"FUNCTIONAL OUTCOME OF SURGICAL FIXATION OF BIMALLEOLAR ANKLE FRACTURES BY FIXING THE LATERAL MALLEOLUS FIRST "

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LIST OF ABBREVIATIONS USED

POD: POST-OPERATIVE DAY

PAB: PRONATION-ABDUCTION

SER: SUPINATION-EXTERNAL ROTATION

SAD: SUPINATION-ADDUCTION

SAB: SUPINATION-ABDUCTION

RTA: ROAD TRAFFIC ACCIDENT

ROM: RANGE OF MOTION

AITF: ANTERO-INFERIOR TIBIO-FIBULAR

PITF: POSTERO-INFERIOR TIBIO-FIBULAR

ABSTRACT

TITLE:"FUNCTIONAL OUTCOME OF BIMALLEOLAR ANKLE FRACTURES BY FIXING THE LATERAL MALLEOLUS FIRST"

INTRODUCTION: Bimalleolar ankle fractures are commonly encountered by Orthopaedic surgeons as a result of road traffic accidents, twisting injuries and sport injuries. These fractures invite special attention owing to the fact that it has maximum load per unit surface area as compared to other joints, minimal soft tissue coverage around ankle joint further makes it more susceptible to injuries.

AIMS AND OBJECTIVES: To Assess The Functional Outcome of surgical fixation in bimalleolar ankle fractures by fixing the lateral malleolus first under the following headings as per "Olerud and Molander scoring"

MATERIALS AND METHODS: Patients with bimalleolar ankle fractures admitted to the department of Orthopaedics at the Kle's Dr. Prabhakar Kore Hospital And Medical Research Centre And Charitable Hospital, Belagavi in between 1st January 2020 to 31st December 2020, over a period of one year were chosen for the study and were fixed surgically and were followed up for a period of 6 months and outcomes studied under subjective and objective scoring system of " OLERUD and MOLANDER".

RESULTS: Road Traffic Accidents, twisting injuries were found to be frequently associated with ankle fractures, further out of the 24 study subjects 22 fractures were found to be united in a satisfactory manner by an average period of 13 weeks and functional outcome was excellent in most of the patients in terms of post-operative pain, early mobilization, range of motion and return to activities of daily living as assessed in the follow up period. SER and SAD were noted to be the common causes of these fractures according to Lauge Hansen's classification, in terms of post-operative complications only 4 patients had surgical site infection and one had non-union due to implant failure following a secondary trauma and also was diagnosed to have Charcot's arthropathy.

CONCLUSION: Open surgical reduction and stabilized internal fixation where the lateral malleoli are fixed before the medial malleolus lends excellent results in the form of better wound healing, early mobilization, faster rehabilitation and swift return to daily activities.

KEYWORDS: Bimalleolar fractures, non-union, Lauge-Hansen, Weber, Olerud-molander

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INTRODUCTION

Fractures around the lower extremities are one of the most commonly observed orthopaedic emergencies in any casualty and amongst them ankle fractures are quite usual.

In 18th century Sir Perci pott, in the year 1768 published a paper discussing various kinds of ligamentous injuries and fractures around the foot and ankle.

1922 -Ashhurt and Bromer attempted to classify various kinds of injuries around the ankle with respect to the forces. A study done in 1948-1953 by Neil Lauge-Hansen recognized 4 ankle fracture variants which were classified on the basis of direction of force and the alignment of the ankle mortise[40].

Almost the majority of cases involving trauma to the joint have both bony and soft tissue elements. In the modern world magnetic resonance imaging is a very helpful tool because of their soft tissue visualization and aid in diagnosing ligament injuries which has to be seriously considered while evaluation and treatment of ankle injuries.

The aim of any surgery around the ankle should be to obtain a stable anatomic reduction by various surgical methods owing to its weight bearing function.

With advent of modern technology and better understanding of the anatomy of ankle mortise the results of fixation of ankle has shown remarkable progress, also with the use of AO principles we have been able to achieve a better understanding of the principles of fixation for the same. Thus with a stable anatomical fixation patient can be mobilized quite early reducing significant disability.

OBJECTIVE

To analyse the functional outcome of surgical fixation of Bimalleolar ankle fractures by fixing the lateral malleolus first.

HISTORICAL REVIEW

Substantial insights were provided by various authors with regards to ankle fractures over the last few centuries.

Sir Pott around the year 1768 first studied traumatic ankle injuries. He was based in St. Bartholomen Hospital in England. He conceived an association between fractures of fibula usually within 2 or 3 inches of its lower tip and talar subluxation with ligamentous disruption.

Dupuytren in his studies around the ankle joint stressed on the alignment of the talus in the tibial plafond at the time of injury which eventually demarcates fractures due to talar impact and the ones caused by avulsion of the associated ligaments. He noticed that when the foot was positioned outwards in presence of a deforming force it usually lead to a injury to the fibula bone. Also in his study he was able to understand and highlight dislocation of the talus and various other ligaments which could get ruptured during the injury.

Jules Germain Maisonneueve in the 19th century published his work about a special variety of fractures seen around the ankle and proximal fibula. It consists of a proximal fibula fracture associated with syndesmotic Injury and deltoid disruption which was found to be caused by force which externally rotates the foot in pronation.

The importance of fibula fixation was proved beyond doubt in the stability of ankle fractures with the advent of AO era[1] . The work of Weber towards ankle injuries like classification, treatment modalities and complications are worth mentioning[4] .

Biodegradable implants are now being used in some centers for fixing bimalleolar ankle fractures. The degradation time within the body by hydrolysis usually takes 2 - 6 months[7].

ANATOMY OF ANKLE

Ankle joint has been classified as a modified variety of hinge joint and it consists of three bones and ligaments that binds these bones together into one functional unit[17]. The structure of Ankle mortise consists of distal articular surface of the tibia that is known as tibial plafond along with its medial extension known as the medial malleolus and a distal fibular extension on the lateral aspect known as the lateral malleolus.

The ankle joint comprises of the following:

a. Tibial plafond
b. distal fibula (tip of fibula)
c. Talus

DISTAL TIBIA

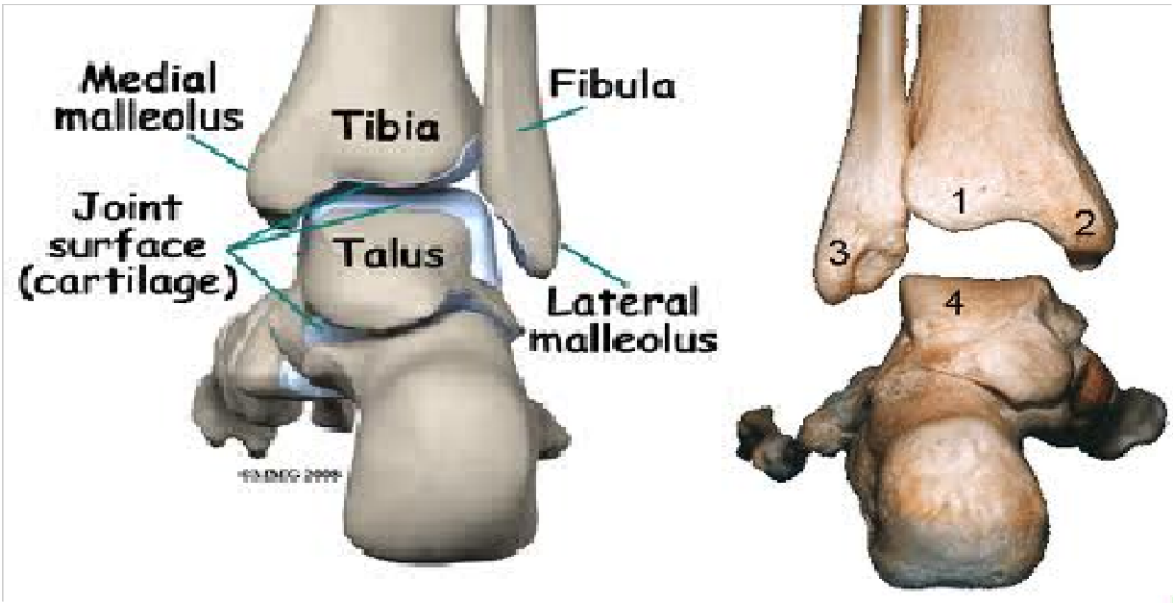
The tibial plafond which articulates with the talus is concave in anterior to posterior plane and convex when viewed from side to side and the width is on the higher side on the anterior aspect and reduces as we go posteriorly. This helps to accommodate the talus in both plantar and dorsiflexion providing stability throughout its range of motion. The medial surface of the talus articulates with the medial extension of the tibia called as the medial malleolus which has its extensions in the antero-posterior direction providing attachment for deltoid ligament making it very important to maintain the stability of the joint.

LATERAL MALLEOLUS

It is an extension of the distal part of fibula which stretches about 0.5 inches farther than the medial malleolus and its located more posteriorly. The anatomic axis of the lateral malleolus is at an angle of about ten to twelve degrees to the long axis of the fibula giving it a natural valgus deviation[19].

THE TALUS

The talar dome is trapezoidal in shape being wider in the anterior aspect compared to the posterior aspect which is in congruence with the shape of the plafond providing it stability throughout its entire ROM. It also has two facets located medially and laterally to articulate with both the malleoli[12].



Ankle joint viewed posteriorly

LIGAMENTS OF THE ANKLE JOINT

The ankle joint is a complex variety of hinge joint. It comprises of a ligamentous framework that adds to its stability while weight bearing. This system consists of:

a. Medial collateral ligament also called as the deltoid ligament.

b. Lateral collateral ligament also known as fibular collateral ligament.

c. AITF AND PITF.

d. TTFL and interosseous ligament.

Medial collateral or deltoid ligament is a triangular band like structure consisting of two varieties of fibers.

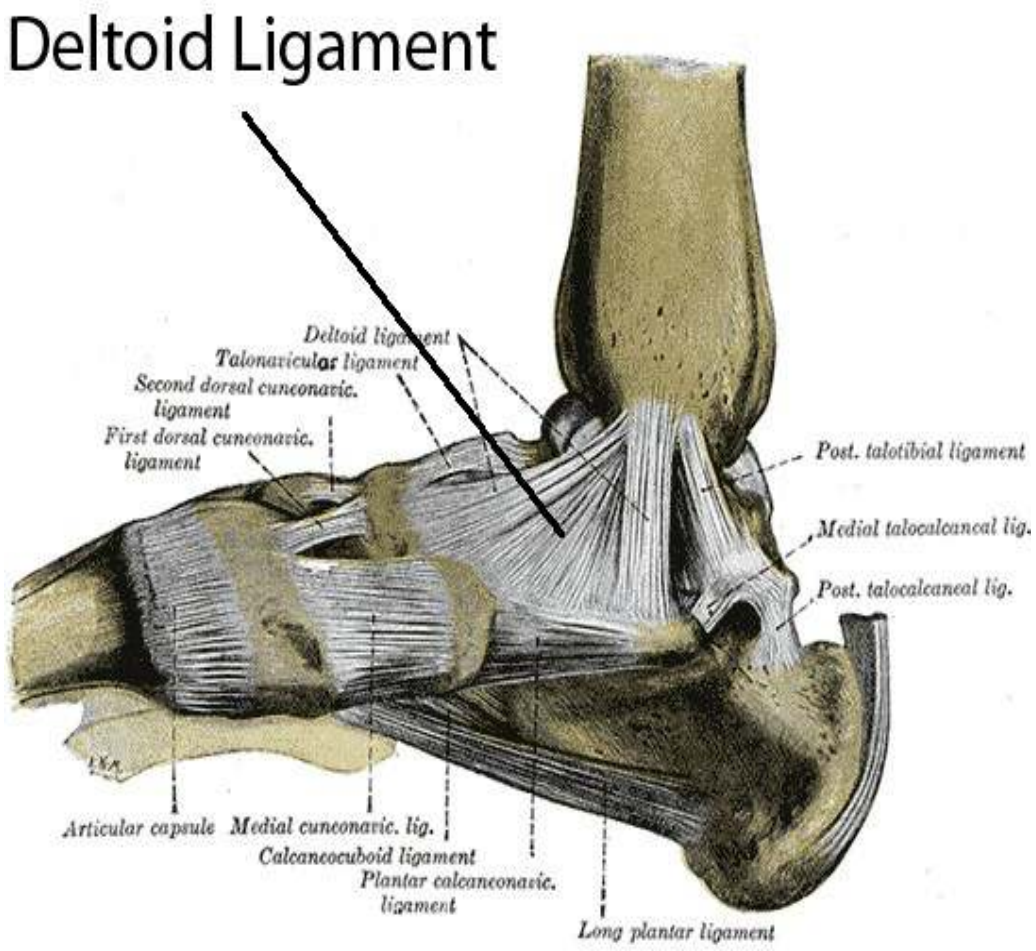
. The part which lies superficially has three parts that originate from the tibia and are attached to

1) Navicular: Tibio-navicular ligament,

2) Calcaneum: Tibio-calcaneal ligament

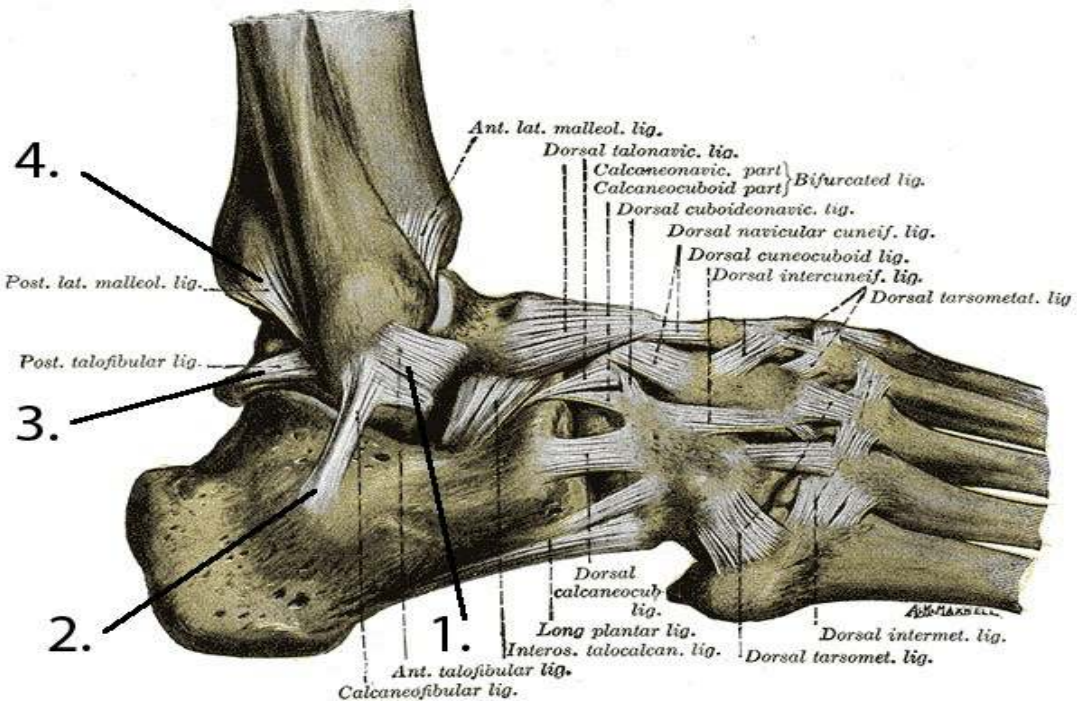
3) Talus: Tibio-talar ligament.

4) The deep portion lies in the joint cavity and the fibers run from the inter-collicular groove to the medial side of talus[15].

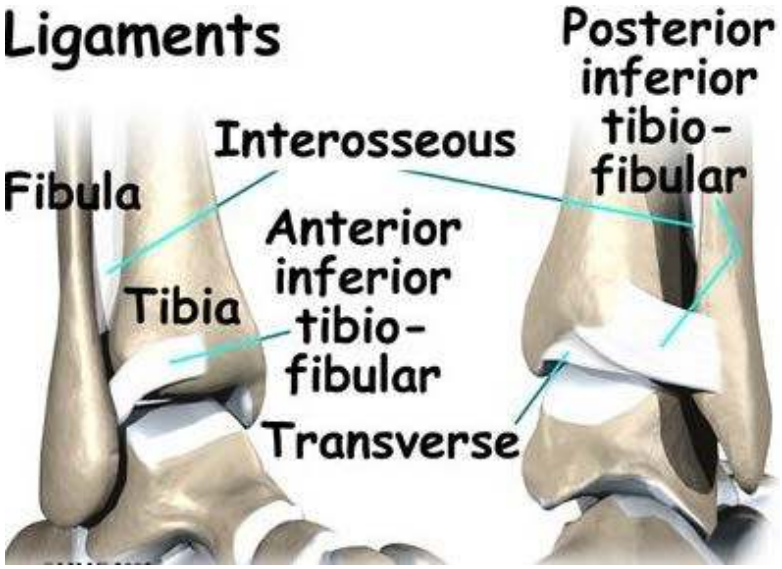


Ligamentous complex

The **fibular collateral ligament** comprises of 3 ligaments that provide support to the ankle on its lateral aspect. The talo-fibular ligament has a an anterior and a posterior counterpart , the anterior being weaker compared to the posterior one , the PTFL being very strong stabilizes the posterior part of the ankle joint by preventing posterior dislocation of the talus whereas the ATFL being wet in nature stabilizes the ankle during plantar flexion. The calcaneo-fibular ligament is an important stabilizer of the subtalar joint.



Lateral ligamentous complex



ligaments around ankle joint

The Syndesmotic ligament complex maintains the integrity of ankle mortise by resisting axial, rotational and translational forces. The ligaments of the syndesmosis are:

a. Anterior inferior tibio-fibular ligament .

b. Posterior inferior tibio-fibular ligament .

c. Transverse tibio-fibular ligament.

d. Interosseous ligament.

The anterior inferior tibio-fibular ligament and posterior inferior tibio-fibular ligament run between anterior and posterior margins of tibia and fibula in the inferior aspect and the transverse tibio-fibular ligaments lie inferior to posterior tibio-fibular ligament. The interosseous ligament is the distal continuation of the interosseous membrane. This arrangement permits slight fibular movement in cranio-caudal, rotatory, medio-lateral, antero-posterior planes during normal ankle movements[7] .

MOVEMENTS OF ANKLE JOINT

The principal movements at the ankle constitute flexion (dorsiflexion) and extension(plantar flexion), no other movements are permitted, it has been observed that the axis of these movements lie laterally and posteriorly hence in the process of dorsiflexion there is associated external rotation and internal rotation during plantar flexion of the ankle, the range of movements are fifteen to eighteen degrees of dorsiflexion and about forty-five degrees of plantar flexion[12].

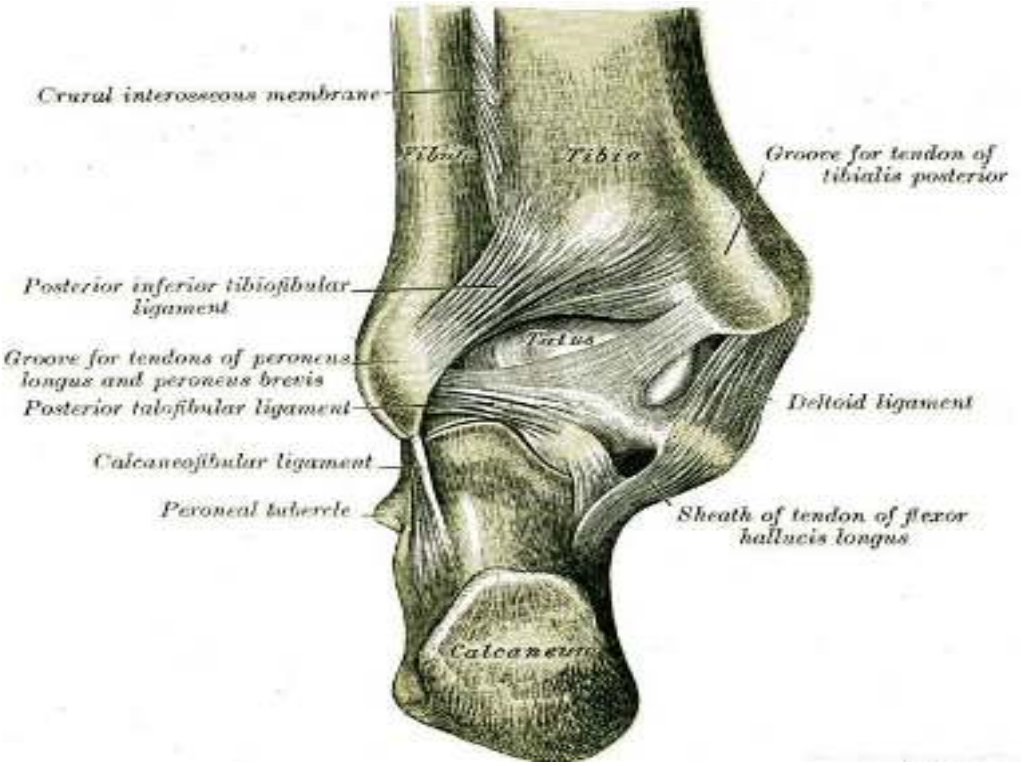
THE MORTISE OF THE ANKLE JOINT

The mortise consists of three bones namely the talus, tibia and the fibula and a ligamentous complex that binds it together. This strong bony-ligamentous complex maintains the anatomical congruity of the ankle and keeps the talus in normal position thus avoiding its tilt or shift. Now with advent of modern technology and better understanding of the ankle joint, it can be safely concluded that most of the injuries around this joint occur due to unusual movements of the talus, for the talus to deviate with an abnormal shift there should be at least two breaches in the continuity of this mortise either in the form of a fracture or a combination of a fracture and a ligament tear[14]. The knowledge about the mortise also holds paramount importance when assessing the future risk of dislocation of the joint

ANKLE MORTISE

ROLE OF BONES AND LIGAMENTS IN THE STABILITY OF ANKLE JOINT

There was no instability when deltoid ligament alone was torn. Medial malleolus fracture at the level of joint produced 10˚ of rotatory instability whereas lateral malleolus fracture distal to anterior tibio-fibular ligament produced instability of about 20˚of inversion and 40˚of external rotation[17]. Fibular collateral ligament injury produced 10˚ of inversion and 30˚of external rotation instability which emphasized on the fact that lateral side was more important than medial side with regard to stability.



Posterior aspect of the ankle joint showing various ligaments

BIOMECHANICS OF JOINT

GAIT AND MOTION

The ankle joint anatomy has evolved with a purpose of providing mobility, it permits flexion (about twenty degrees) and extension (about forty-five degrees) movements at the tibio-talar joint which is quite essential component of the gait cycle.

During walking, the effective range of motion participating in the gait cycle ranges from ten degrees of flexion to twenty degrees of extension also it would be worthwhile to note that the central axis of the foot and ankle is deviated by around nineteen to twenty degrees of external rotation.

FORCES ACTING ON THE JOINT

The ankle joint's structural architecture permits it efficient weight bearing which is a result of multiple vectors acting on the joint which can be broadly classified into the internal forces and the ones acting externally.

Forces acting externally-

1) Body mass

2) Inertia due to various kinds of movements as a result of muscle contractions[2].

Forces acting internally

Internal forces develop in the anatomical structures like the ligaments and and muscles by virtue of various kinds of elicited movements.

Joint incongriuity and weight bearing

The ankle joint exhibits incongruity during swing phase and early stance phase. During ankle motion, the sliding of tibia on the talus contributes to a changing instantaneous center of rotation and also changes contact areas across the joint surfaces[2,29]. The motion between the mortise and talus ,including some incongruence in the ankle joint may be necessary for normal load distribution, cartilage nutrition and lubrication of the ankle joint. The enhanced stability at the ankle joint in dorsiflexion allows the ankle to withstand compression forces to as much as 450 percent of body weight.

Immunity to degenerative arthritis

The ankle despite of being an important weight bearing joint of the body has been found to be free of primary osteoarthritis in majority of the population as opposed to the knee and hip in Indian population. This feature of ankle which renders it immune to the process of primary osteoarthritis can be attributed to its skeletal architecture and other elements like the syndesmosis, ligamentous complex and the fibula which absorbs the energy transmitted through the joint during various

phases of gait and activities that demand high musculoskeletal movements like running ,jumping etc. any disruption of the above mentioned elements will render it susceptible to osteoarthritis however due to presence of loose bodies, fractures or ligamentous injuries secondary osteoarthritis may occur.

CLASSIFICATION OF ANKLE INJURIES

Many attempts have been made at classifying the injuries around the ankle joint over the past three centuries however the ones of significance would be the LAUGE-HANSEN classification which is a mechanism of injury-based system and the radiological classification of Weber can be used.

LAUGE-HANSEN CLASSIFICATION OF ANKLE FRACTURES

Sir Niels Lauge-hansen, a Danish radiologist attempted to classify ankle fractures based on the position of the foot and the types of deforming force acting on it[40]. It was deduced from cadaveric studies and it classified ankle fractures into four major categories. Every classification consists of two parts, the first part deals with the position of the foot when the deforming force was applied and the second part describes the type of the deforming force.

SUPINATION-ADDUCTION (SAD)

This is the only type of injury associated with pathological talar motion.

1st stage - Distal fibular avulsion/ talo-fibular ligament sprain.

2nd stage- Injuries in stage 1 + medial malleolus fracture with a vertical fracture line and impaction of the distal tibia.

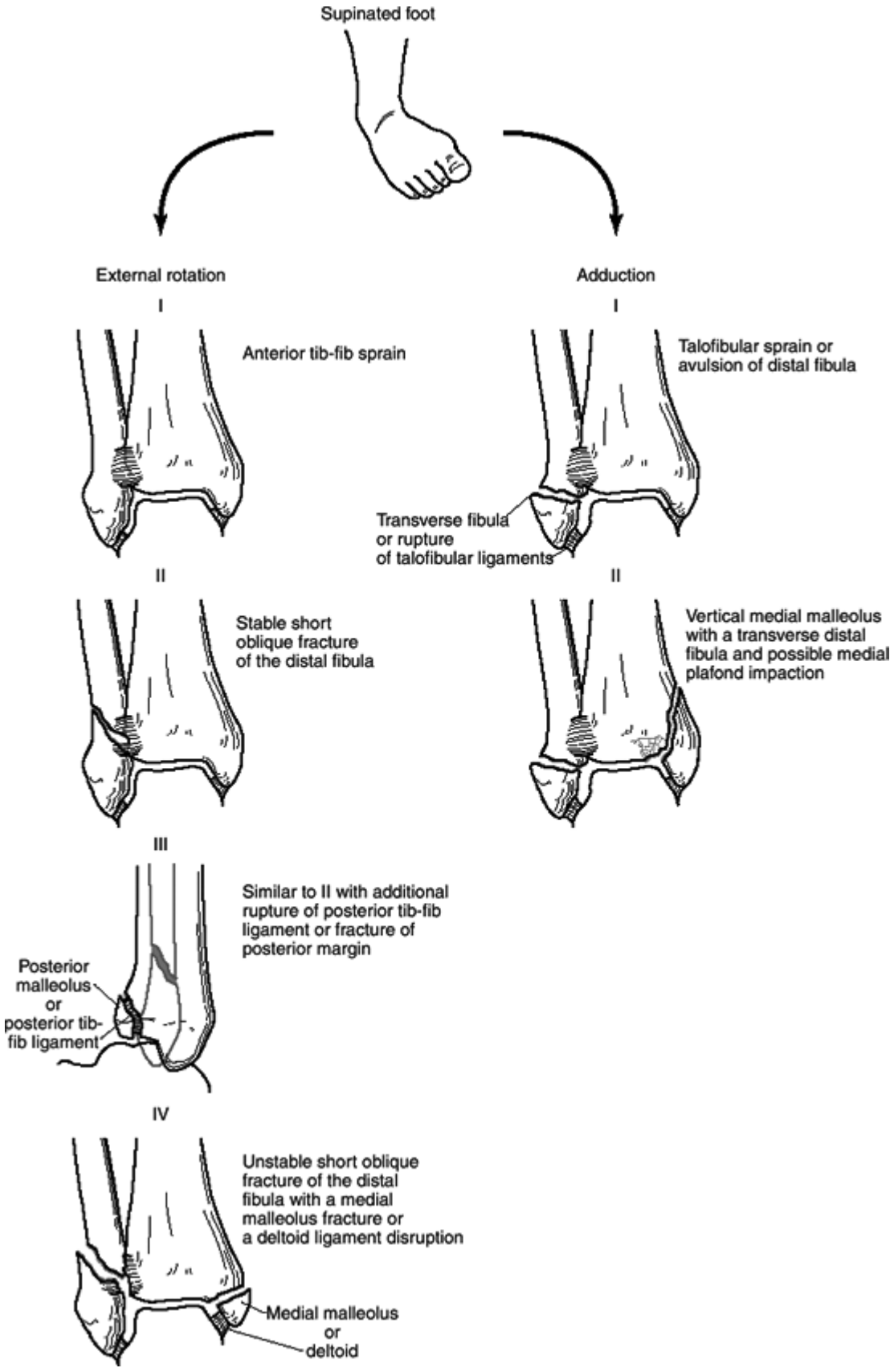
SUPINATION – EXTERNAL ROTATION (SER)

1st stage : AITFL disruption/sprain with or without bony avulsion.

2nd stage : Injuries in stage I + short and oblique fibular fracture.

3rd stage : Injuries in previous stage plus PTFL disruption or posterior malleolar avulsion.

4th stage : Injuries in previous stage plus a stable transverse fracture of the medial malleolus or deltoid ligament disruption.


Supinated foot
External rotation
Adduction
I
Anterior tib-fib sprain
I
Talofibular sprain or avulsion of distal fibula
Transverse fibula or rupture of talofibular ligaments
II
Stable short oblique fracture of the distal fibula
II
Vertical medial malleolus with a transverse distal fibula and possible medial plafond impaction
III
Similar to II with additional rupture of posterior tib-fib ligament or fracture of posterior margin
Posterior malleolus or posterior tib-fib ligament
IV
Unstable short oblique fracture of the distal fibula with a medial malleolus fracture or a deltoid ligament disruption
Medial malleolus or deltoid

PRONATION – ABDUCTION (PAB)

These fractures are seldom associated with syndesmotic instability:

1st Stage -Medial malleolar fracture with a transversely running fracture line/deltoid rupture.

2nd Stage - Injuries sustained in stage I along with rupture of syndesmotic ligaments.

3rd Stage - Injuries sustained in stage II along with transverse fibula fracture at or above the syndesmosis which is usually comminuted.

PRONATION – EXTERNAL ROTATION (PER)

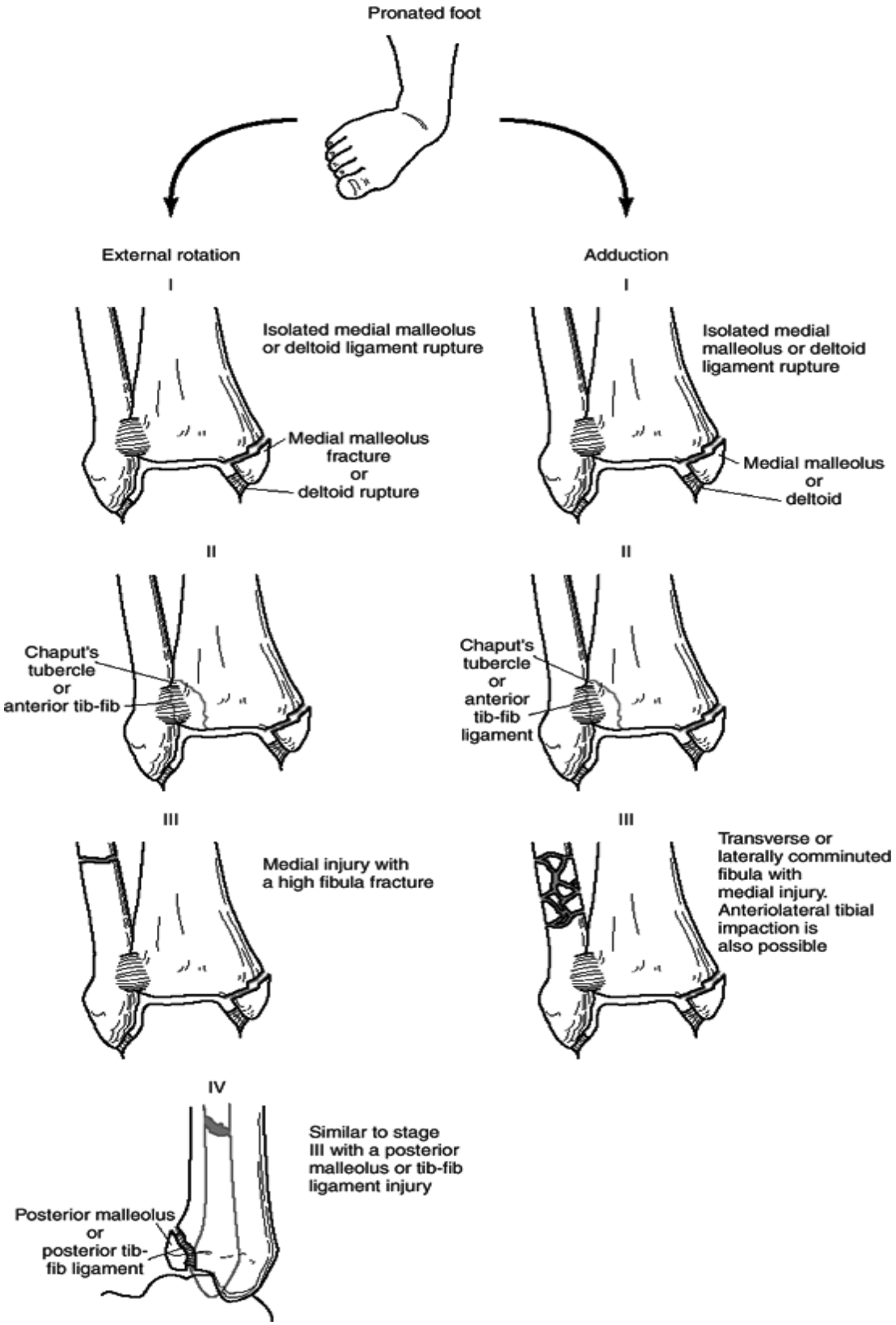
These fractures are also associated with syndesmotic instability.

1st Stage - Medial malleolus fracture (transverse) with or without injury to deltoid ligament

2nd Stage - Injuries sustained in 1st stage along with injury to antero tibio-fibular ligament

3rd Stage - Injuries sustained in 2nd stage associated with a fibula tip spiral fracture usually above the mortise.

4th Stage - Injuries sustained in 3rd stage along with fracture of the posterior malleolus or injury of PITFL.


Pronated foot
External rotation
Adduction
I
Isolated medial malleolus or deltoid ligament rupture
Medial malleolus fracture or deltoid rupture
I
Isolated medial malleolus or deltoid ligament rupture
Medial malleolus or deltoid
II
Chaput's tubercle or anterior tib-fib
II
Chaput's tubercle or anterior tib-fib ligament
III
Medial injury with a high fibula fracture
III
Transverse or laterally comminuted fibula with medial injury. Anteriolateral tibial impaction is also possible
IV
Similar to stage III with a posterior malleolus or tib-fib ligament injury
Posterior malleolus or posterior tib-fib ligament

RADIOLOGICAL CLASSIFICATION OF WEBER

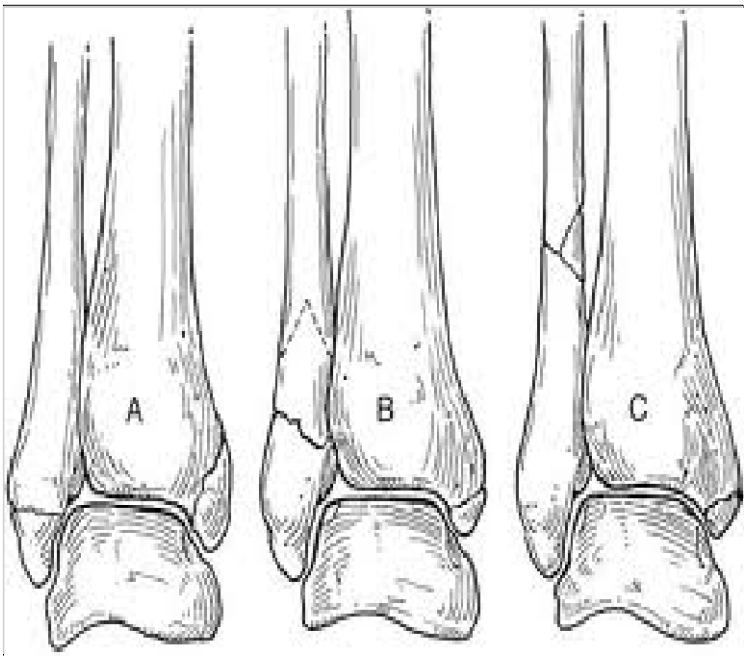
This is a radiological classification system based on the level of lateral malleolus fracture given by Robert Danis and Bernhard Weber. The Weber classification in association with the standard AO classification can be used to accommodate ligamentous injuries and medial malleolus injuries[10].

A**:** The injury is distal to the sysndesmotic joint. The fracture line is transverse in nature however in this fracture pattern the syndesmosis and the deltoid ligament are usually undamaged. This fracture is usually stable, however when associated with a medial malleolus fracture can be rendered unstable.

B: The medial lesion includes medial malleolus fracture and anterior syndesmotic rupture or medial collateral ligament injury. The Volkmann's lesion is fracture of postero-lateral aspect of the distal tibia, but interosseous membrane as a rule is intact.

C: In this type the fracture usually lies above the tibial plafond and frequently associated with instability of the syndesmotic joint. These fractures are very unstable and often require fixation, there is increase in the talo-fibular joint space.

C Type fractures are the most severe and as we go towards type A, the severity decreases



RADIOLOGY

The various views are:

1) The AP radiograph gives us information about the alignment of the talus with respect to the tibial plafond the clear space visualisation.

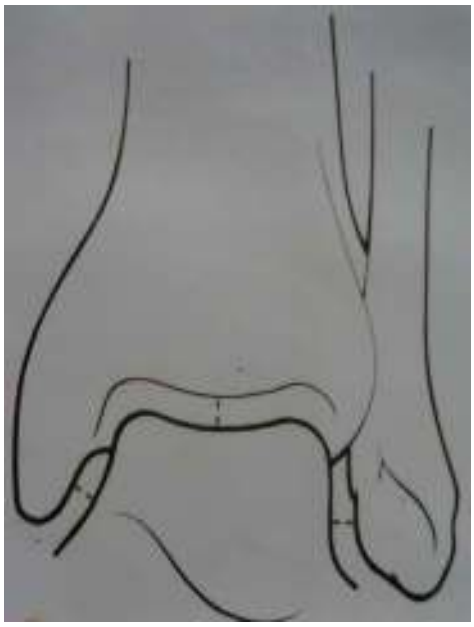
2) In the lateral x-ray the dome of the talus should be centered and congruous with the tibial plafond. This view is useful to demonstrate antero-posterior shift and avulsion fractures of the talus, posterior tibial tuberosity fractures and external rotation fractures of the fibula.

3) The mortise view is a modification of the AP view where there is about fifteen degrees of internal rotation of the foot which in turn is useful for evaluation of the clear joint spaces and any kind of talar displacement can be seen.

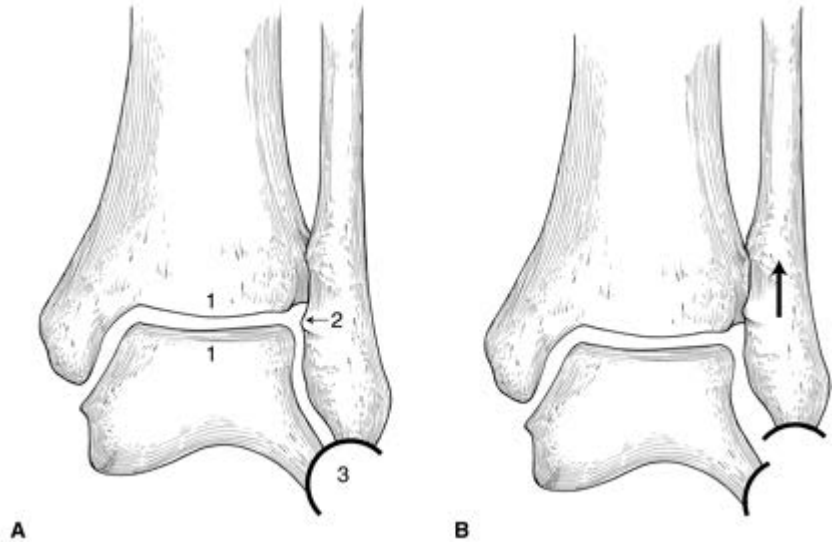
TOOLS TO ASSESS REDUCTION

1. CLEAR SPACE

The distance between the articular surfaces of the talus and the corresponding malleoli on the lateral and medial side of the talus is what we call the clear space and should be uniform throughout. Medial clear space less than 0.2 cm is considered acceptable.

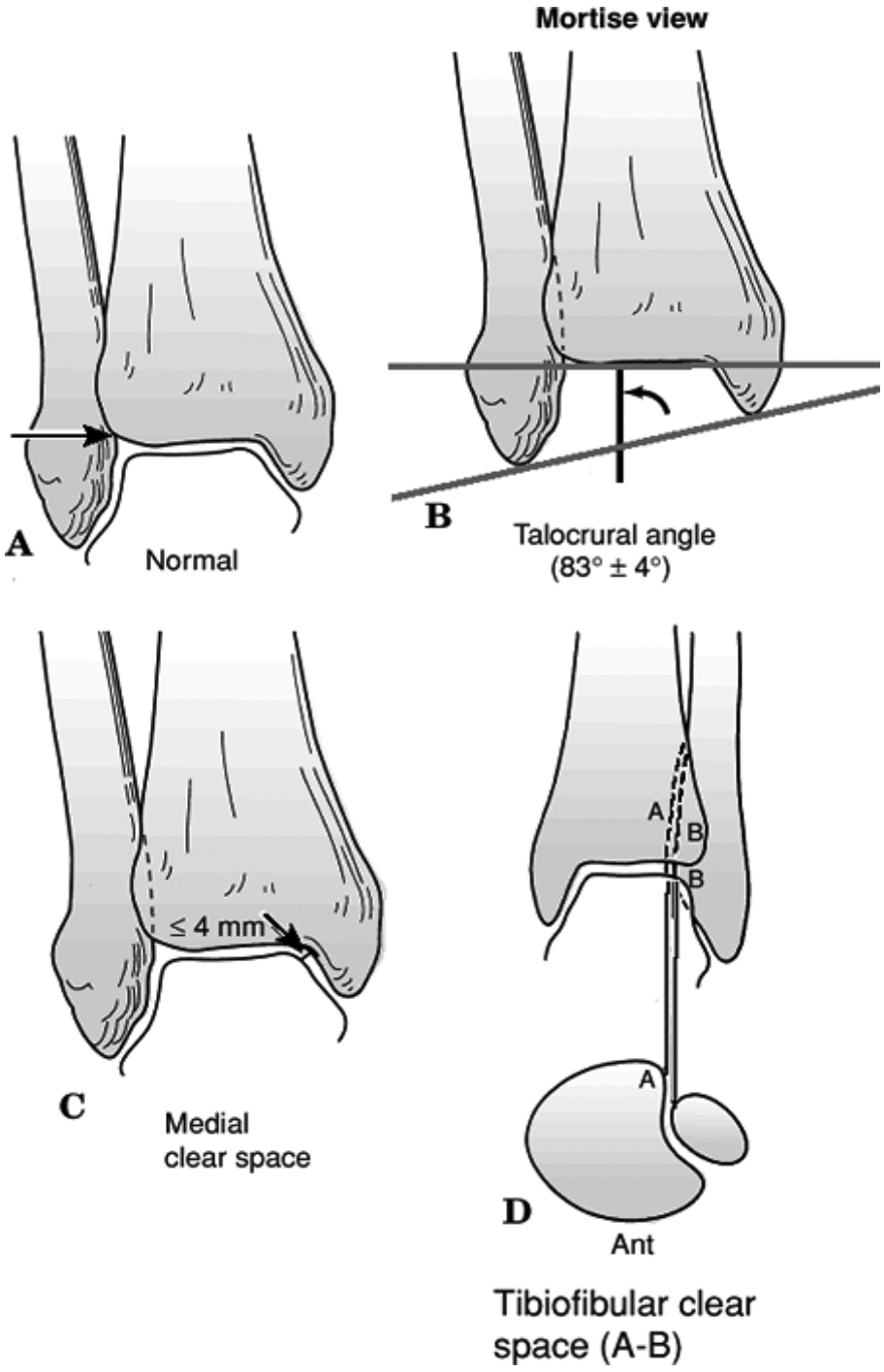


Medial, lateral and superior joint space of equal width.



A- Normal, B- Dime sign

For a detailed assessment of all the above mentioned radiological parameters, it is advised to get proper radiographs preferably without a POP cast which aids in proper visualization.


Mortise view
A
Normal
B
Talocrural angle
(83° ± 4°)
≤ 4 mm
C
Medial
clear space
A
B
B
A
D
Ant
Tibiofibular clear
space (A-B)

TREATMENT OF BIMALLEOLAR ANKLE FRACTURES

A lot of studies like Beauchamp et al concluded that there is no difference in the functional outcome in patients treated conservatively vs surgically usually in people above 50 years of age[3,37]. However there are 2 main modalities of management of ankle fractures, they can be treated conservatively with the help of casts and splints or surgical fixation (ORIF/CRIF).

Our study primarily focuses on treating bimalleolar ankle fractures with different modalities of surgical fixation (ORIF/CRIF) and further evaluation of the functional outcome on the basis of radiological and subjective parameters mentioned in the later part of our study[25].

The bony components of the ankle like the talus and the malleoli all function together as a single functional unit bound by ligaments surrounding the joint. The entire purpose of surgical reduction is to align the mechanical axis of the talus with that of the tibia which ensures normal weight bearing and hence pain free mobility.

OPEN AND CLOSED REDUCTION OF ANKLE FRACTURES

There are a variety of implants that have been used by various orthopedic surgeons in fixing fractures around this joint. They range from simple screws

(partially to full threaded) to locking plates and RUSH pins . AO has laid standard principles to guide surgeons throughout the globe in bringing uniformity in the treatment (surgical fixation) of these fractures.

BASIC PRINCIPLES

As we have highlighted in our study, fixing the lateral malleolus which eventually restores the normal length of the fibula holds paramount importance in surgeries around the ankle[25]. In cases where both the malleoli are fractured it is advisable to fix the lateral side first which restores the length of the fibula, however in certain conditions due to soft tissue impingement this can't be achieved and the medial side reduction becomes important. The joint should be properly examined for any loose bodies. After reduction has been confirmed under image intensifier guidance it should be maintained with the help of Kirschner-wire or bone holding clamps followed by final fixation. The fibula is not straight throughout its course but has a outward curve, which has to be eventually accommodated by the plate, hence 1/3 tubular plate becomes implant of choice as it is quite malleable.

IMPORTANCE OF SOFT-TISSUE HANDLING

As the vascularity around the ankle is not that as good as we get to see in the upper extremities, wound healing is quite often impaired especially in those with co-morbidities hence soft tissue care is very important. This fact was also concluded by our study where surgical site infections were the commonest complication to be seen post-surgery. However, we took the following precautions to avoid the same:

1. Careful handling of the skin and surrounding tissues intra-operatively.
2. Use of traumatic instruments (eg: Allis forceps) to handle the skin was strictly avoided.
3. In case of swelling of the foot, the surgery was delayed by a few days.
4. Limb was maintained in a elevated state either with the help of pillows or splints, proper suction was used and closure was done avoiding undermining of the skin margins.

CARE AFTER THE SURGERY:

The AO group advocates a double U-splint, which prevents an equinus deformity, but at the same time allows dorsiflexion of the ankle[30]. Post-operative dressings were usually done using chlorhexidine-based solutions and carefully examined for any redness, edema, discharge or excoriation. Prophylactic IV antibiotics (usually cephalosporin) were administered for a period of 3 days following the surgery. Dressings were usually done on the 3rd, 5th, 8th and 12th POD. And staples were removed on the last day.

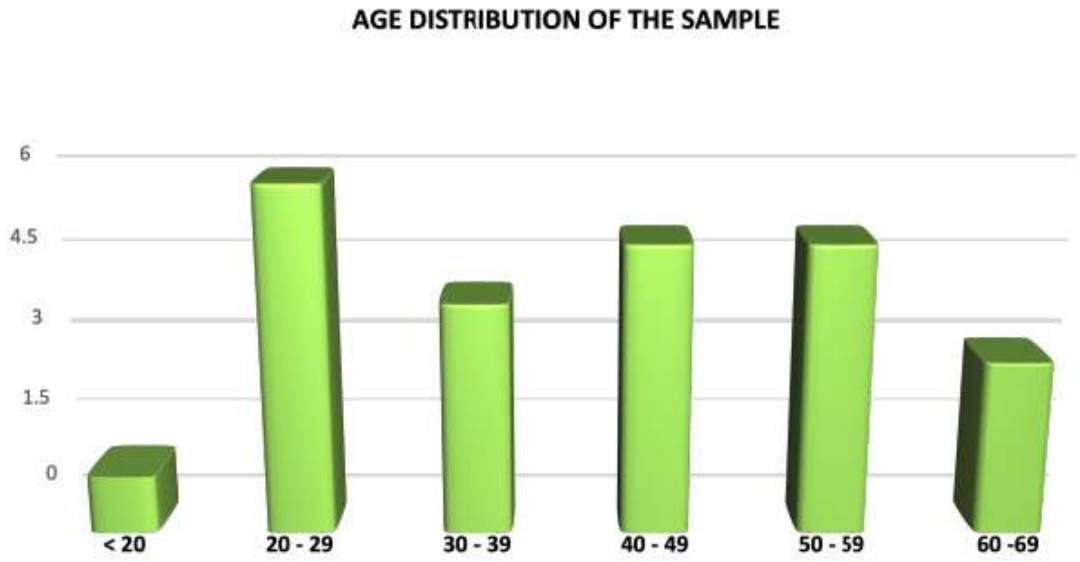
Patients were usually given instructions for non-weight bearing for around 21 days which allows for soft tissue healing.

MATERIALS AND METHODS

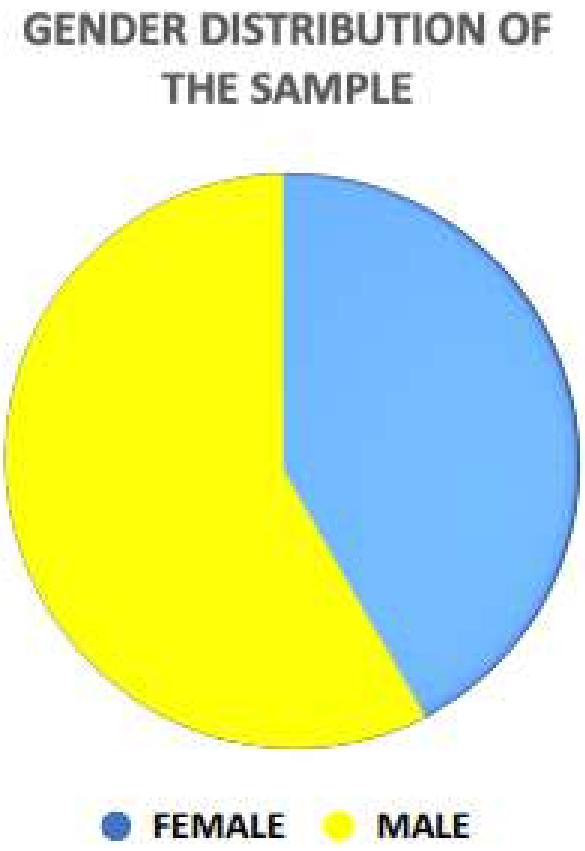
We included a total of twenty-four patients who sustained bi-malleolar ankle fractures at KLE's Dr Prabhakar kore Hospital and Medical Research Centre Belgaum from 01/01/2020 to 31/12/ 2020 for our study who were treated with surgical fixation after obtaining due ethical clearance.

AGE INCIDENCE

AGE	NUMBER	%
< 20	1	4.17
20 - 29	6	25.00
30 - 39	4	16.67
40 - 49	5	20.83
50 - 59	5	20.83
60 -69	3	12.50
TOTAL	24	100.00



GENDER	NUMBER	%
FEMALE	10	41.67
MALE	14	58.33
TOTAL	24	100.00



In our study we noticed that majority(58.33 %) of the study subjects were males as compared to females (41.67 %) which also correlates with the fact that ankle fractures are more common in males as compared to females.

MODE OF INJURY	NUMBER	%
FALL	3	12.50
FALL FROM HEIGHT	1	4.17
RTA	17	70.83
TWISTING	3	12.50
TOTAL	24	100.00

The most common mode of injury in our study were road traffic accidents, which constitute the chunk of the cases (70.83%), these were followed by self fall, twisting injury to the ankle and with one subject with a history of fall from height.

Inclusion criteria:

- Bimalleolar ankle fractures (WEBER type A, B and C)
- Patients >18 years

Exclusion criteria:

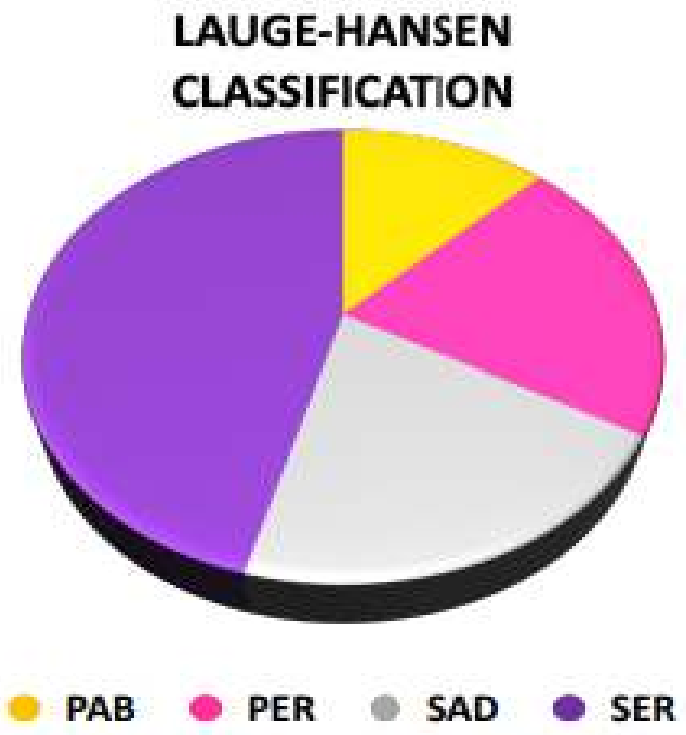
- Open injury with dislocation
- Pre-existing dermatological conditions
- Pathological fractures

Further these fractures were classified on the basis of classification system of LAUGE AND HANSEN and radiological classification of WEBER.

LAUGE-HANSEN CLASSIFICATION

Based on the position of foot and direction of force applied to foot, four type of injury patterns were described by Lauge-Hansen and their incidences

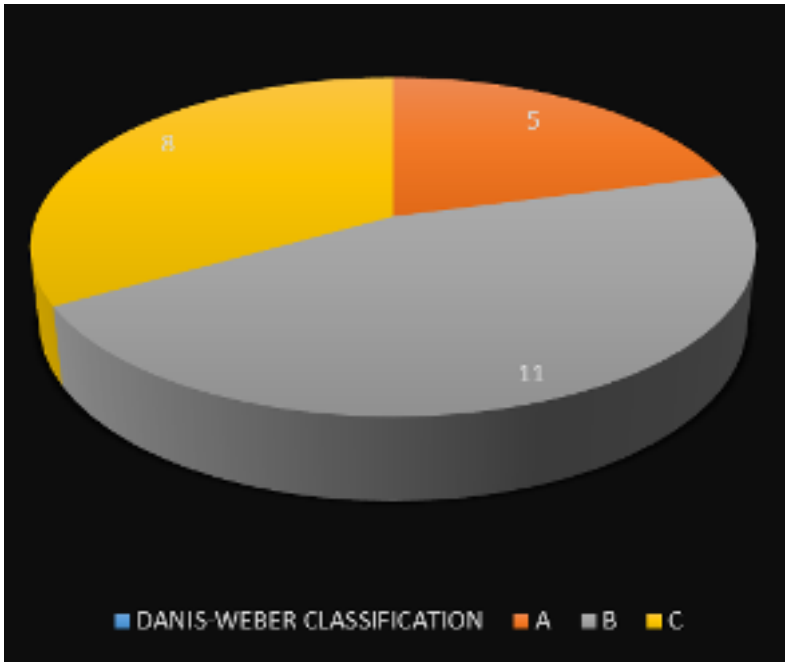
LAUGE-HANSEN CLASSIFICATION	NUMBER	%
PAB	3	12.50
PER	5	20.83
SAD	5	20.83
SER	11	45.83
TOTAL	24	100.00



		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	PAB	3	12.5	12.5	12.5
	PER	5	20.8	20.8	33.3
	SAD	5	20.8	20.8	54.2
	SER	11	45.8	45.8	100.0
	Total	24	100.0	100.0	

Almost 45% of the study subjects had a SER injury pattern followed by SAD (20.8 %), PER (20.8%) and PAB (12.5 %) being the rarest pattern of injury.

DANIS-WEBER CLASSIFICATION	NUMBER	%
A	5	20.83
B	11	45.83
C	8	33.33
TOTAL	24	100.00



		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A	5	20.8	20.8	20.8
	B	11	45.8	45.8	66.7
	C	8	33.3	33.3	100.0
	Total	24	100.0	100.0	

As per the DENIS-WEBER classification type B where the injury was at the level of the syndesmosis was the most common fracture pattern followed by type C and type A.

CASE SCENARIOS

Patients presented mostly to the ER while a few cases presented to the OPD. These patients underwent comprehensive clinical and further radiological assessment to evaluate the injury and plan a further course of action. As these fractures are very painful and disabling they were reduced with the help of adequate traction and immobilized with either with a good quality Posterior slab (POP), the reduction was confirmed with x-rays and work-up was done for surgery. As for any other fracture the plan of surgery and choice of appropriate fixation device is based on the x-rays, also in a few cases radiographs were augmented with a CT Scan where the articular surface involvement or the syndesmosis was in question. MRI is a good modality for soft tissue visualization however only useful in absence of soft tissue edema. These injuries are usually associated with extensive swelling which further hampers skin healing in the post operative period, hence adequate limb elevation was provided to the patient and with good analgesia.

This was followed by extensive pre-anaesthetic work-up and evaluation and patients were prepared for surgery.

INTRAOPERATIVE MANAGEMENT:

The choice of anaesthesia was either Spinal or combined spinal and epidural.

The purpose of the study was to fix the tip of the fibula (malleolus) first and achieve a proper fibular length which was done by taking a incision on the lateral side first and the lateral malleolus was adequately exposed. There were two main modalities that we have used. If the fracture was unstable then reduction was obtained using good quality bone clamps and held in that position which was followed by fixation with screws or 1/3 tubular plate which was well contoured as per the anatomy of the patient and followed by stabilization with screws. In patients where RUSH pins were used the entire process was performed percutaneously depending upon the fracture pattern. In some of our cases k wires were used to temporarily reduce the fracture before putting the plate or as a guide for the partially threaded screws (usually lag screws).

IMPLANTS		
LATERAL MALLEOLUS	NUMBER	%
PLATE	14	58.33
RUSH PIN	5	20.83
SCREWS	5	20.83
TOTAL	24	100.00

Further an incision was taken on the medial side and the medial malleolus was exposed and in a very gentle manner soft tissue dissection was done, in some cases there was some soft tissue impingement that hindered our reduction process which was handled meticulously and reduction was achieved with the help of either bone clamps or toothed forceps. In some of the cases where reduction was difficult, temporary augmentation with Kirschner-wires was done, further the periosteum was elevated and fixation with plate was done. The implants used for the various surgeries are:

IMPLANTS		
MEDIAL MALLEOLUS	NUMBER	%
PLATE	20	83.33
SCREWS	4	16.67
TOTAL	24	100.00

RECOVERY POST-SURGERY

The patients were monitored for a few hours before shifting them to the ward and immediately given limb elevation with the help of pillows and checked for any kind of neuro-vascular damage by asking them to the move the toes augmented with a SPO2 probe monitoring usually after 6 hours of the procedure.

Patients were administered intra-venous antibiotics usually a third-generation cephalosporin along with a aminoglycoside for the first 3 post-operative days followed by a course of oral antibiotics for 5 days.

Dressings were usually done on the 2nd, 5th, 8th and 12th POD, comprehensive dressings under strict aseptic precautions were done using chlorhexidine-based solutions and wounds examined for any evidences of surgical site infections. In case of usuage of a Romovac drain, it was removed within 3 days of the procedure. Adequate analgesia was provided depending on the patient's tolerance to pain. Sutures/ staples were removed on the 12th POD and by then physiotherapy in the form of muscle strengthening exercises and anti-DVT measures like application of crepe bandages were also followed.

FOLLOW UP: Patients were called for a review to the OPD first around 42 days then followed up at regular intervals up to a period of 1 year or till radiological and clinical union was seen usually around 6 months. Once this was confirmed weight bearing starting from toe touch ambulation to full weight bearing was done progressively[29].

RESULTS

The results were analyzed based on Olerud and Molander scoring[24] . In Olerud and Molander, subjective and objective scores was used. The four fracture patterns of Lauge-Hansen classification were analysed for results and complications.

AGE ANALYSIS:

	MEAN	S.D.	MIN	MAX
AGE	40.79	14.20	18	65

AGE	NUMBER	%
< 20	1	4.17
20 - 29	6	25.00
30 - 39	4	16.67
40 - 49	5	20.83
50 - 59	5	20.83
60 -69	3	12.50
TOTAL	24	100.00

Bi-malleolar ankle fractures was more commonly observed in the age group 20-30 and 60-70 which corresponds to a bimodal peak, also we could see that the most common cause in the younger age group was vehicular accidents whereas in the older age group it was a poor bone stock or associate injuries.

OLERUD AND MOLANDER SCORING SYSTEM AFTER ANKLE FRACTURES(1984)

Subjective score Parameters		Score	Result
1. Pain	Never	25	
	Walking on uneven surface	20	
	Walking on even surface outdoors	10	
	Walking indoors constant and severe	05	
2.Stiffness	None	10	
	Present	0	
3.Swelling	None	10	
	Only evenings	05	
	Constant	0	
4.Stair climbing	No problems	10	
	Impaired	05	
	Impossible	0	
5.Running	Possible	05	
	Impossible	0	
6.Jumping	Possible	05	
	Impossible	0	
7.Squating	Possible	05	
	Impossible	0	
8.Type of support	None	10	
	Tapping, wrapping	05	
	Stick or crutch	0	
9.Affecting work and Activities of daily life	Same as before injury	20	
	Loss of time	15	
	Part time work/Simpler job	05	
	Severely impaired	0	
Total			

4.Excellant >90

Subjective score was classified into four groups

1.poor <60

2.fair 60-80

3.Good 81-90

4.Excellant >90

Objective score Parameters		Score	Result
1.Pain	Rest pain	3	
	Routine walking	2	
	Prolonged walking	1	
	Pain free	0	
2.Range of movements(plantar flexion+Dorsiflexion)	No movement	4	
	0-15 degree	3	
Normal 65degree	16 degree-30degree	2	
	31degree -45degree	1	
	Above 45degree	0	
3.Deformity	Present	2	
	Absent	0	
4.Radiological criteria	Osteo arthritic changes	3	
	Unacceptable Talar shift and or Talar tilt	2	
	Acceptable Talar shift and or Talar tilt	1	
	Normal	0	

Objective score was classified into 3 groups

Good - 0 -3

Fair - 4 -6

Poor - 07-12

Based on the subjective scoring these are the results.

Overall functional outcome for our patients are as follows.

GROUP	NUMBER	%
EXCELLENT	13	54.17
FAIR	4	16.67
GOOD	5	20.83
POOR	2	8.33
TOTAL	24	100.00

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	EXCELLENT	13	54.2	54.2	54.2
	FAIR	4	16.7	16.7	70.8
	GOOD	5	20.8	20.8	91.7
	POOR	2	8.3	8.3	100.0
	Total	24	100.0	100.0	

Almost 70 % of our study subjects had fair to excellent outcomes in terms of the subjective scoring system of Olerud and Molander and only 2 patients (8.3 %) had poor outcomes .

Based on the objective scoring these are the results.

Overall functional outcome for our patients are as follows.

CATEGORY	NUMBER	%
FAIR	4	16.67
GOOD	17	70.83
POOR	3	12.50
TOTAL	24	100.00

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	FAIR	4	16.7	16.7	16.7
	GOOD	17	70.8	70.8	87.5
	POOR	3	12.5	12.5	100.0
	Total	24	100.0	100.0	

In terms of the objective scoring 86% patients had fair to good functional outcomes whereas three patients had poor outcome possibly owing to their co morbidities or poor bone quality.

MODE OF INJURY	NUMBER	%
FALL	3	12.50
FALL FROM HEIGHT	1	4.17
RTA	17	70.83
TWISTING	3	12.50
TOTAL	24	100.00

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	FALL	3	12.5	12.5	12.5
	FALL FROM HEIGHT	1	4.2	4.2	16.7
	RTA	17	70.8	70.8	87.5
	TWISTING	3	12.5	12.5	100.0
	Total	24	100.0	100.0	

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OUTCOME IN TERMS OF UNION:

UNION	NUMBER	%
MALUNITED	1	4.17
NON UNION	2	8.33
UNION	21	87.50
TOTAL	24	100.00

Majority of our patients (87.5%) went on to have a full union and could resume their activities of daily living however in one case there was mal-union leading to restriction of movements and some disability and 1 patient had non-union due to Charcot's arthropthy which was further treated with arthrodesis of the joint.

ANALYSIS OF ENCOUNTERED COMPLICATIONS:

COMPLICATIONS	NUMBER	%
MALUNITED	1	4.17
NON UNION	1	4.17
SEPTICEMIA	1	4.17
SEVERE ARTHRITIS	1	4.17
SKIN INFECTION	4	16.67
NIL	16	66.67
TOTAL	24	100.00

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	MALUNITED	1	4.2	4.2	4.2
	NIL	16	66.7	66.7	70.8
	NON UNION	1	4.2	4.2	75.0
	SEPTICEMIA	1	4.2	4.2	79.2
	SEVERE ARTHRITIS	1	4.2	4.2	83.3
	SKIN INFECTION	3	12.5	12.5	95.8
	SKIN INMECTION	1	4.2	4.2	100.0
	Total	24	100.0	100.0	

Amongst the study subjects the most common post operative complications were skin infections, especially in the age group more than 50 years probably due to poor skin quality or diabetes, it was followed by mal-union, non union and one patient landed in septicemia due to his de-gloving injury which was further treated with broad spectrum antibiotics followed by a STSG skin graft.

OTHER INJURIES IN STUDY SUBJECTS:

ASSOCIATED INJURIES	NUMBER	%
1ST METATARSAL FRACTURE	1	4.17
BOTH BONE FOREARM#	1	4.17
DEGLOVING INJURY	1	4.17
DER#	1	4.17
FEMUR SHAFT#	1	4.17
HEAD INJURY(SDH)	1	4.17
HUMERUS #	1	4.17
TALUS #	1	4.17
NIL	16	66.67
TOTAL	24	100.00

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1ST METATARSAL FRACTURE	1	4.2	4.2	4.2
	BOTH BONE FOREARM#	1	4.2	4.2	8.3
	DEGLOVING INJURY	1	4.2	4.2	12.5
	DER#	1	4.2	4.2	16.7
	FEMUR SHAFT#	1	4.2	4.2	20.8
	HEAD INJURY(SDH)	1	4.2	4.2	25.0
	HUMERUS #	1	4.2	4.2	29.2
	NIL	16	66.7	66.7	95.8
	TALUS #	1	4.2	4.2	100.0
	Total	24	100.0	100.0	

ANALYSIS OF THE IMPLANTS USED:

MEDIAL MALLEOLUS

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	PLATE	20	83.3	83.3	83.3
	SCREWS	4	16.7	16.7	100.0
	Total	24	100.0	100.0	

	CATEGORY					
MEDIAL MALLEOLUS	FAIR	GOOD	POOR	TOTAL	p VALUE	INFEENCE
PLATE	4	15	1	20	0.0389	SIGNIFICANT
SCREWS	0	2	2	4		
TOTAL	4	17	3	24		

LATERAL MALLEOLUS

IMPLANTS		
LATERAL MALLEOLUS	NUMBER	%
PLATE	14	58.33
RUSH PIN	5	20.83
SCREWS	5	20.83
TOTAL	24	100.00

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	PLATE	14	58.3	58.3	58.3
	RUSH PIN	5	20.8	20.8	79.2
	SCREWS	5	20.8	20.8	100.0
	Total	24	100.0	100.0	

The most common choice of implants for both medial and lateral malleolus tends to be plates and screws giving a superior functional outcome probably owing to the stability of the construct and the anatomic reduction achieved with them.

TREATMENT OF COMPLICATIONS

Patients with superficial infection were treated with repeated dressings and appropriate antibiotics. They all responded well to this mode of treatment. Patients with deep infection were treated with repeated saline dressings and intravenous antibiotics. Those patients who did not respond were treated with early removal of implants.

One patient with moderate to severe skin necrosis was treated with spilt thickness skin graft, once the area was covered by healthy granulation tissue.

The patient with non-union of medial malleolus was treated with freshening of fracture site and revision fixation was done.

DISCUSSION

In my study consisting of twenty-four cases of bi-malleolar ankle fractures, males were more susceptible to injury as compared to female counterparts.

Accidental injuries (RTA) 70% of injuries, followed by slip and fall while walking or twisting of ankle during daily activities (30%) while one of the study subjects sustained the injury due to fall from height (>10 ft). Out of 24 subjects, 11 - SER pattern, 5 - PER pattern, 5 -SAD pattern and 3 -PAB pattern.

Amongst the study subjects the most common mode of injury was found to be Supination - External rotation. Stress radiography views turns out to be a useful tool in order to assess ankle instability. Evaluation of deep deltoid ligament injury associated with ankle instability is assessed by stress radiographs which help to differentiate SER2injury from SER4 equivalent injury[15.] SER4 fractures are unstable and needs ligament reconstruction and syndesmotic stability[16.]

In patients who sustained a SER category of injury 16/18 patients had either good or excellent functional outcomes. The other 2 in the similar category had fair outcome. The first patient had a surgical site infection on the 4th post-operative day which prolonged his wound healing to 3 weeks and immobilization post-surgery and there was a delay in initiation of physiotherapy as compared to the other patients in the same category.

In the category of Supination-Adduction variant, anteromedial incision was used to fix the fracture as suggested by Hamilton et al[14.] 3 patients had excellent outcome whereas one had a poor outcome, amongst these 2 patients had a small lateral malleolar fragment which was fixed with malleolar screws. The antero-medial approach being the standard modality to approach these fractures.

There were three subjects with Pronation-Abduction injury, two of which responded well to the procedure, however the third patient showed some cellulitic changes and had to undergo one more session of debridement and recovered fully within a span of 3 weeks, thus all the three patients went on to have a full recovery in terms of radiological union where the first two showed excellent and good outcome respectively which is deviant from the studies where the medial malleoli was fixed with plating before the fibular fragment like Aaron et al[28]

Good to excellent results in terms of functional outcome were obtained in 3 cases, fair in 1 and poor for one case of Pronation-external rotation type. One of the patients with poor outcome had uncontrolled diabetes for the previous 10 years and was on irregular treatment. Patient went on to have an infective non-union later on diagnosed with Charcot's arthropathy and eventually underwent arthrodesis with Charnley's external fixator.Thus anatomical reduction and stable fixation play a crucial role in the outcome as concluded by maverick et al[19.]

The results are in agreement with the study done by V Senthil Kumar et al[41]. in 2014 where they safely concluded in terms of age, sex distribution , fracture pattern of ankle fractures and obtained good results in terms of functional outcome when evaluated on the basis of scoring system of Olerud and Molander. The prognosis also is determined by the energy of the injury[14].

However in cases where the injury pattern was PAB they advocated fixing the medial side first with preferably a locking plate before fixing the lateral side, however in our study we found good to excellent functional outcome even with fixing the lateral malleolus first. Also in our study we could safely conclude that

plating gives better outcome as compared to percutaneous fixation as deduced by the above mentioned study.

Thus the displacement of the talus depends on the integrity of the deltoid ligament[18,] hence deltoid if torn should be repaired[7]. Stable fractures are usually unaffected by axial loading[1].

In a study done in 2015 by Njau Michael Mwaura et al[42]. in Kenya where they concluded that most of the patients were below 40 years of age as most of the patients presenting to their hospital are young whereas in our study. In our study we concluded that the most common modes of injury were RTA and self fall so patients with H/O RTA are usually young in agreement with the above mentioned study. However patients in whom self fall was the mechanism of injury, it was more common in the elderly age group > 50 years due to osteoporosis and poor bone stock.

Several authors like Huges et al[03], Tunturi et al[04] and Phillips et al[05] implicate factors such as Weber B type fracture pattern, shortened fibula and widened ankle mortise for early post traumatic arthritis.

According to Micheal Bekorom[26], pronation injuries/weber C are commonly associated with syndesmotic injuries than supination injuries/weber B.

CONCLUSION

Ankle fractures were most commonly sustained following a Supination-external rotation modality of injury as per the standard classification also it is the one seldom associated with infections.

The other type of injuries like Pronation-external rotation usually had good functional outcome and satisfactory results.

Bi-malleolar ankle fractures treated in time with a good surgical fixation that restores the normal anatomy of the ankle mortise and provides excellent results in terms of early mobilization, restoration of normal function and patient satisfaction.

It can be safely concluded that a good anatomical reduction that provides sufficient stability leads to early weight-bearing and hence the patients can revert back to their routine activities in due course of time.

ILLUSTRATIVE CASES

CASE 1:

AGE: 52 YEARS

SEX: MALE

PRE-OP XRAY

SIX MONTHS FOLLOW UP

Six months follow up x-rays show radiological union and good outcome in terms of ankle and dorsiflexion.

CASE 2:

AGE: 45 YEARS

SEX:MALE

PRE-OPERATIVE X-RAY:

POST-OPERATIVE XRAYS

6 MONTHS FOLLOW-UP

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PROFORMA

"FUNCTIONAL OUTCOME OF SURGICAL FIXATION OF BIMALLEOLAR ANKLE FRACTURES BY FIXING THE LATERAL MALLEOLUS FIRST - A ONE YEAR HOSPITAL BASED PROSPECTIVE STUDY"

PATIENT NO : IP NO:

NAME:

AGE: SEX:

ADDRESS:

OCCUPATION:

DOA: DOS: DOD:

CHIEF COMPLAINTS:

PRESENTING COMPLAINTS:

Pain

Swelling

Instability

Inability to walk

Wound

Deformity

HISTORY OF PRESENT ILLNESS:

NATURE OF INJURY:

Road Traffic Accident

History of fall

Others

MODE OF INJURY:

Direct

Indirect

DURATION SINCE INJURY:

…….days

a) History of Diabetes Mellitus, Hypertension, Asthma, Rheumatoid Arthritis,

Tuberculosis and other chronic illness

Yes

No

Previous history of ankle fracture

Yes

No

Previous history of any medication received :

PERSONAL HISTORY:

Diet : Veg/ Mixed/ Nonveg

Appetite : Increased or Decreased

Habits : Smoking/ Alcohol /Tobacco chewer / others

Bowel & Bladder Habits: Normal or Abnormal

FAMILY HISTORY:

GENERAL PHYSICAL EXAMINATION:

Built :

Temperature: Pulse:

Blood Pressure: Respiratory Rate:

Pallor

Cyanosis

Icterus

Clubbing

Pedal edema

Lymphadenopathy

SYSTEMIC EXAMINATION:

Cardiovascular System Examination:

Respiratory System Examination:

Per Abdomen Examination:

Central Nervous System Examination:

LOCAL EXAMINATION:

PARAMETERS		**Score**
1. Pain	Never	25
	Walking on uneven surface	20
	Walking on even surface outdoors	10
	Walking indoors constant and severe	05
2.Stiffness	None	10
	Present	0
3.Swelling	None	10
	Only evenings	05
	Constant	0
4.Stairclimbing	No problems	10
	Impaired	05
	Impossible	0
5.Running	Possible	05
	Impossible	0
6.Jumping	Possible	05
	Impossible	0
7.Squating	Possible	05
	Impossible	0
8.Type of supports	None	10
	Tapping, wrapping	05
	Stick or crutch	0
9.Affecting work and Activities of daily life	Same as before injury	20
	Loss of tempo	15
	Part time work/Simpler job	15

	Severely impaired	0

Subjective score was classified into four groups

1.poor <60

2.fair 60-80

3.Good 81-90

4.Excellant >90

OBJECTIVESCORE:

Objective score was based on clinical and Radiological criteria. Clinical criteria includes Pain, Range of ankle movements and Deformity. Radiological criteria on the evidence of osteo-arthritic changes, talar-tilt, talar-shift and restoration of joint congruity.

Objective score was classified into 3 groups

Good - 0 -3

Fair - 4 -6

Poor - 7-12

Objective score Parameters		Score	Result
1.Pain	Rest pain	3	
	Routine walking	2	
	Prolonged walking	1	
	Pain free	0	
2.Range of movements(plantar flexion+Dorsiflexion) Normal 65	No movement	4	
	0-15	3	
	16 -30	2	
	31 -45	1	
	Above 45	0	
3.Deformity	Present	2	
	Absent	0	
4.Radiological criteria	Osteo arthritic changes	3	
	Unacceptable Talar shift and or Talar tilt	2	
	Acceptable Talar shift and or Talar tilt	1	
	Normal	0	

INFORMED CONSENT

TITLE OF THE STUDY -"FUNCTIONAL OUTCOME OF SURGICAL FIXATION OF BIMALLEOLAR ANKLE FRACTURES BY FIXING THE LATERAL MALLEOLUS FIRST - A ONE YEAR HOSPITAL BASED PROSPECTIVE STUDY"

PRINCIPAL INVESTIGATOR: DR. KUNAL KHARA

GUIDE: DR. S.V. UDAPUDI

INTRODUCTION AND PURPOSE:

Ankle fractures are one of the commonest injuries sustained following a trauma. The incidence is growing rapidly due to increase in ageing of human population and increasing road traffic accidents. It is commonly associated with trivial trauma in older age patient and usually with high energy trauma in younger age group, however result in different fracture configurations. Non operative approach includes reduction via traction and immobilization, however it usually resulted in malunion, varus and external rotation deformities resulting in short limb gait. As a result of prolonged immobilization complications like bedsores, deep vein thrombosis, respiratory infections can be noted. When seen in older age group, the aim of the surgery is to obtain early mobilisation, rigid and stable fixation, thus preventing the complications due to prolonged recumbency. This leads to recommendation of surgery by internal fixation.

The advantages of operative treatment are:

1. Decreases hospitalization [4]
2. Reduces complications of prolong recumbency [4]
3. Early mobilization and weight bearing
4. Walking exercise is possible with new implant and fixation techonology [5].
5. Helps to achieve anatomical reduction.

The purpose of this study is to determine the best Clinical outcome for "FUNCTIONAL OUTCOME OF SURGICAL FIXATION OF BIMALLEOLAR ANKLE FRACTURES BY FIXING THE LATERAL MALLEOLUS FIRST - A ONE YEAR HOSPITAL BASED PROSPECTIVE STUDY" in Orthopaedic department of KLE'S Dr.Prabhakar Kore Hospital and Medical Research Centre and Charitable Hospital, Belagavi from 1st January 2020 to 31st December 2020.

BENEFITS

1. Decreases hospitalization [4]
2. Reduces complications of prolong recumbency [4]

3. Early mobilization and weight bearing
4. Walking exercise is possible with new implant and fixation techonology [5].
5. Helps to achieve anatomical reduction.

RISKS:

a. Shortening
b. Surgical site infection
c. Varus collapse
d. Non union
e. Implant failure
f. Mortality

VOLUNTARY PARTICIPATION/ WITHDRAWL:

Taking part in this study is voluntary. I may choose not to take part in this study, or if I decide to take part I can later change my mind and withdraw from the study. My decision will not change the present or future health care or other services that I receive. The investigator or the sponsor may stop my participation in this study. I will notify the investigator of any important new findings that may change my willingness to continue to take part. If I choose not to take part in the study, I will receive the standard treatment for patients with my condition.

COMPENSATION:

As the subject voluntarily consents to be a part of the study, no compensation will be given.

CONFIDENTIALITY:

All information collected about the subject during the course of the study will be kept confidential to the extent permitted by the law. The code numbers will identify the subject in this research record. Information from this study may be presented but the subjects identity will be confidential in any publication.

If any enquiries in the future or in case of study related injury or illness, you may contact following person:

PRINCIPAL INVESTIGATOR:

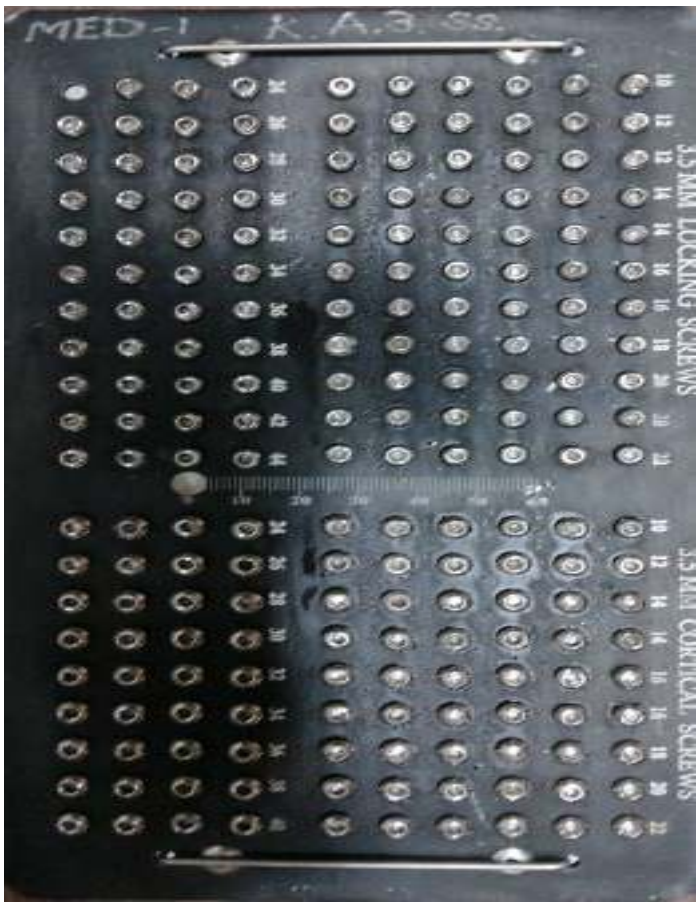
DR. KUNAL KHARA,
PG. RESIDENT,
DEPARTMENT OF ORTHOPAEDICS,
KAHER,
JAWAHARLAL NEHRU MEDICAL COLLEGE,
NEHRU NAGAR,
BELAGAVI – 590010

GUIDE: DR. S. V. UDAPUDI M.S(Ortho) D.Ortho.,
PROFESSOR AND HEAD,DEPT. OF ORTHOPAEDICS,
KAHER J. N. MEDICAL COLLEGE, BELAGAVI – 590010

If you still have any queries please contact:

Dr. Mrs. ROOPA BELLAD M.D.,
Chairperson,
Institutional Ethics Committee for
Human Subjects Research,
Jawaharlal Nehru Medical College,
Belgaum -590010
Ph No. 0831-2473777

PHOTOGRAPHS


MED-1 K.A.3.SS.
3.5 MM LOCKING SCREWS
3.5 MM CORTICAL SCREWS


8 HOLE 316L GENIUS 8 - 0S 2001

K.L.E. ACADEMY OF HIGHER EDUCATION AND RESEARCH
(Deemed - to-be-University)
Accredited 'A' Grade by NAAC (2nd Cycle) Placed in Category 'A' by MHRD (Govt)

JAWAHARLAL NEHRU MEDICAL COLLEGE,
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Ref: MDC/DOME/ 223 **Date: 10/11/2021**

To,

Dr. Kunal Khara
PG student in Orthopedics,
J.N.Medical College,
BELAGAVI.

Sub: Institutional Ethical Clearance for the study.

With reference to the above, we wish to inform you that your revised research proposal titled **"FUNCTIONAL OUTCOME OF SURGICAL FIXATION OF BIMALLEOLAR ANKLE FRACTURES BY FIXING THE LATERAL MALLEOLUS FIRST"**, is ethical and justifiable. The proposed research project has been cleared by the JNMC Institutional Ethics Committee on Human Subjects Research.

(Dr. Smita Sonoli)
Member Secretary
JNMC Institutional Ethics Committee
on Human Subjects Research,
J.N.Medical College, Belagavi.

(Dr. Harsha Hegde)
Chairman,
JNMC Institutional Ethics Committee
on Human Subjects Research,
J.N.Medical College, Belagavi

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