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Functional Outcome of Bimalleolar Ankle Fractures Treated With Semitubular Plate for Lateral Malleolus and Malleolar Screws for Medial Malleolus

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Background: *Malleolar injuries are the most common significant lower extremity fractures. These injuries gain importance, because the whole body weight is transmitted through the ankle, and locomotion depends on the stability of the ankle. Open reduction and internal fixation have become the mainstay of treatment for most of the unstable bimalleolar fractures, as these operative methods restores the anatomy, biomechanics and contact loading characteristics of the ankle.*

Objectives:

1. *To study the functional outcome of surgically managed bimalleolar fractures of ankle in adults.*

2. To restore the anatomy of malleoli and ankle perfectly by operative treatment with internal fixation

Methods: *A prospective study of 30 cases of bimalleolar fractures of ankle in adults, managed surgically by screw for medial malleolus and plate for lateral malleolus during the period from dec 2015- June 2017 and followed up to dec 2017,at Narayana medical college ,Nellore.*

Inclusion Criteria:

• All closed fractures.
• Open type 1, 2 , 3a (Gustillo-Anderson).
• Above 18 years.

Exclusion Criteria:

• With associated Pilon fracture.
• Patients unfit for surgery.
• Patients with minimally displaced mono-malleolar fractures, avulsion fractures and stable fractures

Follow-up was taken at 1month, 3 months, and 6 months post-operatively. At every visit check radiographs were taken to assess the radiological union.

Results: *In our study we achieved 86.6% excellent to good results, 6.6% fair results, 6.6% poor results. The results were comparable to other studies.*

Conclusions -

The operative results were satisfactory in 86.6% cases, with good to excellent functional outcome.
• Excellent results are obtained with stable fixation of fracture. Cancellous screws or malleolar screws are better in internal fixation of medial malleolus and lateral plating was the best for fibular fractures.
• Good functional results are obtained by surgical management of bimalleolar ankle fractures. Early weight bearing and mobilisation is achieved in these patients.
• Anatomical reduction with restoration of the articular congruence is essential in all intra articular fractures, more so, if a weight bearing joint like ankle is involved. Open reduction and internal fixation restores the articular congruity of the ankle joint.

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I. Introduction

Malleolar fractures are one of the most common fractures in orthopaedictraumatology. As with all intra articular fractures, malleolar fractures necessitate accurate reduction and stable internal fixation. When malleolar fractures are not reduced accurately they may lead to post traumatic painful restriction of motion or osteoarthritis or both.

Sir Robert Jones said, "Ankle is the most injured joint of the body but the least well treated"[1]. Ankle injuries gain importance because body weight is transmitted through the joint and locomotion depends upon the stability of it. They are usually mixed injuries, ligamentous and bony; and each injury is an end result of the sequence of ligamentous and bony failure due to deforming forces. Malleolar fracture have

varied presentations which have given rise to a wide variety of classification systems, of which two are in vogue: Lauge-Hansens and Danis-Weber classification.

As for the treatment of malleolar fractures, many of them which are stable are reduced by conservative treatment and have given good result. The other unstable displaced and open fractures require open reduction internal fixation. The superiority of ORIF over closed treatment have been thoroughly demonstrated in literature

The operative method restores the anatomy and contact-loading characteristic of the ankle. Additional advantages include easier rehabilitation without a cast, early mobilization and earlier weight bearing. However all studies have not obtained good results in cases of bimalleolar fractures.

SURGICAL ANATOMY[30,31]

The ankle is a composite joint (hinge). It consists of two dissimilar articulations: syndesmosis connecting the distal end of crural bones and diarthrosis between their ends and talus. The ankle is a mortise in which the talus is constrained by the fibula laterally and tibia both superiorly and medially, this configuration as also been referred to as the malleolar fork.

The ankle often is divided into medial, lateral, and syndesmotic complexes to help the physician to understand the mechanism of injury better and to devise a treatment plan. The medial complex consists of the medial malleolus, the medial facet of the talus, and the superficial and deep components of the deltoid ligament, the lateral complex consists of the distal part of the fibula, the lateral facet of the talus, and the lateral collateral ligaments of the ankle and subtalar, and the syndesmotic complex the articulation between the tibia and the fibula as well as the interconnecting ligaments of the syndesmosis and the interosseous membrane.

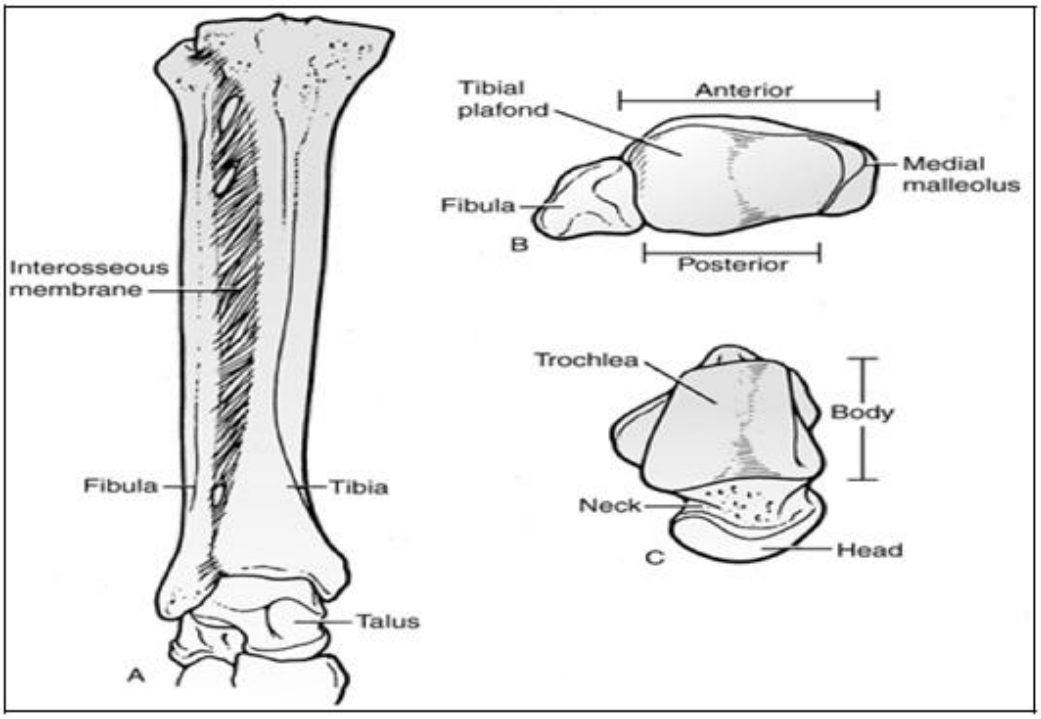


Fig 1 – skeletal components of ankle joint

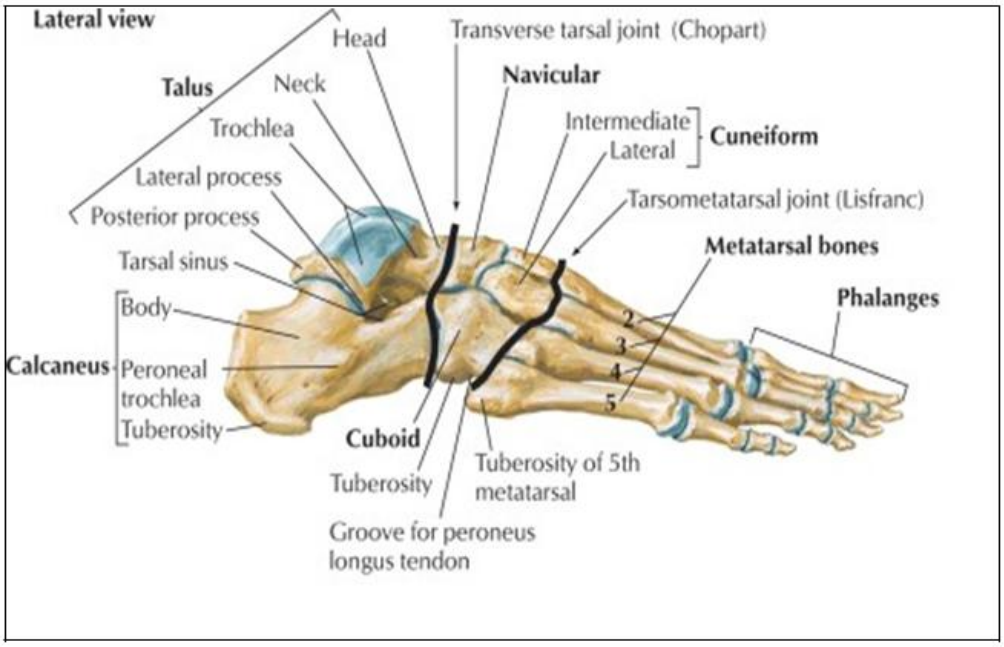
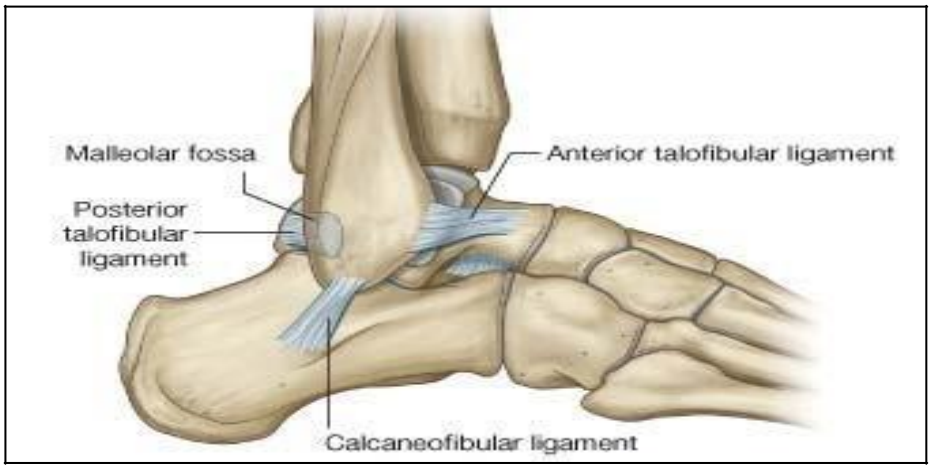


Fig 2 – skeletal component of ankle joint and foot

LIGAMENTS:[Fig.3]
The ligaments supporting the ankle joint are considered to be made up of three distinct groups:
A) The lateral collateral ligaments and
B) The medial collateral ligaments
C) The syndesmotic ligaments

Fig 3 - lateral collateral ligament



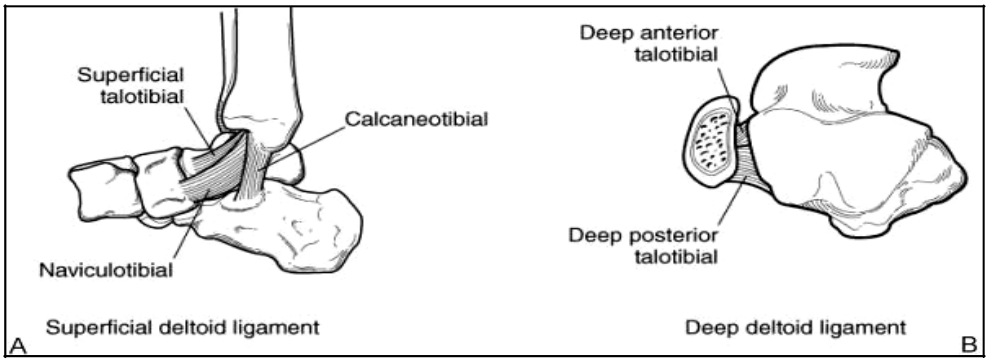


Fig 4 – medial collateral ligament

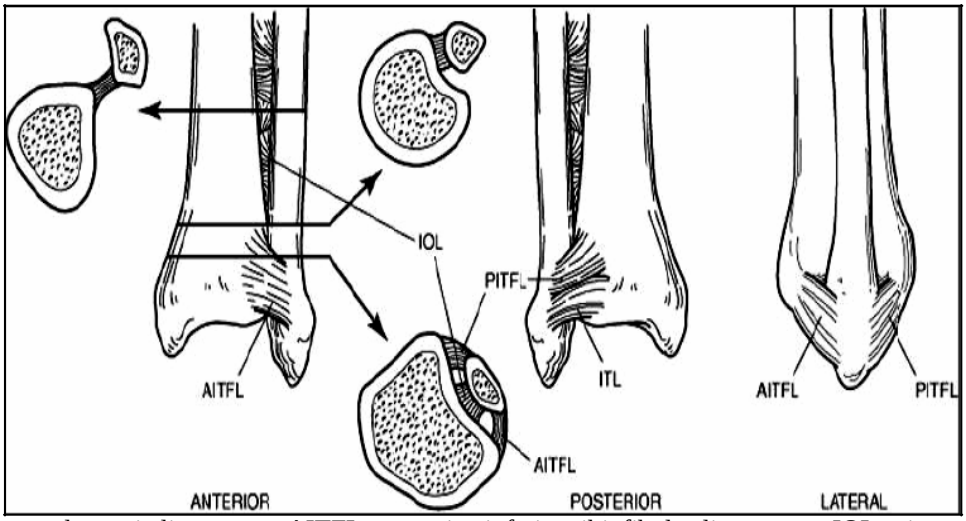


Fig – 5 – syndesmotic ligaments - AITFL = anterior inferior tibiofibular ligament IOL = interosseous ligament PITFL = posterior inferior tibiofibular ligament ITL = inferior transverse ligament

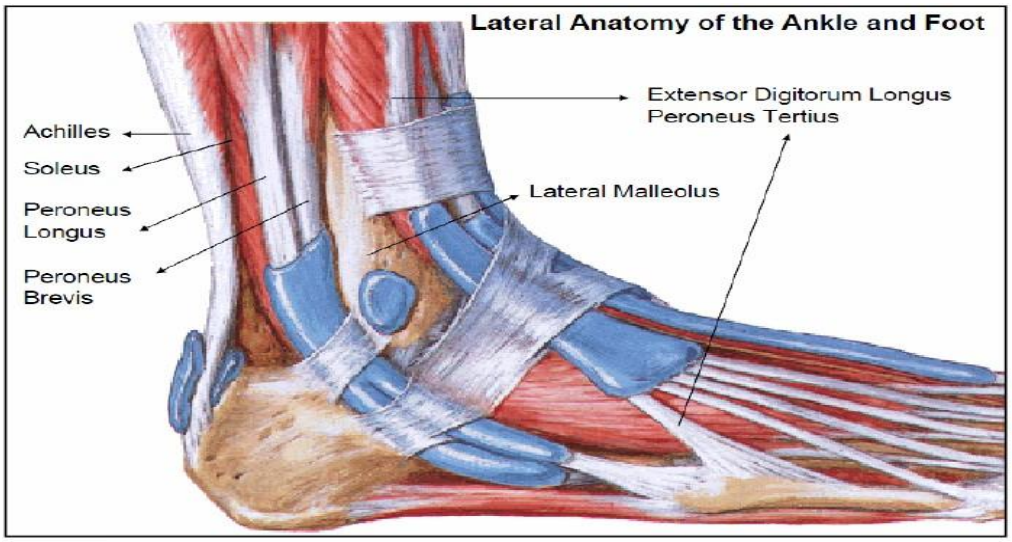


Fig 6 – lateral anatomy of foot and ankle

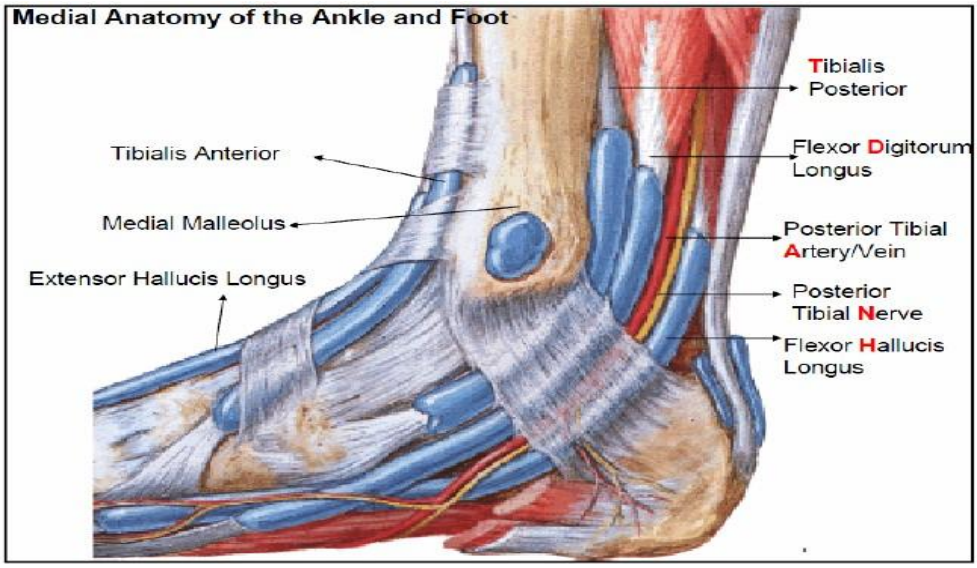


Fig 7 – medial anatomy of foot and ankle

Normal range of motion at ankle joint –

Sl. No.	Movements	Range of Movements in degree	Muscle Acting	Nerve Supply
1	Dorsiflexion	20-25	Tibilias anterior External digtorium longus External hallucis longus Peroneus tertius	Deep peroneal nerve
2	Plantarflexion	35-50	Tibialis posterior Flexor hallucis longus Flexor digitorum longus	Tibial nerve
3	Inversion	0-35	Tibialis anterior Tibialis posterior	Deep peroneal nerve Tibial nerve
4	Eversion	0-35	Peroneus longus Peroneus brevis	Superficial peroneal nerve

MECHANISM OF INJURY –

The ankle fractures occur as a result of strong rotational or predominantly axial Loading forces. The malleolar fractures are caused predominantly by rotational forces whereas axial loading causes tibial plafond fractures, predominantly.

The malleolar fractures primarily involve lateral or medial malleolus and often other parts of the ankle as well. Shearing and tensile forces apposed through the talus produce them indirectly. Most malleolar fractures occur when the part, including the talus, is fixed on the ground by the body's weight.

The type of malleolar fracture that occur depends on two factors the position of the foot at the time of injury, either supination or pronation, and the deforming force,which are external rotation, abduction or adduction . A relative bending moment is created with rotation either in the coronal plane, producing talar adduction or abduction relative to tibia or transverse plane causing relative internal rotation of the tibia on the talus. These injuries are referred to as external rotation injuries.

The initial position of the foot is important because it determines which structures are tought and therefore are most likely to be injured first. When the foot is pronated and the deltoid ligament is tense, the initial injury is medial- either a medial malleolar fracture or a deltoid ligament disruption will occur .The two most common injury patterns are the supination external rotation (SER) and the pronation external

LAUGE – HANSEN CLASSIFICATION

SUPINATION – ADDUCTION (SA):

1. Transverse avulsion–type fracture of the fibula below the level of the joint or tear of the lateral collateral ligaments.
2. Vertical fracture of the medial malleolus.

SUPINATION – EVERSON (EXTERNAL ROTATION) (SER):

1. Disruption of the anterior tibiofibular ligament.
2. Spiral oblique fracture of the distal fibula.
3. Disruption of the posterior tibiofibular ligament or fracture of the posterior malleolus.
4. Fracture of the medial malleolus or rupture of the deltoid ligament.

PRONATION – ABDUCTION (PA):

1. Transverse fracture of the medial malleolus or rupture of the deltoid ligament.
2. Rupture of the syndesmotic ligaments or avulsion fracture of their insertions.
3. Short, horizontal, oblique fracture of the fibula above the level of the joint.

PRONATION-EVERSION (EXTERNAL ROTATION) (PER):
1. Transverse fracture of the medial malleolus or disruption of the deltoid ligament.
2. Disruption of the anterior tibiofibular ligament.
3. Short oblique fracture of the fibula above the level of the joint.
4. Rupture of posterior tibiofibular ligament or avulsion fracture of the posterolateral tibia

PRONATION – DORSIFLEXION (PD):
1. Fracture of the medial malleolus.
2. Fracture of the anterior margin of tibia.
3. Supramalleolar fracture of the fibula.
4. Transverse fracture of the posterior tibial surface.

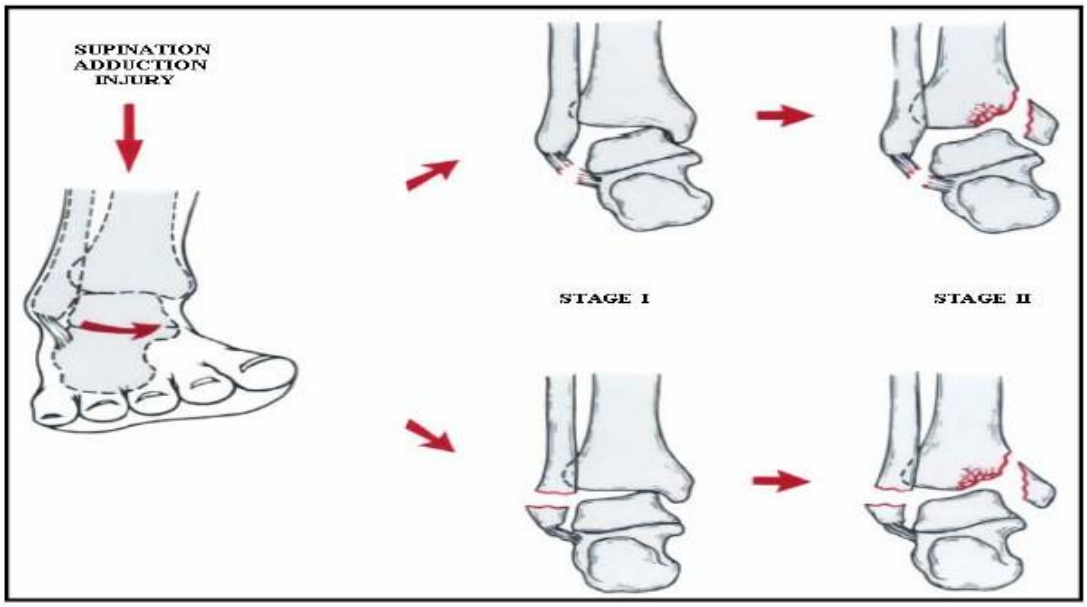


Fig 8 - Supination Adduction Injury

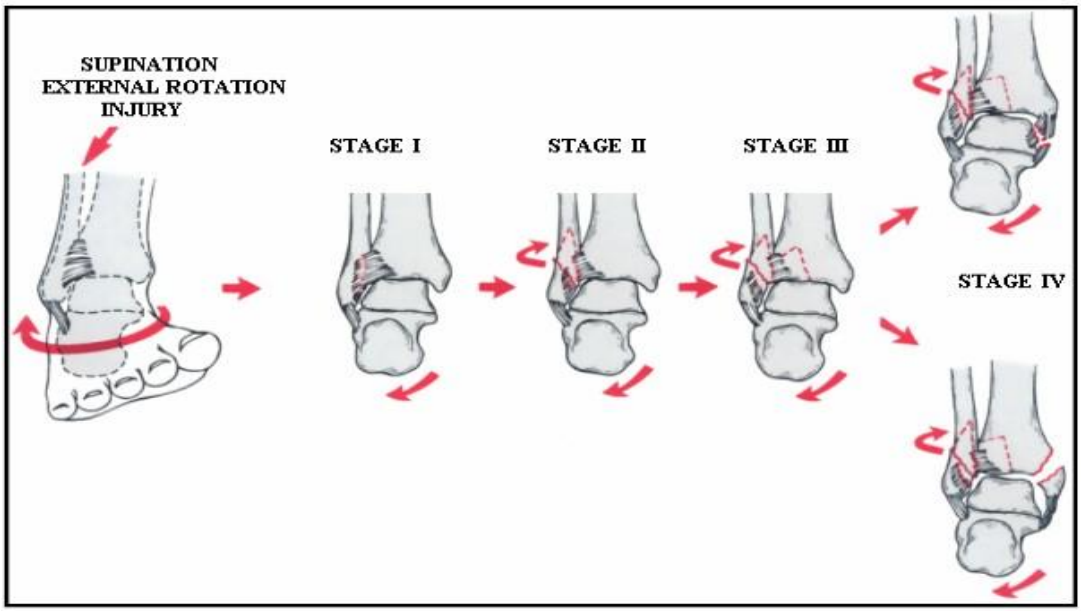


Fig 9 - Supination External Rotation Injury

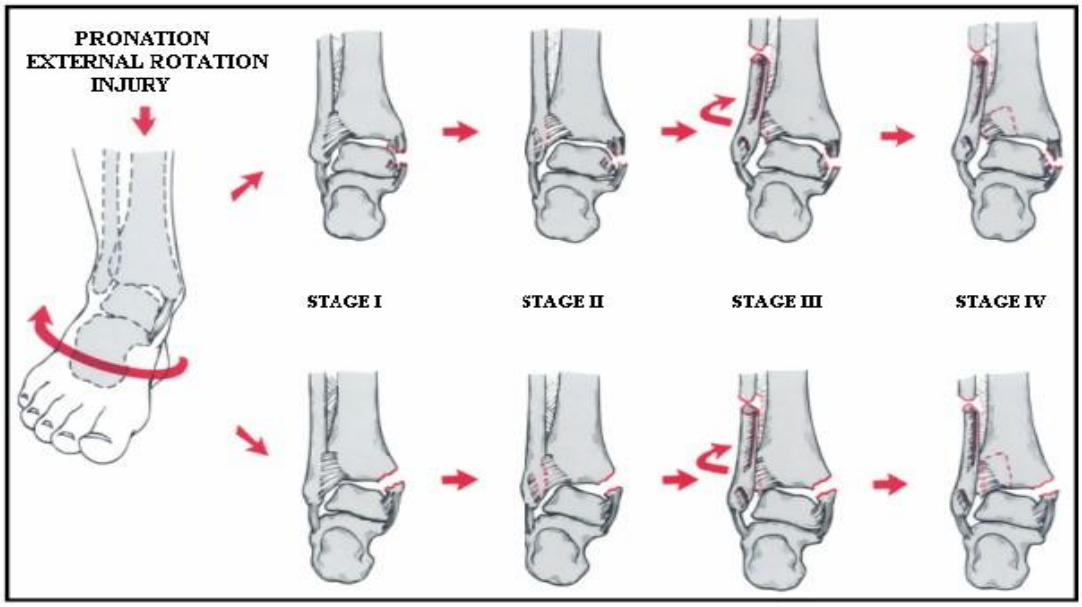


Fig 10 - Pronation External Rotation Injury

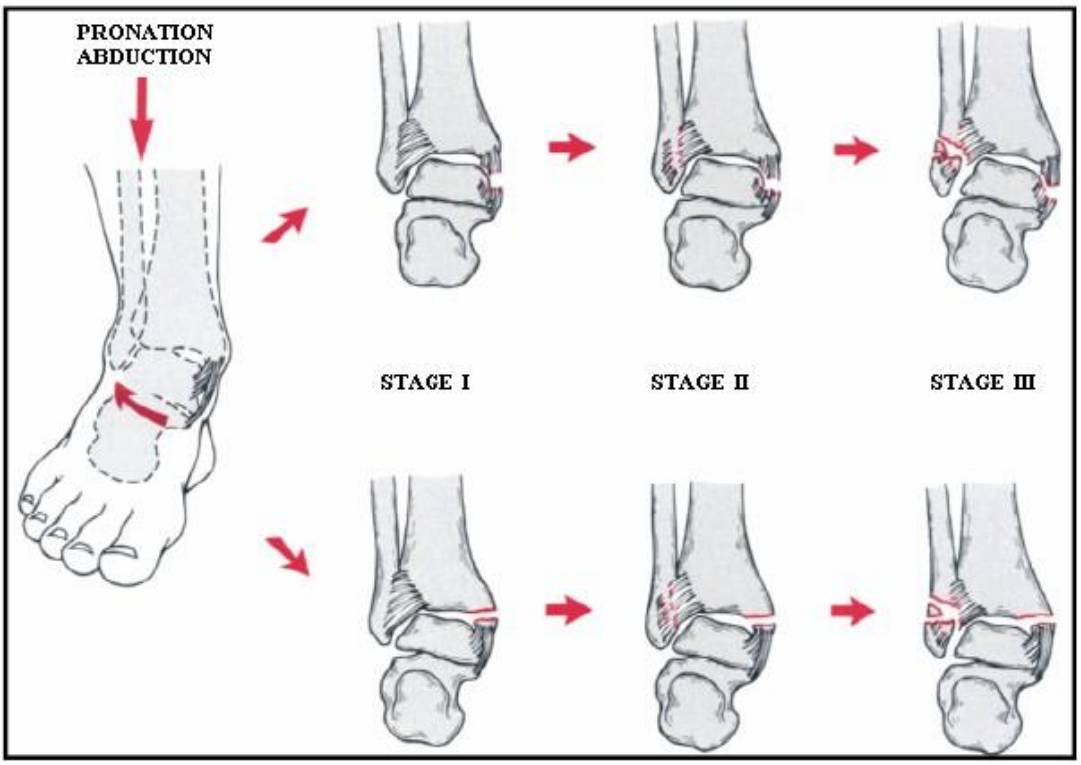


Fig 11 - Pronation Abduction Injury

DENIS WEBER CLASSIFICATION

The Danis – Weber system is based on the level of the fracture of the fibula. The risk of injury is greater to the syndesmosis, with more proximal fracture of the fibula,and the more likely that the joint will be unstable[34].

There are three types of fractures in this classification system. The fractures are categorized into types A, B and C, based on the level of the fibular fracture.Type "A"fractures are below the level of distal tibiofibular syndesmosis, "B" fractures at the level of the syndesmosis and "C" fractures above the syndesmosis[34].

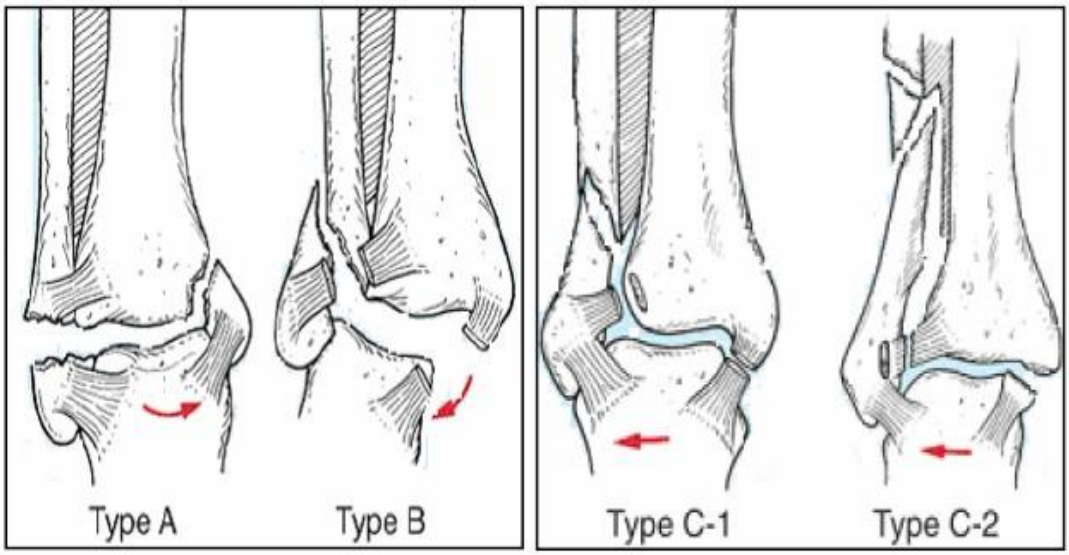


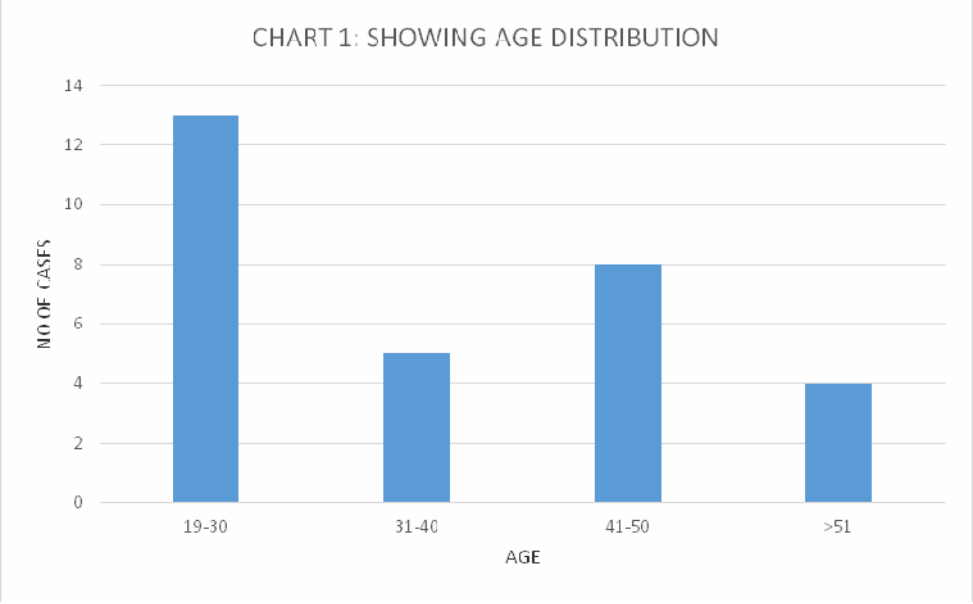
Fig 12 – denis weber classification

Injuries of the syndesmotic ligaments occur as a result of abduction or externalrotation of the talus within the ankle mortise. This mechanism most commonly occurs in association with pronation-externalrotation, pronation-abduction, and occasionally supination-external rotation injuries (type-C and some type – B injuries)[32].

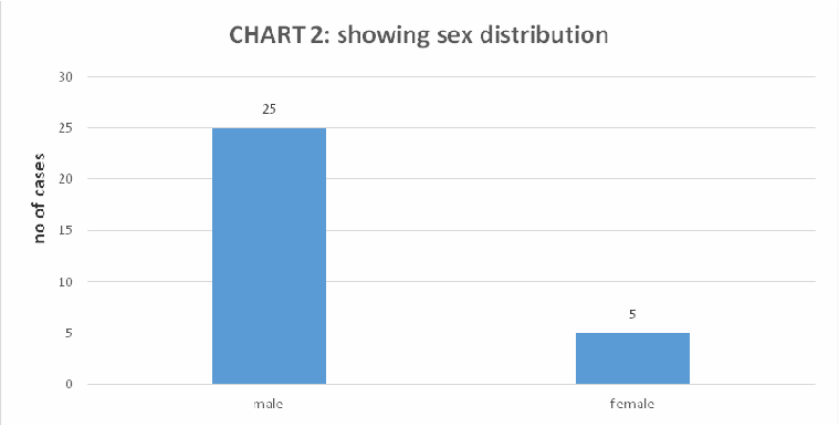
For a given foot position and the direction of the deforming force, the sequence of injured structure as the force increases is similar and reproducible. But it is important to recognize that in abduction and adduction fractures the direction of deforming force is translational rather than rotational. The supinated feet sustain adduction fractures and pronated feet sustain abduction fractures[32].

II. Materials And Methods

Total of 30 patients were included in this study, the youngest patient was 19 years old and the oldest one 80 years old



Out of these 5 were female and 25 male



Side – right side involvement 13, left side 17 cases.

The most common cause of injury was road traffic accidents and next were trivial falls. Inclusion Criteria :
• All closed fractures.
• Open type 1 , 2 , 3a (Gustillo-Anderson).
• Above 18 years.

Exclusion Criteria:
• With associated Pilon fracture.
• Patients unfit for surgery.
• Patients with minimally displaced mono-malleolar fractures, avulsion fractures and stable fractures

In the present study majority of the cases i.e. 14 (46.6 %) are supination external rotation injuries followed by pronation abduction injuries 10 (33.3%) cases.

LAUGE-HANSEN TYPES	NO OF CASES	PERCENTAGE
SER	14	46.6
SA	3	10
PA	10	33.3
PER	3	10

In this series most cases were operated between day 1 and day 3 (90%).
Lateral malleolus fracture was fixed with semitubular plate through direct lateral approach, and medial malleolus was fixed with 4.0 mm partially threaded cancellous screw or malleolar screw.
Syndesmotic 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 about 1.5 to 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 4 to 8 weeks, weight-bearing was delayed till screw removal.

Post – Operative Protocol:

Parenteral antibiotics were given in the post-op period for 3-5 days according to the wound condition. After 10 to 12 days, the sutures were removed and a below knee cast was applied for 4 weeks. Non-weight bearing gait was started from first or the second postoperative day. Partial weight bearing was started after the removal of the cast (after clinical and radiological signs of union become evident).Active exercises of the ankle was advised.

In patients with syndesmotic 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 assessment, all patients were questioned with regard to pain, use of analgesics, stiffness, swelling, activities of daily living, use of walking aids, and return to work and participation in sports. At examination, the gait, any thickening, swelling, tenderness of the ankle and the range of motion of the ankle were evaluated. Anteroposterior, lateral and mortise radiographs of ankle were made at the time of examination. Baird and Jackson's ankle scoring system of subjective, objective and radiographic criteria was used for the study. All the patients were evaluated and Scores were given.

III. Results

Excellent results were achieved in 18 cases (60 %), good in 8 cases (26.6%), fair in 2 cases (6.6 %), poor in 2 cases (6.6 %). Excellent results were seen in most of the bi malleolar fractures, 4 patients who had fair to poor results were seen in cases with delayed union of medial malleolus , superficial and deep infection. The patients who had poor results had mild pain during their activities of daily living, diminution in their ability to run and do work, reduced motion of ankle and narrowing of joint space.

FUNCTIONAL SCORE	NO OF CASES	PERCENTAGE
EXCELLENT	18	60
GOOD	8	26.6
FAIR	2	6.6
POOR	2	6.6

IV. Discussion

There has been gradual evolution in management of ankle fractures due to improved analysis of biomechanics, improvement in fixation techniques and analysis of results of recent studies. The goal of treatment is to provide fracture union with painless full motion of ankle and with anatomical restoration of the injured ankle.

Closed method of treatment is often inadequate in restoring the anatomy and biomechanics of ankle in unstable malleolar ankle fractures. Conversely, open reduction with internal fixation is an excellent method for restoration of normal anatomy of joint. Several studies indicated that, internal fixation of displaced malleolar fractures of ankle provides better results

The treatment of malleolar fractures with accurate open reduction and stable internal fixation using AO method and principles was found to give a higher percentage of excellent and good results[15]. This study supports these conclusions.

In the current study, we have 30 patients with bimalleolar ankle fractures, who were operated upon. All patients were followed up with minimum period of 6 months

In this present study, Lauge-Hansen classification system was used for operative evaluation. The most common type of injury was supination-external rotation (46.6%), followed by pronation-abduction injury (33.3%), in accordance with by Roberts RS, Beris et al, Baird and Jackson

The results in current study were compared with that of Burnwell & Charnley[41],Colton[46]**,** De souza et al**Error! Bookmark not defined.**, Beris et al[15] .

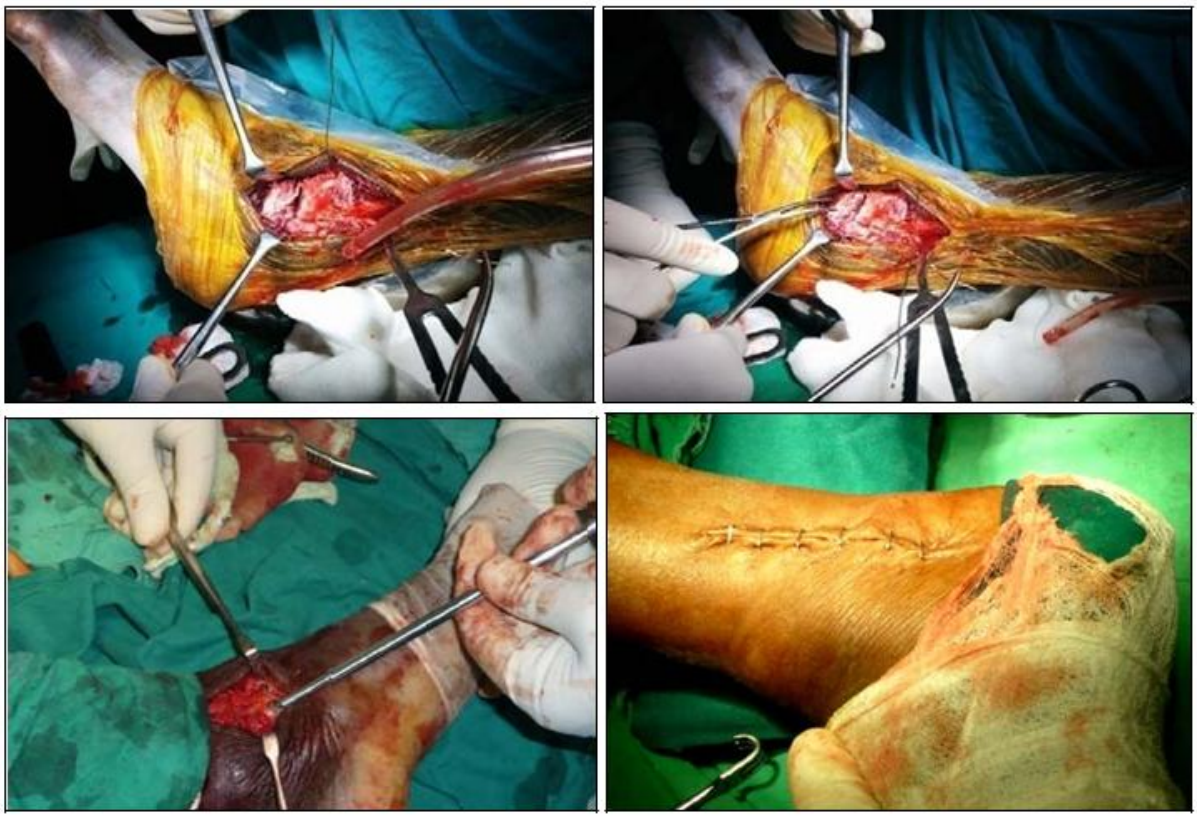
In Colton**Error! Bookmark not defined.** series, 70% of the patients had a good to excellent results. Burnwell &Charnley[41] in their series of 132 patients, 102 (77.3%) had good results, 16% had fair results and 6% were found to poor score.

In De souza[42] series, 150 cases of ankle fractures treated by open reduction and internal fixation using AO/ASIF method, obtained 90% good results. In a study by Beris et al[15], of 144 patients with ankle fractures, 105 (74.3%) had good to excellent results.

The functional results of the present study were comparable with that of the above cited studies, with 86.6% had good to excellent results, 6.6% had fair results and poor results in 6.6%.

MEDIAL MALLEOLUS FRACTURE FIXATION

FIGURE- 13-INTRA OP PHOTOGRAPHS



LATERAL MALLEOLUS FRACTURE FIXATION
FIGURE- 14- intra op photographs

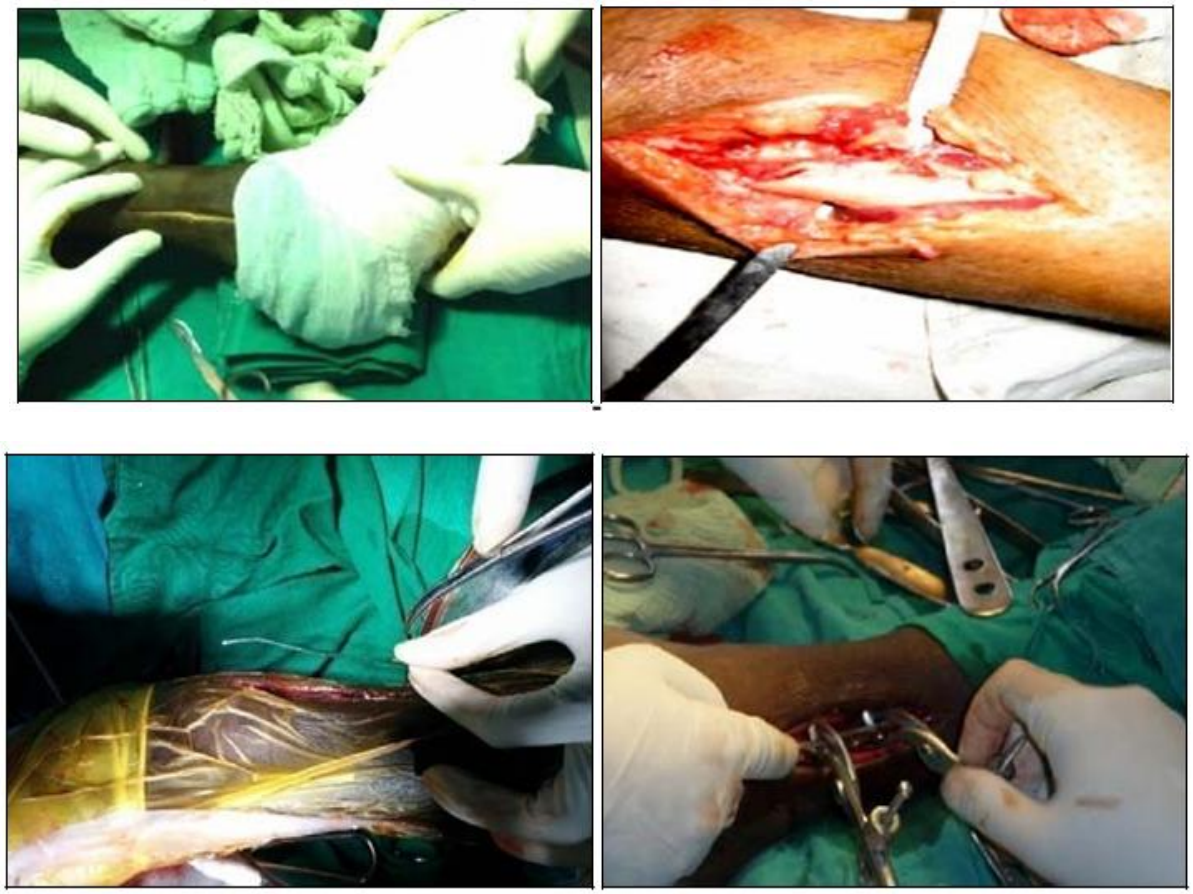



FIG 15-below knee cast after suture removal

FIGURE 16 - SKIAGRAMS


PRE OP IMMEDIATE POST OP

UNION AT 10 WEEKS

UNION AT 6 MONTHS

FIG 17 - ANKLE ROM

V. Conclusion

The operative results were satisfactory in 86.6% cases, with good to excellent functional outcome.

• Excellent results are obtained with stable fixation of fracture. Cancellous screws or malleolar screws are better in internal fixation of medial malleolus and lateral plating was the best for fibular fractures.

• Good functional results are obtained by surgical management of bimalleolar ankle fractures. Early weight bearing and mobilisation is achieved in these patients.

• Anatomical reduction with restoration of the articular congruence is essential in all intra articular fractures, more so, if a weight bearing joint like ankle is involved. Open reduction and internal fixation restores the articular congruity of the ankle joint.

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