of which most important are: Lauge-Hansen and Danis-Weber classification.

The purpose of this study is to assess the functional outcome and the results of surgical treatment of bimalleolar fractures by various modalities such as malleolar or cancellous screw fixation, tension band wiring, K-wire fixation for medial malleoli and 1/3<sup>rd</sup> tubular or recon plate, rush pin, K-wire or cancellous screw fixation for lateral malleoli.

#### Mechanism of Injury <sup>[4]</sup>

The Ankle joint has described as shaped like part of a cone, with the apex of the cone directed medially towards the medial malleolus and the base of the cone directed laterally toward the distal part of fibula. The axis of the cone resembles the mechanical axis of the joint and continue from just below the tip of medial malleolus to the tip of lateral malleolus. In the frontal plain the axis is aligned 80 degree to the long axis of the tibia and the axis is rotated 20-30 degree external to the axis of knee. Although the actual centre of rotation moves slightly during the arc of rotation, for most clinical purposes the axis of motion can be studied to lay between the distal tips of medial and lateral malleoli. The malleoli acts as pillars for attachment of the ligaments close to the rotational axis of the joint. This enable some portion of the ligament complex medially and laterally to remain taut throughout the range of flexion and extension and thus provides rotational stability. Rotational forces and axial loading are predominantly responsible for ankle fractures, in which malleolar fractures results due to rotational forces and axial loading results in fracture of tibia plafond.

Medial or lateral malleoli are predominantly affected in malleolar fracture and sometimes other structure of ankle as well. Most malleolar fracture results when talus is fixed on the ground through body weight, and shearing and tensile

forces are passed through it.

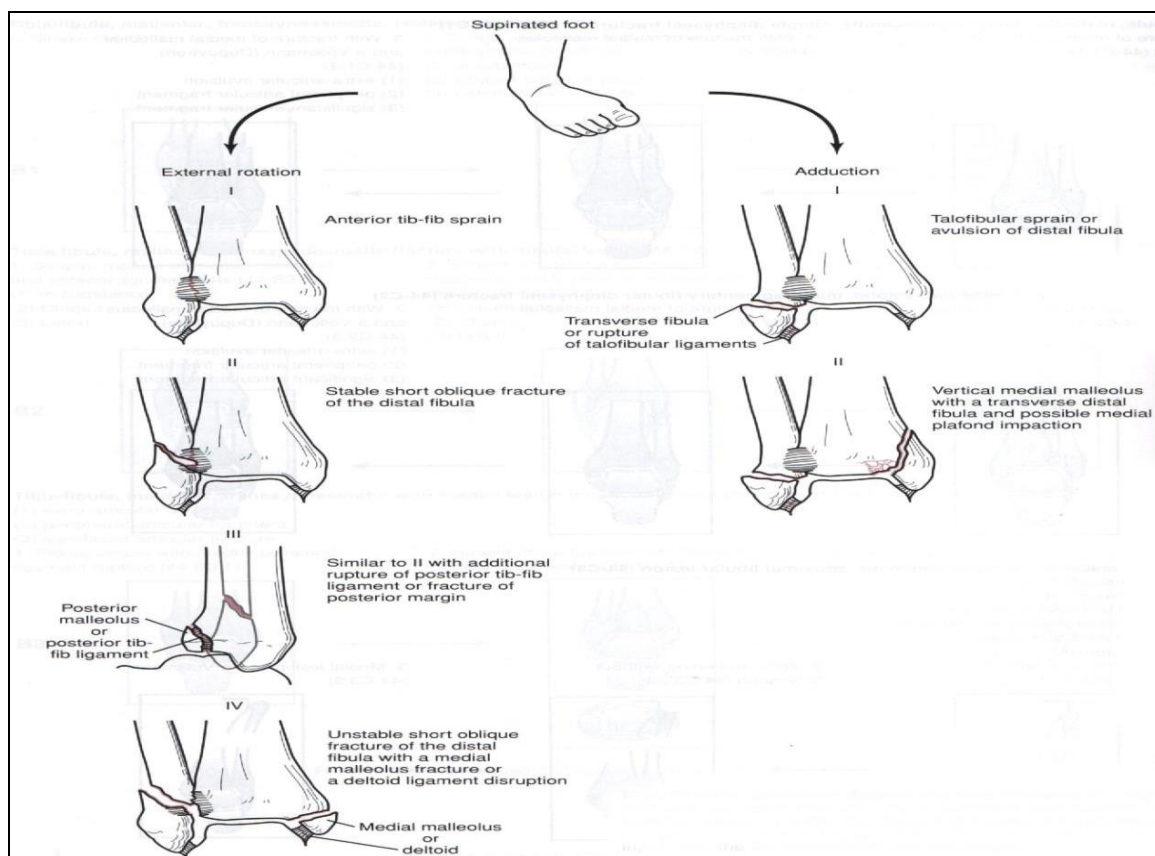
Injury patterns depends on various factors including patients age, bone quality, foot position at injury time and the rate and direction of the loading forces. The current knowledge of ankle injury mechanism is derived from: Lauge-Hansen classification. They underlined the correlation between the foot position and deforming forces direction at the time of injury.

#### Supination adduction (SAD)

As the foot is in supination and hindfoot goes in adduction results in the tightening of lateral structures, continued adduction force may cause rupture of talofibular ligament or avulsion fracture of distal fibula below the level of syndesmosis. This results in stable injury. If the adduction forces continues further the talus may impact against the medial side of the joint, which results in vertical shear fracture of the medial malleolus. This results in unstable injury. Further force results in an impaction fracture of medial plafond from talus.

#### Supination External Rotation (SER)

As the foot is in supination and deforming force externally rotates the foot, this causes tibia and fibula to move apart resulting in disruption of anterior syndesmotic ligament, with or without avulsion fracture from its bony attachment. In the second stage further external rotation results in fibula fracture at syndesmosis level with oblique fracture line. The fracture is stable as medial structures are intact. In third stage, if deforming force continues, it increases tension on posterior syndesmosis, resulting in disruption of the posterior tibiofibular ligament or fracture of posterior malleolus. In fourth stage, the medial structures gets involved, resulting in disruption of deltoid ligament or oblique fracture of the medial malleolus.



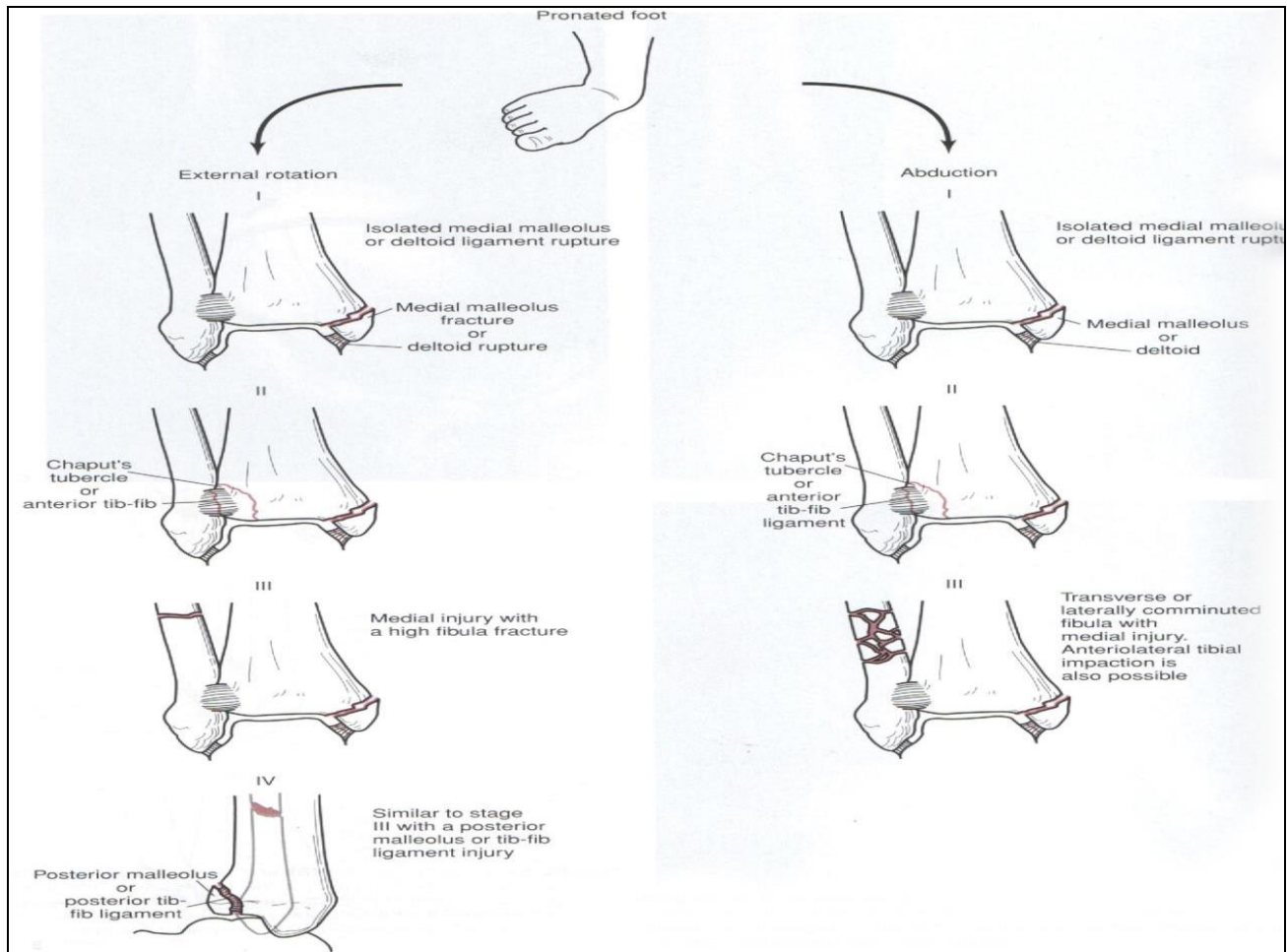
**Fig 1:** Schematic diagram and case examples of Lauge-Hansen SER and supination adduction ankle fractures

### Pronation abduction (PAB)

If foot is in pronation and with abduction deforming force, the medial structures get tighten and are injured first, there is either an avulsion fracture of medial malleolus or rupture of deltoid ligament. In the second stage If the deforming force continues it results in disruption of syndesmotic ligaments or avulsion from their bony insertion. In the third stage continued abduction forces from the talus result in comminuted fracture of the fibula at or above the level of the syndesmosis.

### Pronation External Rotation (PER)

In first stage, External rotation leads to medial collateral ligament disruption or fracture of medial malleolus. With continued deforming force second stage results in rupture of the anterior tibiofibular ligament with or without avulsion from its bony insertion. In third stage, further external rotation produces spiral fracture of the fibula at or above the level of syndesmosis. In fourth stage with continued rotation, the posterior tibiofibular ligament gets ruptured or avulsion fracture of posterior malleolus.



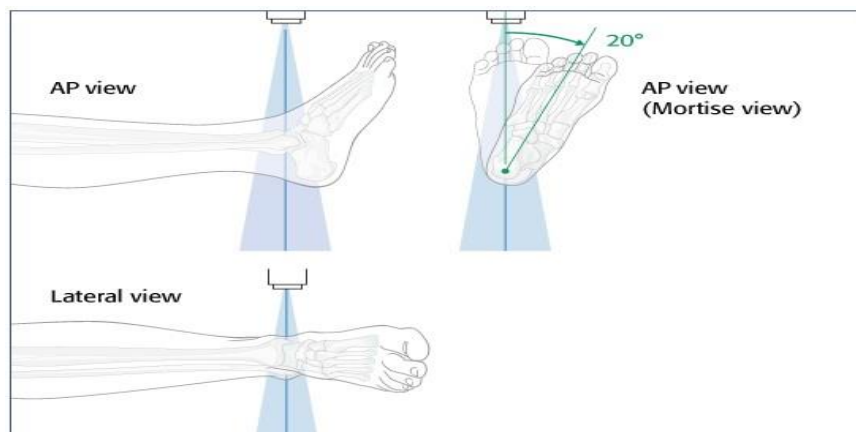
**Fig 2:** Schematic diagram and case examples of Lauge-Hansen pronation-external rotation and pronation-abduction ankle fracture

### Radiological diagnosis <sup>[11]</sup>

For radiographic assesment of the ankle joint antero-posterior, lateral and mortise views are taken. Computed tomography (CT) scan are helpful in patients with plafond injury as the

cross section of the joint define bony anatomy.

Magnetic resonance imaging (MRI) scan are used to check ligament, tendon or catilage injury.



**Fig 3:** Patient positioning for antero-posterior, lateral and mortise views



### Tibio-Fibular clear space

It is the cartilaginous area between medial border of distal fibula and lateral border of posterior tibia. Normally clear space should be less than 5mm in AP or mortise view, if distance is more it suggest syndesmotic injury.

### Talo-crural Angle

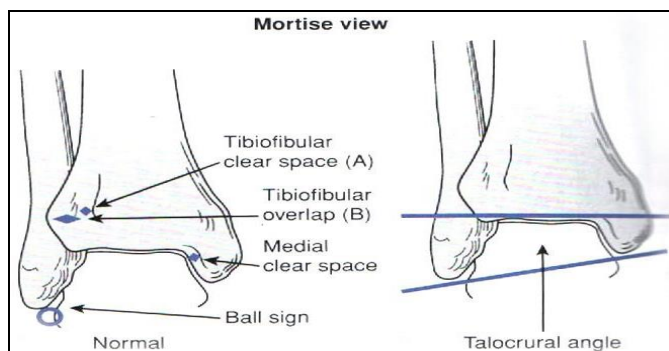
The talo-crural angle is formed by intermalleolar line and perpendicular to distal tibia articular surface. This angle is normally in the range of  $83^{\circ} \pm 4^{\circ}$  and should be within  $2^{\circ}$  to  $3^{\circ}$  of the opposite side.

### Medial Clear Space

It is the space between lateral border of the medial malleolus and the medial border of talus on mortise view. This space is normally equal to the superior clear space between the talus and distal tibia and less than or equal to 4mm, if the space is greater than 4mm it suggest lateral shift of the talus.

### Ball or Dime sign

The ball or dime sign on AP view is described as constant curve connecting the recess in the distal tip of the fibula and the lateral process of talus when the fibula is out to length <sup>[21]</sup>. If fibula is malreduced then dime sign is broken.



**Fig 4:** Radiological findings

### Talar Tilt

Several methods of measuring:

- In mortise view, a line drawn across the distal tibia articular surface and another line drawn across the talar dome normally both lines should be parallel to each other.
- The normal tilt angle is  $0^{\circ}$ , with a range from  $-1.5^{\circ}$  to  $+1.5^{\circ}$ .
- In AP view the difference in the width of the superior clear space and between the medial and lateral side of the joint should be less than 2mm.

**Treatment:** The aim of our treatment is to obtain <sup>[5, 6]</sup>:

- Anatomical reduction of talus in the mortise.
- Maintain this reduction until the fracture heals
- To restore full length of fibula
- No tibiofibular diastasis
- Restoration of painless, mobile and stable ankle of patients with there pre-injury level of functions <sup>[5]</sup>.

The first step in managing ankle fracture-dislocations is to reduce the talus underneath the tibia. As a part of the initial evaluation, the ankle should be gently reduced and immobilized in a padded splint to prevent further soft tissue injury and decrease the swelling. Application of ice packs, elevation of the extremity, and compression are used to reduce swelling as evaluation and treatment planning proceed <sup>[11]</sup>.

### Nonoperative Treatment

Stable fractures can be treated non-operatively only if, the reduction can be achieved and maintained anatomically, and in patients who are not fit for surgery and who are refusing surgical intervention.

Closed reduction is done for stable fractures and open reduction and internal fixation for the unstable fractures. Stability is defined as the ability of the injured ankle to withstand stress without displacement, then a stable fracture is one that will not become displaced on the application of physiological stress, and an unstable fracture is one that will.

### Operative Treatment

The fibula is reduced first to correct rotation and to maintain fibular length. But sometimes medial side may be reduced first, as in compound comminuted fractures and in fibula discontinuity. Incisions should be placed Longitudinally for proper exposure at the operative site and skin should be retracted gently without any tension. The skin flaps should be of kept as thick as possible for that skin incisions should extend directly to the periosteum of the bone. Interposed soft tissue and hematoma at the fracture site are removed by applying distraction at the fracture site. Then reduction is made by reversing the mechanism of injury. All fractures requiring open reduction should be fully-exposed, reduced, and provisionally stabilized before proceeding with definitive fixation.

### Surgical Approaches & Fracture Fixation <sup>[9, 10]</sup>

#### I. Lateral Malleolus

**Approach:** For reducing and internally fixing distal fibula fractures a direct lateral approach over fibula was the standard approach. The dissection is made between peroneus tertius anteriorly and posteriorly peroneus longus and brevis. Sometimes the lateral incision is shifted slightly anterior if there is demand for fixing the Chaput's tubercle fragment from the antero-lateral side of distal tibia <sup>[17, 18]</sup>.

**II. Medial Malleolus Approach:** The incision was taken centrally over the medial malleolus itself and was shifted anteriorly for better access to the joint and carefully reflecting the involuted periosteum from the fracture site. Different number of surgical techniques has been describe for fixation of medial malleolus. Selection depends on size and integrity of the fragment, options include screw fixation, tension band wiring and plate fixation. When the fragment too small to accept two screw, one screw and a k-wire will afford some rotational stability. It remains unclear what the optimal screw length is, but an overly long screw with threads in metaphyseal bone may have little grip.

**III. Syndesmosis Trans fixation:** If the fibula and medial malleolous are fractured, they are reduced first than trans-syndesmotic screw to be placed for reduction of the distal tibiofibular joint. Many methods for fixation are available, including suture and synthetic grafts, have been reported, but fixation with screws is the most common technique <sup>[18]</sup>.

### Choice of fixation

1. The mainstay of internal fixation of malleolar fractures is the use of small fragment plates and screws, most often one-third semi-tubular plates and 3.5-mm and 4-mm partially and fully threaded screws. Rarely, for severely comminuted cases or for repair of fibular malunion, heavier 3.5mm reconstruction or dynamic compression

plates are required. The 4.5mm fully threaded cortical screws are used for transfixing the syndesmosis. Kirschner wires (K-wires) are used in conjunction with wire for a tension band or along with screw for definitively fixing the medial malleolus.

2. The use of intramedullary implants has been limited because of poorer rotational control of the fibula and the inability to use adjunctive screw fixation for the syndesmosis.
3. Bioabsorbable implants for fixing ankle fractures are being extensively investigated. They have the potential advantages of eliminating the need for hardware removal, decreasing irritation over prominent screws and plates, and allowing for gradual stress transfer from the implant to the bone.

### Postoperative care and management

A double U-splint is advocated by AO group, which prevents an equinus deformity as well as allows dorsiflexion of the ankle<sup>57</sup>. This is removed by about fourth to tenth day, depending on several conditions like pain, oedema, wound condition etc. Many surgeons prefer to immobilize the ankle joint for three to six weeks, to aid in the healing of ligaments and soft tissue injury. Non-weight bearing crutch walking is permitted. Then active movements of ankle are started. Full weight bearing is allowed only after fracture unites radiologically. Usually pronation injuries takes longer time for full weight bearing as compared with Supination injuries which takes less time. Physiotherapy is must for ankle joint mobilization.

### Complications<sup>[8]</sup>

1. Massive swelling and fracture blisters:
2. Non – Union:
3. Malunion:
4. Wound Problems:
5. Infection:
6. Arthritis:



**Fig 5:** Blister formation following medial malleolus fracture

### Surgical procedure

**Fixtion with 4mm cannulated cancellous screws:** For definitive fixation two guide wires were drilled parallel to each other across the fracture site crossing the fracture orthogonally in to the distal tibia and was confirmed fluoroscopically. A drill with a 3.5 mm bit was used to create path for the screws. Two 4 mm cannulated cancellous lag screws with or without washer were inserted over the guide wires. Care was taken to ensure the screws did not cross the articular surface. The complete fixation was again confirmed

fluoroscopically.

### Fixation with tension band wiring

For definitive fixation two 2 mm kirschner wires were drilled parallel to each other across the fracture site crossing the fracture orthogonally into the distal tibia and was confirmed fluoroscopically. Care was taken to ensure the kirschner wires did not cross the articular surface. A drill hole was made proximal to the fracture, on the tibia from antero-medial to anterior aspect or to antero-lateral aspect with 3.5mm drill bit and flexible stainless steel wire was passed from anteriorly or a cortical screw was passed anterolaterally and over which flexible stainless steel wire was passed and encircled around the kirschner wires in a figure of eight manner and tightened. The kirschner wires were bend acutely through 180 degrees and cut and were rotated and impacted over the flexible wire with a impactor. The complete fixation was again confirmed fluoroscopically.

Closure was done with thin absorbable sutures. Skin was closed with non-absorbable sutures. Sterile dressing was given. Below knee plaster slab was given.

### Fixation with fibular plating

The fibular fracture is fixed with a semi tubular plate. The plate can be applied on the lateral, posterolateral or posterior aspect of the fibula. For very distal fibular fracture with posterior subluxation and osteoporotic bone, the plate can be applied posteriorly. The peroneal retinaculum may need to be released partially so that plate can be placed beneath the peroneal tendon. The posterior surface of fibula is relatively flat and the plate can be used as a buttress to stabilize the fracture. Screws placed in the postero-anterior direction in the distal fragment does not penetrate the joint.

If the distal fragment is too small to be fixed with plate, other options can be included cannulated cancellous screw, Rush nail or TBW.

### Fixation with intramedullary device

Intramedullary fixation offers a minimally invasive approach to the distal fibula with little palpable metalwork. Initially popular intramedullary implants, such as Rush nails (2mm, 2.5mm, 3mm, 3.5mm or 4mm) were smooth devices with no fixation to bone and were predisposed to backing out, therefore not controlling fibular length or preventing talar shift. Despite this, functional outcomes were excellent or good with no complications.

To reduce the problems of backing out, 4.0 mm partially threaded cannulated cancellous screw or TBW were reported good results in patients with minimal fracture comminution.

### Syndesmosis transfixation

The tibiofibular joint reduction must be maintained during placement trans-syndesmotc fixation. The fixation screw or position screw (fully threaded) was used independently or in conjunction with a plate, depending on the type of fibular injury.

The screw was inserted at the top of the fibular sulcus in the tibia, fixation is usually obtained by placing one or two screws from posterolaterally in the fibula to antero-medially in the tibia around 3.0 cm above the plafond. Fixation of the syndesmosis was done with the ankle in full dorsiflexion to avoid over tightening of the mortise and loss of dorsiflexion postoperatively.

Removal of the screw was done after at least 6 to 8 weeks, weight-bearing was deferred till screw removal.

## Case-1



**Fig 6:** Pre-operative x-ray



**Fig 7:** Lateral malleolous fixation



**Fig 8:** Medial malleolus fixation



**Fig 9:** Post-operative x-ray



**Fig 10:** ROM at the end of 6 months

## Case-2



**Fig 11:** ORIF with CC screw to medial malleolus and semitubular to lateral malleolus

### Post – operative protocol

Post-operatively, patient operated limb was immobilized in a plaster splint and elevated, antibiotics and analgesics were started. Dressings were done regularly and sutures were removed on average on 15<sup>th</sup> day (decided according to the wound inspection). The below knee splint was continued or cast was done till 6 weeks of postoperative and was then removed. From first or the second postoperative day patients were allowed to do non-weight bearing walk. Once signs of union are present radiologically then patients are allowed to do partial weight bearing. Active ankle exercises were advised. In patients with syndesmotomic screw fixation, weight bearing was delayed till screw removal.

Follow up of cases was done at regular intervals of 6 weeks for minimum of 6 months. At each follow-up, all patients were asked regarding ankle pain, daily activities of living like ability to walk, ability to run, ability to work, the stability of the ankle joint was assessed and the motion of ankle joint were evaluated. Anteroposterior and lateral radiographs of the ankle were made at the time of follow-up to know the radiographic results. All patients were evaluated according to Baird and Jackson's ankle scoring system for statistical analysis and functional grading.

### Observation and Results

In our study, which includes 30 cases of bimalleolar fractures of ankle, studied prospectively were treated surgically at Bharati Vidyapeeth Deemed To be University Medical College and Hospital, Sangli from June 2017 to December 2018.

#### 1) Distribution of patients

**1. Mode of injury:** Most common mode of injury is Road Traffic Accidents – 19 patients (63.33%), followed by fall from height contributed to 8 patients (26.67%) and twisting injury were 3 patients (10%).

**Table 1:** Mode of injury

Mode of injury	No. of cases	Percentage
Road traffic accident (RTA)	19	63.33%
Fall	8	26.67%
Twisting injury	3	10%
Total	30	100



**2. Fracture Type According to Lauge Hansen Classification:** Out of 30 patients, the most common injury pattern seen in our study was SER type injury – 18 patients (60%), followed by SAD type – 5 patients (16.67%), PER type were 4 patients (13.33%) and PAB type were 3 patient (10%). SER was found to be most common.

**Table 2:** Lauge and Hansen classification

Type of injury	No. of patients
SAD	5 (16.67%)
SER	18(60%)
PER	4(13.33%)
PAB	3 (10%)

**3. Fracture type according to Danis weber classification:** Out of 30 patients, Danis Weber type B was found to be most common – 18 patients (60%), Type A was found in 5 patients (16.67%) and type C was found in 7 patients (23.33%). Thus Type B was found to be most common.

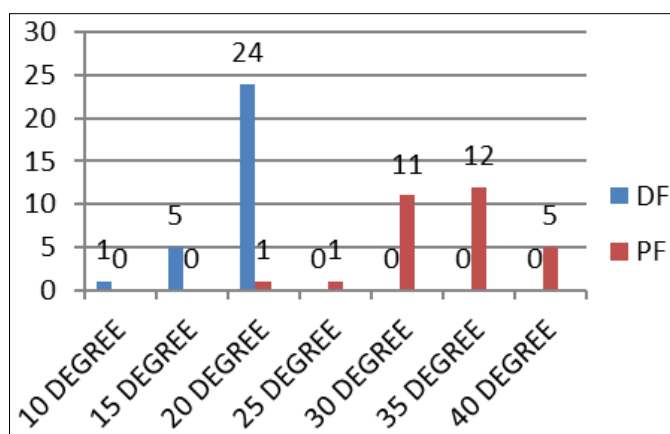
**Table 3:** Danis-Weber classification

Danis Weber	No. of patients
A	5(16.67%)
B	18(60%)
C	7(23.33%)

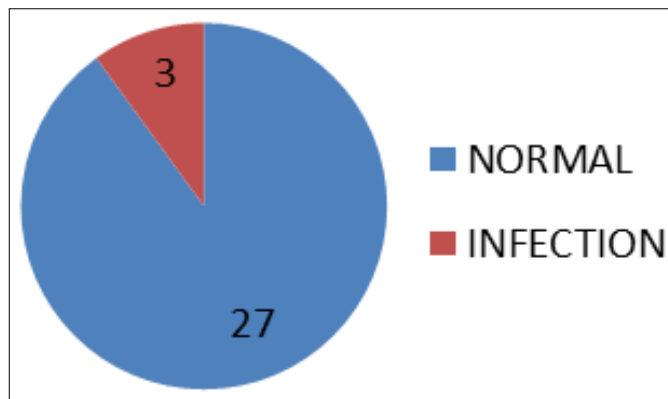
**4. Comparison of Range of dorsiflexion and plantarflexion at the end of 6 months**

**Table 4:** Range of dorsiflexion and plantarflexion at the end of 6 months

Column1	Dorsiflexion	Plantar flexion
10 DEGREE	1 (3.33%)	0 (0%)
15DEGREE	5 (16.67%)	0 (0%)
20 DEGREE	24 (80%)	1 (3.33%)
25 DEGREE	0 (0%)	1 (3.33%)
30 DEGREE	0 (0%)	11 (36.67%)
35 DEGREE	0 (0%)	12 (40%)
40 DEGREE	0 (0%)	5 (16.67%)



**Graph 1:** Range of dorsiflexion and plantarflexion at the end of 6 months



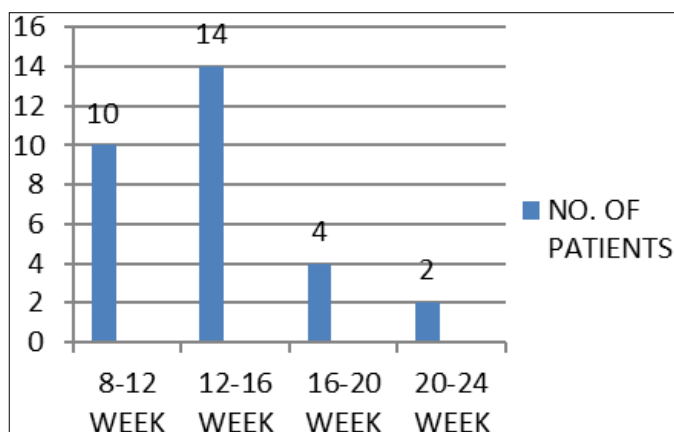
**Graph 2:** Post operative complications

Out of total 30 patients treated in this study, 3 cases (10%) were developed post-operative infection.

**5. Comparison of time taken for radiological union:**

**Table 5:** Time taken for radiological union

Union in weeks	No. of patients
8-12 WEEKS	23 (40%)
13-16 WEEKS	3(40%)
17-20 WEEKS	4(13.33)
Average Time	12.3



**Graph 3:** Time taken for radiological union

**6. Final Score According to Subjective, Objective And Radiological Criteria As Per The Baird & Jackson's Ankle Scoring System (At 24 weeks follow up)**

- Ankle Pain:** In our study, more than half of the patients had no pain i.e 17 patients and pain associated with strenuous activities present in 11 patients and 2 Patients had grade 3 pain i.e mild pain with activities of daily living.
- Stability of the ankle:** clinical instability was not present in any patients.
- Ability To Walk:** In our study, maximum patients could walk desired distances without limp or pain i.e 23 and few patients were able to walk desired distances with mild limp i.e 7.

- d Ability To Run:** In our study, patients who were able to run desired distances without pain were 10, slight pain while running desired distances present in 18 patients and moderate restriction in ability to run with mild pain present in 2 patients.
- e Ability To Work:** In our study, patients who were able to do regular occupation without restriction were 17 and patients who were able to do regular occupation with restriction in some strenuous work were 13.
- f Motion of The Ankle:** In our study, range of motion within  $10^0$  of uninjured ankle was present in 23 patients, range of motion within  $15^0$  of uninjured ankle was present in 7 patients.
- g Radiograph:** 29 patients had anatomic radiographic reduction with intact mortise and 1 patient had mild reactive changes at the joint margins.

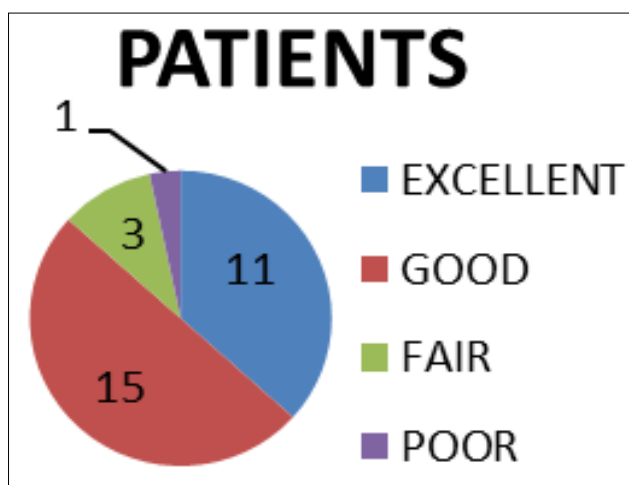
**Table 6:** Final score according to Baird & Jackson's Ankle scoring system (At end of 24<sup>th</sup> week)

Category	A	B	C	D	E	Total
Ankle pain	17	11	2	0	0	30
Stability of the ankle	30	0	0	0	0	30
Ability to walk	23	7	0	0	0	30
Ability to run	10	18	2	0	0	30
Ability to work	17	13	0	0	0	30
Motion of the ankle	23	7	0	0	0	30
Radiographic results	29	0	1	0	0	30

- 7. Functional grading:** In the present study, 30 patients with Bimalleolar fractures were treated surgically. Excellent results were obtained in 11 (36.67%) good results were obtained in 23 patients (82.14%), 3 patients (10%) had fair results and 1 patient (3.33%) had poor result.

**Table 7:** Functional grading

Functional Results	No. of patients	Percentage
Excellent	11	36.67
GOOD	15	50
Fair	3	10
Poor	1	3.33
Total	30	100



**Graph 4:** Functional Grading

## Discussion

Out of all the weight bearing joint, the intraarticular fractures of ankle joint is most commonly involved. To regain ankle functions and to prevent arthritis it is managed by either

closed treatment, which includes close reduction by manipulation and immobilization in a plaster cast or open reduction and internal fixation. Burwell and Charnley showed that anatomical reduction, rigid fixation and early mobilisation led to early return to function<sup>[19]</sup>.

In the current study, 30 cases with bimalleolar fractures were treated surgically and we evaluated our results and compared them with those obtained by various other studies, our analysis is as follows:

Follow up of all patients was for a period of minimum 6 months.

In the present study out of 30 cases 18 were males and 12 were females. The independent 't' test analysis showed significant differences between the gender ( $p < 0.05$ ). 60% of Male predominance and male: female ratio of 3:2, which is proportionate with the study by Motwani GN<sup>[10]</sup> and Maruthi CV<sup>[20]</sup>. This is possibly due to the fact of male dominance over female in occupational injuries, travelling etc. in India.

**Table 8:** Grading in sexes

Study	No of Patients	Male: Female	%males
Motwani GN <sup>[10]</sup>	40	5:1	82.5
Maruthi CV <sup>[20]</sup>	40	7:3	70
Present study	30	3:2	60

In this study, bimalleolar fractures were common in fourth decade of life. Mean age of patients was 43.9. Similar results were observed in Mohapatra A, Raj K<sup>[6]</sup> with mean age of 43.8, however finding by Beris *et al.*<sup>[4]</sup>, Lee *et al.*<sup>[12]</sup>, Roberts SR<sup>[16]</sup> and Baird and Jackson<sup>[14]</sup> bimalleolar fracture were common in age group of 31 to 40 years with slight variation in this study.

**Table 9:** Age Distribution grading

Study	Number of Patients	Mean age
Mohapatra A, Raj K <sup>[11]</sup>	84	43.8
Beris <i>et al.</i> <sup>[4]</sup>	144	30
Roberts SR <sup>[3]</sup>	25	40
Present study	30	43.9

Road Traffic Accidents are the commonest mode of injury – 19 patients (63.33%) which was in accordance with study by Mohapatra A, Raj K<sup>[11]</sup> and Lee *et al.*<sup>[4]</sup>.

**Table 10:** Grading according to mode of injury

Study	Number of Patients	Common mode of Injury
Lee <i>et al.</i> <sup>[4]</sup>	168 (98)	Road Traffic Accidents
Mohapatra A, Raj K <sup>[11]</sup>	84 (43)	Road Traffic Accidents
Present study	30 (19)	Road Traffic Accidents

Out of 30 patients, 18 patients (60%) are SER pattern, 5 patients (16.67%) of SAD pattern, 04 patients (13.33%) are PER pattern and 03 patients (10%) of PAB pattern. In which SER is most common type, which was in accordance with study by Parvataneni Prathap DA<sup>[21]</sup>, Roberts RS<sup>[13]</sup> and Beris *et al.*<sup>[4]</sup>.

**Table 11:** common type involvement percentage

Study	Number of Patients	Most common type	Percentage
Parvataneni Prathap <sup>[21]</sup>	30	SER	46.6
Roberts RS <sup>[13]</sup>	25	SER	34
Beris <i>et al.</i> <sup>[4]</sup>	144	SER	45
Present study	30	SER	60



Average time required for radiological union was 12.3 weeks, which was in accordance with study by Parvataneni Prathap DA [21] and Maruthi CV [20]. The mean time for radiological union was on higher side as compared to other study, this is possibly due to patients in our study are mostly from low socioeconomic status and have long standing comorbidities such as hypertension, diabetes mellitus, varicose veins, osteoporosis etc.

**Table 12: Follow of Statistics**

Study	Follow-up period	Mean for Radiological Union
Parvataneni Prathap [21]	6 Months	10.6 Weeks
Maruthi CV [20]	6 Months	8 Weeks
Present study	6 Months	12.3 Weeks

In this study, at the end of 6 months the plantar flexion was 30° or more in 28 patients (93.33%) and dorsiflexion 20° or more in 24 patients (80%), similar results was observed in Shah ZA, Arif U [15] study.

**Table 13: Degree of flexion grading**

Study	Time Duration	≥30° Plantarflexion	≥20° Dorsiflexion
Shah ZA, Arif U [15]	6 Months	87.5%	82.5%
Present study	6 months	93.33%	80%

According to Baird and Jackson score at the end of 6 months, Out of 30 patients we studied 11 (36.67%) patients had excellent, 15 (50%) patients had good, 03 (10%) patients had fair and 1 (3.33%) patient had poor results, similar results was observed in other study like Shah ZA, Arif U [15], De souza *et al.* [16], Beris *et al.* [4], Motwani GN [10].

**Table 14: Post operative outcome grading**

Study	Good to Excellent	Fair	Poor
Shah ZA, Arif U [15]	33 (82.5%)	5 (12.5%)	2 (5%)
Beris <i>et al.</i> [4]	105 (74.3%)	21 (14.6%)	16 (11.1%)
De souza <i>et al.</i> [16]	135 (90%)	9 (6%)	6 (4%)
Motwani GN. [10]	33 (82.5%)	5 (12.5%)	2 (5%)
Polisetty VSP <i>et al.</i> [17]	34 (85%)	4 (10%)	2 (5%)
Present study	26 (86.67%)	03 (10%)	01 (3.33%)

A significant improvement was noted in the ankle function from 6 week to 3<sup>rd</sup> month and from 3<sup>rd</sup> month to 6<sup>th</sup> month post-op, assessed using subjective criteria. In our study, we observed that lateral malleolus is important for the anatomical reduction of bimalleolar fractures, as per the contention of Yablon *et al.* [12] because the talus displacement is mostly associated with talonavicular ligament and lateral malleolus. There will be residual shortening and poor tibio-talar alignment in a poorly reduced lateral malleolus.

Various methods available for fixation of lateral malleolus. Lateral plate, as advised by AO group has become widely accepted for management of fibular fracture<sup>4</sup>. Hughes *et al* favored that first fix the lateral malleolus, then the medial malleolus is checked for stability and fixed if necessary. This allows fast recovery and minimum postoperative immobilization [8]. In our study, the patients who went for stable internal fixation of the medial malleolus by cancellous or malleolar screw had better functional outcome, but those who fixed with tension band wiring gave similar results. Complications like skin irritation which was common in patients with screw fixation were reported less with tension

band wiring.

Although the type B weber cases were more but, syndesmotom injury was noted in only three cases (10%) intra-operatively as assessed by Hook test after stabilizing the fractures and in these patients fully threaded screw were used to fix the syndesmotom injury. Weight bearing was delayed for 6-8 weeks until screw were removed.

Although the AO group has advocated for early mobilization, but in the current study we kept the patients immobilize for 4 weeks. Non weight bearing walk was advised from day 1<sup>st</sup> or 2<sup>nd</sup> post surgery. Cases with early radiological signs of union was advised for partial weight bearing and full weight bearing was advised when the signs of union were complete.

In this study, fair to poor score were observed due to wound infection. Good to excellent results were present in majority of the patients (86.67%), similar results were noticed in other studies like Motwani GN [10], Shah ZA, Arif U [15], De souza *et al.* [16], Beris *et al.* [4] and Polisetty VSP *et al.* [17].

The bimalleolar fractures were reduced accurately with open reduction and stable internal fixation and give a high percentage of excellent and good results<sup>4</sup> provided the fixation is anatomically stable and rigid.

## Conclusion

Road traffic accidents are common cause of unstable bimalleolar ankle fractures, which are more common in middle-aged men. For anatomical reduction and fixation the injury mechanism need to be figure out. Supination-external rotation (60%) was the most common type. The lateral stability of the ankle is maintained by correcting Fibular alignment i.e length and rotation. All intra- articular fractures are need to be reduced anatomically with rigid fixation and articular congruency should be restored, that can be achieved by open reduction and internal fixation. In 86.67% cases, operative results were satisfactory with good to excellent functional outcome. kTBW provide better results in medial malleolus internal fixation and for distal fibula fractures plating was best. Open reduction of bimalleolar fractures provided good functional outcome. In these patients mobilization and weight bearing were achieved early. Hence, we conclude that anatomical reduction and stable internal fixation restore the articular congruity of ankle joint which results in excellent to good functional outcome and help in early mobilization after surgery with good functional outcome.

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