OUTCOME ANALYSIS OF OPEN FRACTURES OF

THE ANKLE JOINT

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CERTIFICATE

This is to certify that this dissertation titled "**OUTCOME ANALYSIS OF OPEN FRACTURES OF THE ANKLE JOINT "** is a bonafide record of work done by DR.SANTHANA KUMARAN.D during the period of his Post graduate study from June 2014 to June 2017 under guidance and supervision in the INSTITUTE OF ORTHOPAEDICS AND TRAUMATOLOGY, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai-600003, in partial fulfillment of the requirement for M.S.ORTHOPAEDIC SURGERY degree Examination of The Tamilnadu Dr. M.G.R. Medical University to be held in April 2017.

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DECLARATION

I declare that the dissertation entitled "**OUTCOME ANALYSIS OF OPEN FRACTURES OF THE ANKLE JOINT"** submitted by me for the degree of M.S is the record work carried out by me during the period of March2016 to Auguest 2016 under the guidance of Prof. M.Sudheer M.S.Ortho, D. Ortho., Professor of Orthopaedics, Institute of Orthopaedics and traumatology, Madras Medical College, Chennai. This dissertation is submitted to the Tamilnadu Dr.M.G.R. Medical University, Chennai, in partial fulfilment of the University regulations for the award of degree of M.S. ORTHOPAEDICS (BRANCH-II)) examination to be held in April 2017.

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CONTENTS

INTRODUCTION

Fractures of the ankle joint are the second most common lower limb fractures after the hip fractures and they represent 10 % of all fractures with an incidence of around 137 per 1,00,000 persons per year .Around 2% of ankle fractures are open fractures .[1,2]

Ankle fractures have a bimodal distribution with peak incidences in younger men and older women[2,3] , however below the age of 50 years ankle fractures are common in men . These are typically low energy injuries with majority occurring due to simple falls or sport . Even open ankle fractures are low energy injuries due to simple falls in elderly women . The most common causes are injuries due to twist and falls followed by sports injuries.

A fracture presents with a wound over the fracture site resulting in a communication between fracture and outside environment due to damage to the skin and underlying soft tissues is an Open fracture. The effective treatment of open fractures aims at prevention of infection , promotion of fracture healing and prevention of complications with restoration of normal function".[4]

The prognosis in the outcome of open fractures is determined by the type of skin and soft tissue injuries caused by the amount of energy at the time of

injury itself. The soft tissue loss including skin and bone loss is significant in some open fractures, either from initial injury and during subsequent wound debridement. The restoration of joint congruity, wound closure and fracture healing will be difficult in these fractures. Hence these fractures often end with poor results.

Open injuries around the ankle joint cause destruction of not only the bony architecture but also often the ligamentous and soft tissue components including skin. Only a slight variation from the normal anatomy of the ankle mortice after fracture reduction results in normal joint function in these fractures. Hence the treatment goals should be aimed at

- " the restoration of ankle mortice to near normal anatomy,
- the weight-bearing alignment of the ankle must be maintained in such a way that it should be at a right angle to the longitudinal axis of the leg, and
- the satisfactory reduction of contours of the articular surface."

The best method used to accomplish this will be open reduction and internal fixation (ORIF) by restoration of the normal anatomy of the ankle.

The advantages of primary internal fixation of open ankle fractures, including Gustilo type III wounds, compared with either closed immobilization with delayed fixation or immediate provisional fixation with Kirschner wires is

evidenced by several studies . We also prefer immediate internal fixation after surgical debridement in GrI & GrII open fractures within 24 hours. A temporary external fixator can be placed spanning the ankle if the wound is severely is contaminated and open reduction can be done when the wound is judged to be clean and swelling has decreased.

Ngcelwane et al [5] stated that " dirt and grass at the syndesmosis in some medial wounds, possibly sucked in by the vacuum created by dislocation of the ankle and he recommended a lateral incision for cross irrigation, especially for displaced Danis-Weber types B and C fractures with gas shadows".

A temporary external fixator that spans the ankle joint can be used to make wound care easier in addition to internal fixation. The fixator can be removed when soft tissue healing is complete.

Wiss et al.[6] pointed out that " Although most patients (80%) can be expected to return to work after the fracture has healed, only 18% return to their pre injury recreational level. The rate of deep infection in open ankle fractures is approximately 5%. Open ankle fractures, especially fracture-dislocations, in diabetic patients, especially patients with neuropathy, are problematic and frequently become infected or have hardware failure, sometimes resulting in amputation. Supplemental external fixation is advisable in these patients."

AIM OF THE STUDY

To study the functional and radiological outcome of open ankle fractures treated by various treatment modalities.

REVIEW OF LITERATURE

FRANKLIN JL et al 1984 , JBJS [7] - stated that " we reviewed thirty-eight cases of open ankle fractures that had been treated with a standard protocol of immediate rigid anatomical internal fixation, and delayed primary closure at five days, after alignment and splinting of the fracture at the scene of injury if possible, antibiotics administered in the emergency room and continued for forty-eight hours, admission of the patient to the operating room as quickly as possible, copious irrigation and thorough debridement of the wound and we concluded that all of the fractures united, but three patients required subsequent ankle fusion because of cartilage damage noted at the initial operation. Of the thirty-five ankles with complete follow-up, the functional result was excellent in twenty-six and fair or poor in nine."

WISS et al[6] – "Journal of orthopedic trauma 1988" stated that "We believe immediate internal fixation is the treatment of choice for displaced open ankle fractures, but this form of treatment does have a significant rate of complications."

BRAY et al [8]– "clinical orthopedic related research (CORR) 1989" concluded that "The fractures treated with immediate open reduction and internal

fixation showed less impairment of range of motion but had a greater incidence of chronic ankle swelling .” and also stated that “The hospitalization time was significantly shorter for the patients treated by open reduction and internal fixation. Immediate open reduction and internal fixation of open ankle fractures speed recovery with no greater incidence of infection than encountered with conservative treatment.”

NGCELWANE et al [5]– “ INJURY 1990” stated that “An interesting observation, in some of the displaced fractures, was the presence of debris far removed from the site of the wound. This was obviously sucked in during the mechanism of the injury.”

SANDERS et al[9] – “ JOT (Journal of orthopedic trauma) 1992 – (The Salvage of Open Grade IIIB Ankle and Talus Fractures)” stated that “Although fusion and eradication of infection in this specific group of patients was possible, significant functional and psychosocial disability remained and Patients with open grade IIIB tibiotalar injuries with significant bone loss may therefore benefit from early amputation.”

JOHNSON et al [10]– CORR 1993 “(Open ankle fractures - The indications for immediate open reduction and internal fixation)” - “Twenty-two patients with open ankle fractures or fracture-dislocations were treated with

irrigation and debridement, reduction, and immediate stable internal fixation at an average of six hours from initial evaluation" and they concluded that " Immediate debridement, irrigation, reduction, and internal fixation of open ankle fractures is clearly indicated in Grade I and clean Grade II open injuries."

WHITE et al [11]– " CORR 2003 (Open ankle fractures in patients with diabetes mellitus)" stated that " Open ankle fractures in patients with diabetes are limb-threatening injuries with high amputation and infection rates despite contemporary techniques of open reduction and internal fixation, intravenous antibiotics, and emergent irrigation and debridement."

JOSHI et al[12] – "Journal of American podiatric medical association (JAPMA) March 2006" stated that "Immediate debridement, anatomical reduction, and internal fixation of open ankle fractures leads to better functional results, especially in grade I and grade II injuries."

LEE et al [13] 2008 - stated that " we reported Forty-seven patients with open lateral malleolar (AO type-B2) fractures treated with copious irrigation and radical debridement, reduction, and immediate fixation by Knowles pins or lateral plates and both the groups have shown excellent and good results" .

HULSKER et al [14] "Archives of Orthopedic and Trauma Surgery (AOTS) November 2011, 131:1545" , stated that " We have performed a

systematic review of the literature concerning the clinical results and complication rates in the treatment of open ankle fractures." They also stated that " From 1968 to April 2010 all studies searched and identified in relation to the treatment of open ankle fractures. Fifteen articles concerning 498 patients with treatment of an open ankle fracture were identified. The number of included patients varied from 11 to 64. There were 2 prospective and 13 retrospective studies. All articles were case series and classified as Level IV evidence and we have formulated a treatment guidelines based on the existing literature" . The guidelines are

- In emergency room all debris and contamination from all wounds should be removed.
- Antibiotics should be administered in the emergency department without delay preferably cephalosporins. Wound swabs need not be taken before administering antibiotics as initial swabs taken do not represent the microbes that eventually cause infection.
- The optimal duration of antibiotic treatment should be individualized.
- All Patients should be taken to the theatre within 24 hours.
- Thorough debridement of all devitalized tissues, irrigation of the wound should be carried out with caution.

- The use of tourniquets during debridement is controversial, however tourniquet use in a open wound without vascular insult minimize the blood loss , and identification of devitalized tissues and dirt made easy.
- With the aim of restoring the anatomy of ankle mortise and preventing long-term secondary degenerative changes resulting in pain and stiffness primary open reduction and internal fixation (ORIF) should be tried in all cases of open ankle fractures . Only when there is inadequate soft tissue and skin to cover osteosynthesis materials, external fixation should be considered .
- Grade I wounds - if the wound is not under tension it can be closed primarily or left open to heal by secondary intention .
- Grade II wounds - should be left to heal by secondary intention, or be closed primarily at a later time when the wound is free of infection in post operative period.
- Grade IIIA, IIIB wounds- should be left open , and managed postoperatively either by skin grafts or free flaps or combined methods depending upon the wound condition.

SURGICAL ANATOMY

The Ankle joint functions as a mortise with the body of the talus articulating with a confluent area of the tibia consisting of the tibial plafond (ceiling) superiorly, and the medial malleolus medially and a dorsal projection of the tibia, the posterior malleolus, serves to enlarge this confluent area. The lateral articulation of the talus is with the distal fibula. The articular surfaces shares in load distribution during weight bearing, with the fibula, for example, taking 1/6th of the load. [15,16]

The medial malleolus is both shorter and more anterior, and thus the axis of the joint is in 15 degrees of external rotation. The tibial and fibular articular surfaces together comprise the mortise in which the talus sits.(fig -1) The relationship between the tibia and fibula centers on the syndesmosis where the fibula lies in the incisura of the lateral aspect of the tibia, and is stabilized by the anterior-inferior tibio fibular ligament (AITFL), the posterior-inferior tibio fibular ligament (PITFL), and the interosseous ligament which is confluent

with the interosseous membrane above .(fig -2) The AITFL arises from a prominence of the anterolateral tibia known as the tubercle of Chaput (which may be avulsed, typically in children ankle injuries), and inserts onto an equivalent prominence on the fibula: The tubercle of Wagstaffe.

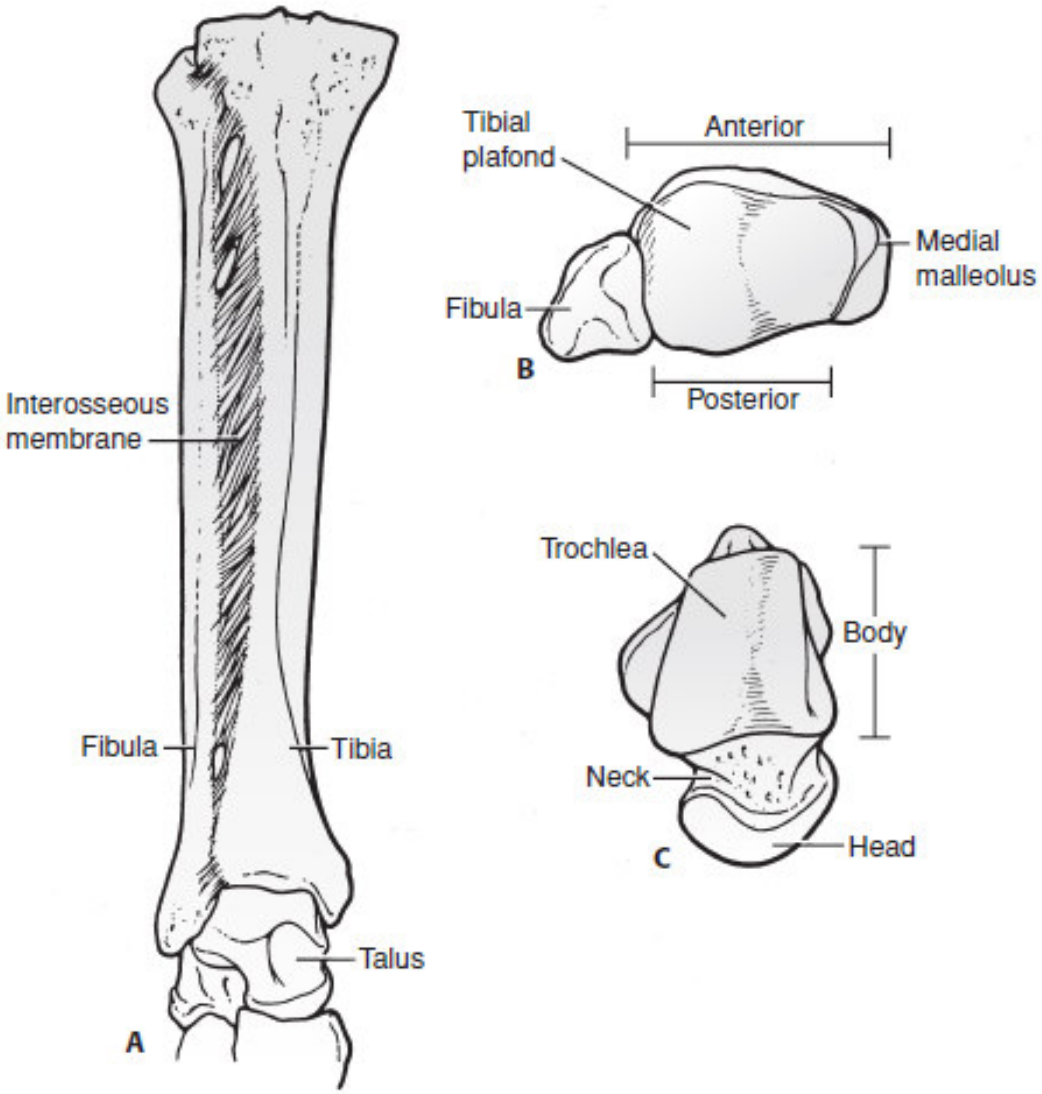


FIGURE -1 BONY ANATOMY OF THE ANKLE. Ankle mortise view(A),

the tibio fibular side of the joint –(inferio-superior view) B,

superior– inferior view of the talus (C).

The ankle joint is a joint of three articulating bones with a larger talar articular surface and tibio fibular articular surface. The lateral circumference of the talar dome is larger than the medial circumference. The dome is anteriorly wider than posteriorly

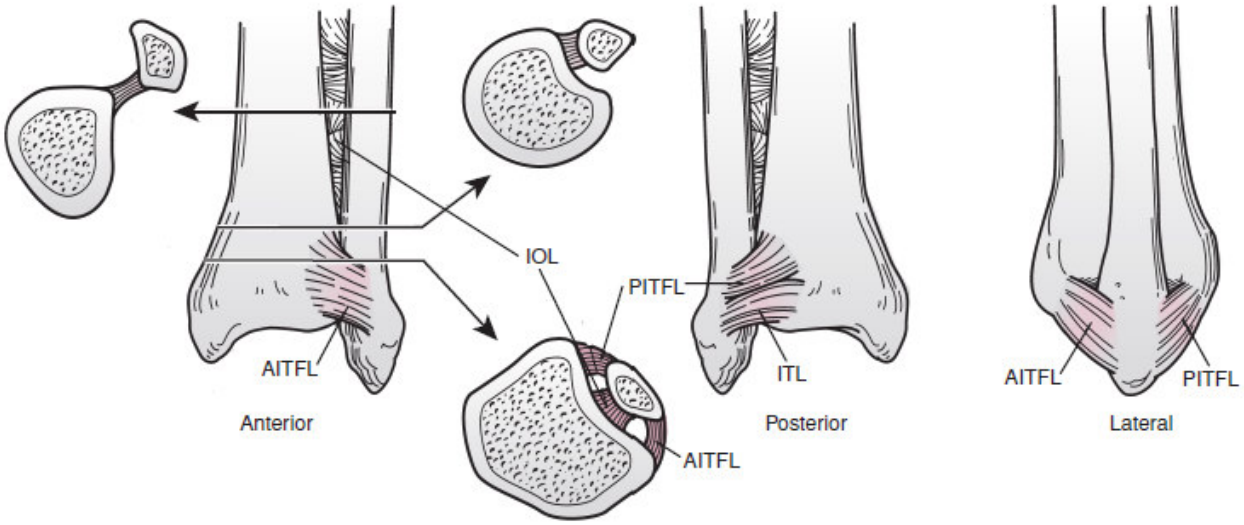


Figure -2 The views of the tibio fibular syndesmotic ligaments. (3 views) Anteriorly, the AITFL - from the anterior tubercle and anterolateral surface of the tibia to the anterior fibula.

Posteriorly, the tibio fibular ligament has two components: The superficial PITFL, which is attached from the fibula across to the posterior tibia, and the thick, strong ITL, which constitutes the posterior labrum of the ankle. Between the anterior and PITFLs resides the stout interosseous ligament (IOL).

The PITFL arises from Volkmann's tubercle of the posterior malleolus. It is extremely strong and in tri malleolar fractures the fragment usually remains solidly attached to the fibula via this ligament. This relationship can be exploited surgically, reduction of the distal fibula usually assists in reduction of the posterior malleolus, and stabilization of the posterior malleolus will often restore stability to a fractured fibula.[17,18]

The talus itself is remarkable that its surface is 70% covered in articular cartilage, it has no direct ligamentous attachments for muscle action and it has a tenuous retrograde vascular supply. The body of the talus is geometrically complex and describes a frustum, a cone with its apex removed, lying transversely in the mortise, being broader anteriorly and narrower posteriorly. This complex shape prevents the medial and lateral facets of the talus, and their relationships with their respective malleoli, from being seen on any single radiographic projection and this results in considerable uncertainty when attempting to measure joint spaces. As a result of its frustral shape, the talus is compressed within the mortise of the ankle in dorsiflexion (the position of heel strike), causing the fibula to rotate externally, and is most stable in this position.

In plantar flexion (at toe off) the talus is held less rigidly, allowing physiologic external rotation and inversion.[19] Osseous stability of the ankle increases with axial loading, when the congruency of the articular surfaces provides very substantial stability even after division of all ligamentous restraints.[20,21]

The superior surface of the talus (the talar dome), conforms closely to the plafond of the tibia, and the contact area between the two surfaces decreases markedly with displacement of the talus. Ramsey and Hamilton's[22] famous study reported a decrease in contact area of 42% after just 1 mm of lateral talar displacement. Although this study has been criticized, and the precise relationship between displacement, contact area, and contact pressure remain contentious, it is widely accepted that loss of congruence of the mortise leads to altered biomechanical loading and is principally responsible for the poor outcomes observed in patients with residual displacement of the talus after ankle fracture.

The stability of the ankle is enhanced by its capsule and ligaments. Medially, the deltoid (medial collateral) ligament has two components.(Fig -3)The superficial deltoid ligament arises from the anterior colliculus of the malleolus and extends in a broad fan shape to insert into the talus,

navicular, and the sustentaculum of the calcaneus. This insertion is continuous with the tendon sheaths of the tibialis posterior and flexor hallucis longus tendons.

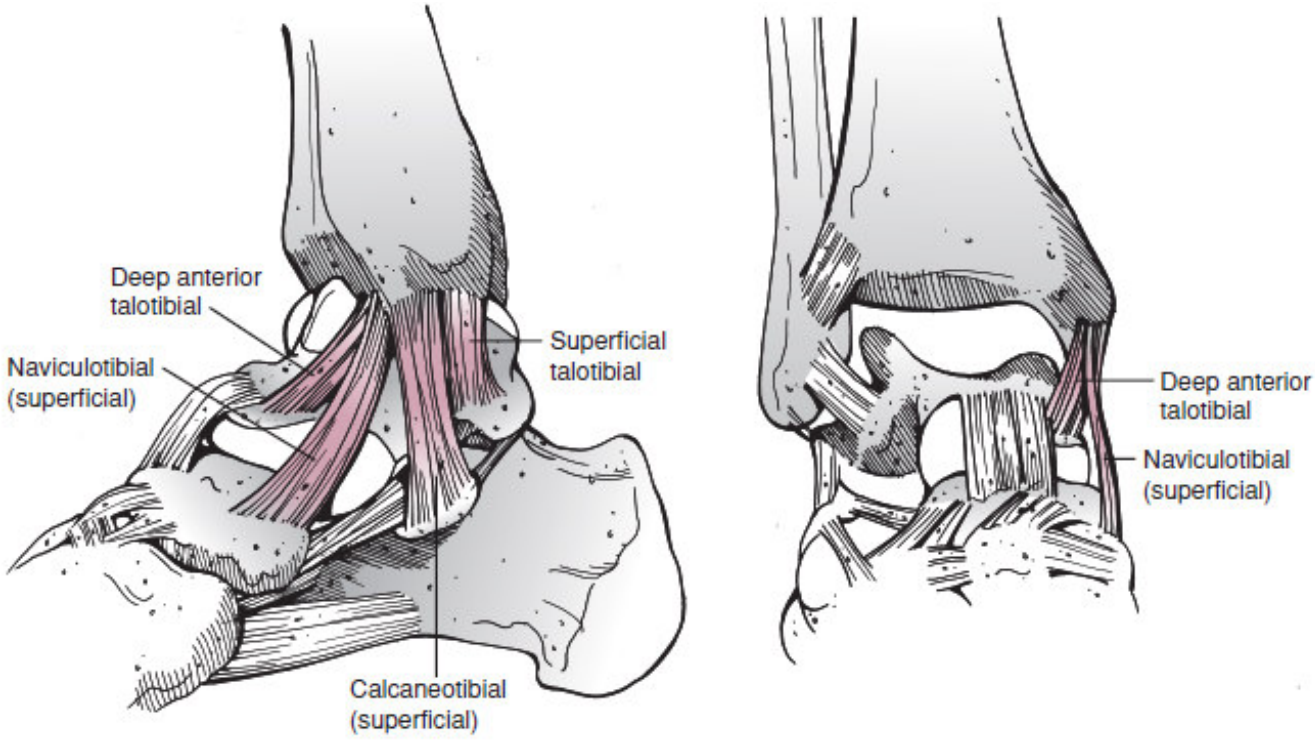


Figure – 3 The deltoid ligament and its individual components.

The deep deltoid ligament is intra articular and extends from the posterior colliculus (and intercollicular groove) of the malleolus to the dome of the talus. It is the deep component that is important in restraining the talus against lateral displacement and rotation, and it is the focus of much interest and research.

The lateral collateral ligamentous complex consists of three defined ligaments. The anterior talo fibular ligament (ATFL) is the weakest of these and is commonly injured in ankle sprains. The posterior talofibular ligament (PTFL) extends backward from the tip of the fibula, and between these two the fibulocalcaneal ligament (FCL) passes vertically down to an insertion on the lateral aspect of the calcaneus. (fig – 4)

The ankle is therefore considered to have three important static stabilizers: The medial and lateral osteo ligamentous complexes and the syndesmosis. The relative importance of these stabilizers has been widely debated, but it is clear that each has an important role.[19] A useful simplification is that two out of the three complexes should be intact for the ankle to be stable. Whereas the static stabilizers of the ankle have been widely characterized in cadaveric studies, it is clear that they have an uncertain relevance to the clinical situation, and this is partly explained by our relatively poor understanding of the dynamic stability of the ankle.

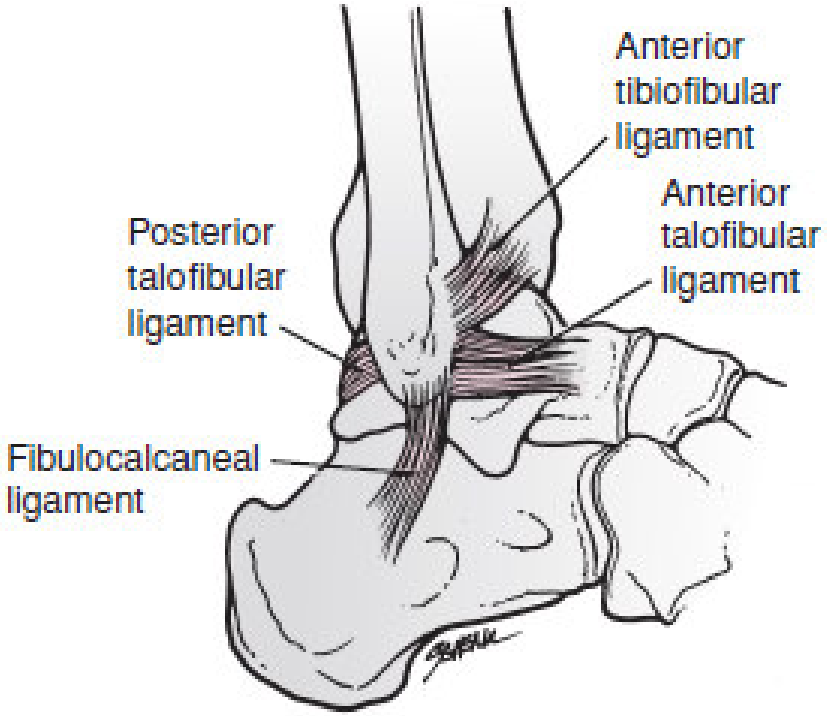


Figure -4 (Anatomy of lateral ligamentous complex)

Axial loading changes the behavior of the ankle, increasing the restraining effect of bony congruity and making the ankle stiffer. Moreover, six important musculo tendinous groups cross the ankle joint which act to stabilize as well as move the ankle. Four of these units are placed at the four “corners” of the ankle joint and act in concert. The tibialis anterior acts to dorsiflex the ankle along with the peroneus tertius, and to invert the ankle along with tibialis posterior, whilst

peroneus longus and brevis act to plantarflex with tibialis posterior and to evert with peroneus tertius.

Dynamic stability is provided by antagonistic contraction of these groups of muscles. Power and stability are augmented by the action of two further units: Dorsiflexion by extensor digitorum longus and extensor hallucis longus, and plantarflexion by the triceps surae (gastrocnemius and soleus), plantaris, flexor hallucis longus, and flexor digitorum.

Michelson demonstrated that even when both the medial and lateral osteo ligamentous complexes are completely de functioned by injury, the talus is Surprisingly stable: Its range of movement in relation to the mortise during the gait cycle in each of the coronal, sagital, and transverse planes is no more than a single degree in excess of that of intact ankles. The concept of dynamic instability is highly important when considering the nature of ankle injury and repair.

Structures crossing the ankle joint anteriorly pass under the superior extensor retinaculum proximal to the ankle and the Y-shaped inferior retinaculum distal to the joint.(Fig -5)Tibialis anterior passes most medially and extensor

hallucis longus passes adjacent to it. A safe plane for an anterior surgical approach to the ankle lies between these tendons. Lateral to the extensor hallucis lie the deep peroneal nerve and the dorsalis pedis artery, and then the tendons of extensor digitorum longus and peroneus tertius. The tendons, and the superficial peroneal

nerve which lies in the subcutaneous plane, can often be seen and palpated with the ankle and toes maximally dorsiflexed. Laterally, the peronei lie deep to the peroneal retinaculum immediately posterior to the fibula. The retinaculum may be

ruptured here resulting in tendon subluxation. The superficial peroneal nerve emerges from the deep fascia at a variable point in the distal third of the leg before dividing: A substantial branch has been reported to lie within 5 mm of the fibula in 50% cases when measured at 10 cm from the lateral malleolar tip and in 20% cases at 5 cm from the tip[23], leaving it vulnerable to injury in the lateral approach to the fibula. In the subcutaneous plane, the sural nerve lies in a variable position

approximately two-thirds of the way between the distal fibula and the tendo Achilles. Medially, a number of structures run posterior to the medial malleolus under the lacinate ligament, (which forms the tarsal tunnel) and their constant relationship from anterior to posterior is : Tibialis posterior, flexor digitorum, the tibialis posterior artery and vein, posterior tibial nerve, and flexor hallucis longus.

Superficially in the subcutaneous plane, the great saphenous vein and nerve pass immediately anterior to the medial malleolus .

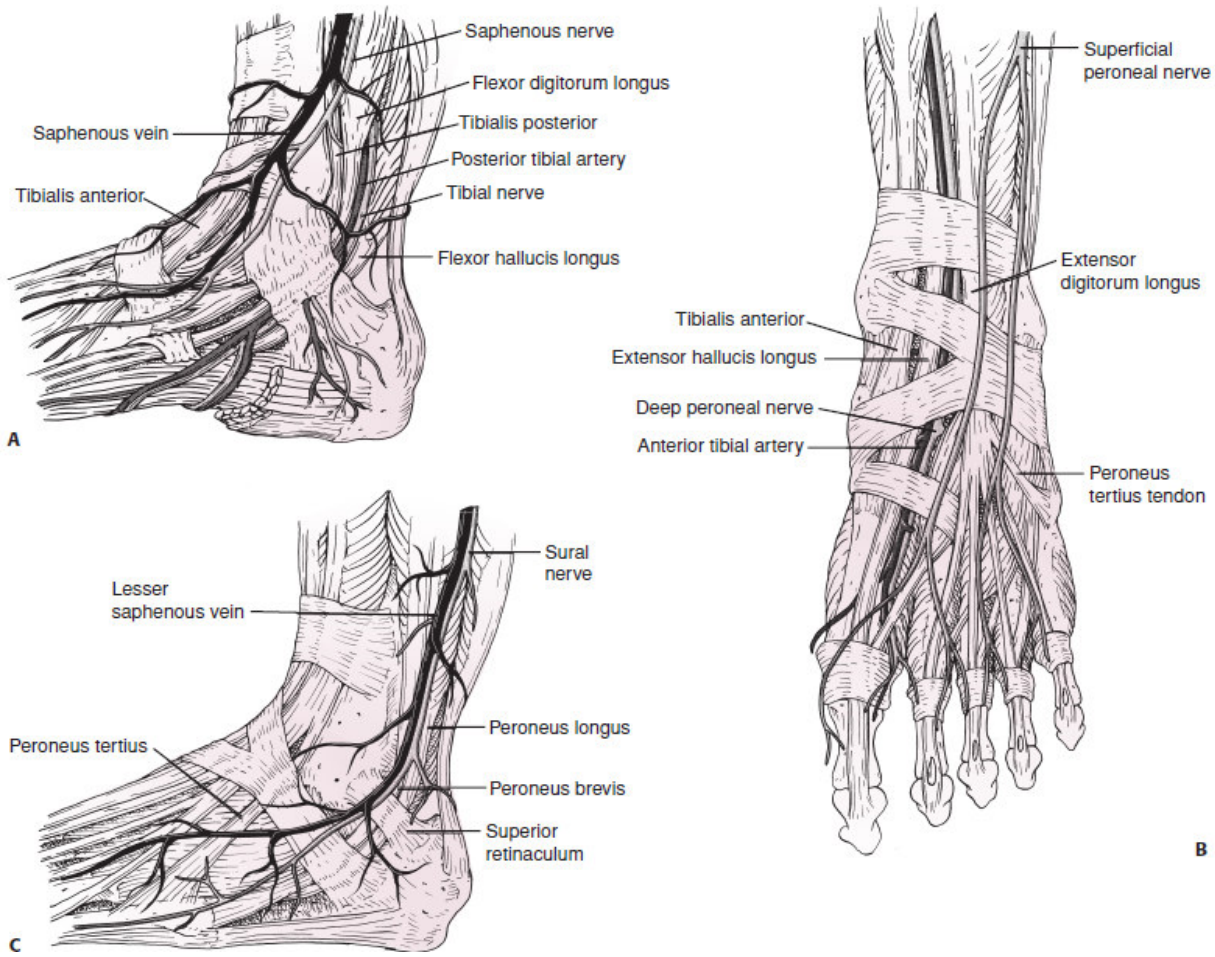


Figure -5 A: Structures crossing the medial ankle. B: Structures crossing the anterior ankle. C: Structures crossing the lateral ankle.

CLASSIFICATIONS

OPEN FRACTURES CLASSIFICATION

The importance of classification of open fractures lies in the fact that it allows communication between surgeons and comparison of results in scientific publications. At the time of debridement of the traumatic wound is the optimal time to classify and it also gives the surgeon guidelines for prognosis and to make some decision statements in the management of open wounds.

The most widely accepted and quoted is “the wound classification system of Gustilo and Anderson” and “the subsequent modification by Gustilo et al” followed in most parts of the world. Although there is wide inter observer variation in the interpretation and use of the Gustilo Anderson classification it is widely used. The modified classification is based on “ the size of the wound, periosteal soft tissue damage, periosteal stripping, and vascular injury .”

“ GUSTILO ANDERSON’S CLASSIFICATION[24, 25]

GRADE I: Clean skin opening of <1 cm, usually from inside to outside; minimal muscle contusion; simple transverse or short oblique fractures.

GRADE II: Laceration >1 cm long, with extensive soft tissue damage; minimal to moderate crushing component; simple transverse or short oblique fractures with minimal comminution.

GRADE III: Extensive soft tissue damage, including muscles, skin, and neurovascular structures; often a high-energy injury with a severe crushing component.

IIIA: Extensive soft tissue laceration, adequate bone coverage. segmental fractures, gunshot injuries, minimal periosteal stripping.

IIIB: Extensive soft tissue injury with periosteal stripping and bone exposure requiring soft tissue flap closure; usually associated with massive contamination.

IIIC: Vascular injury requiring repair.”

CLASSIFICATION OF ANKLE FRACTURES

POTT CLASSIFICATION

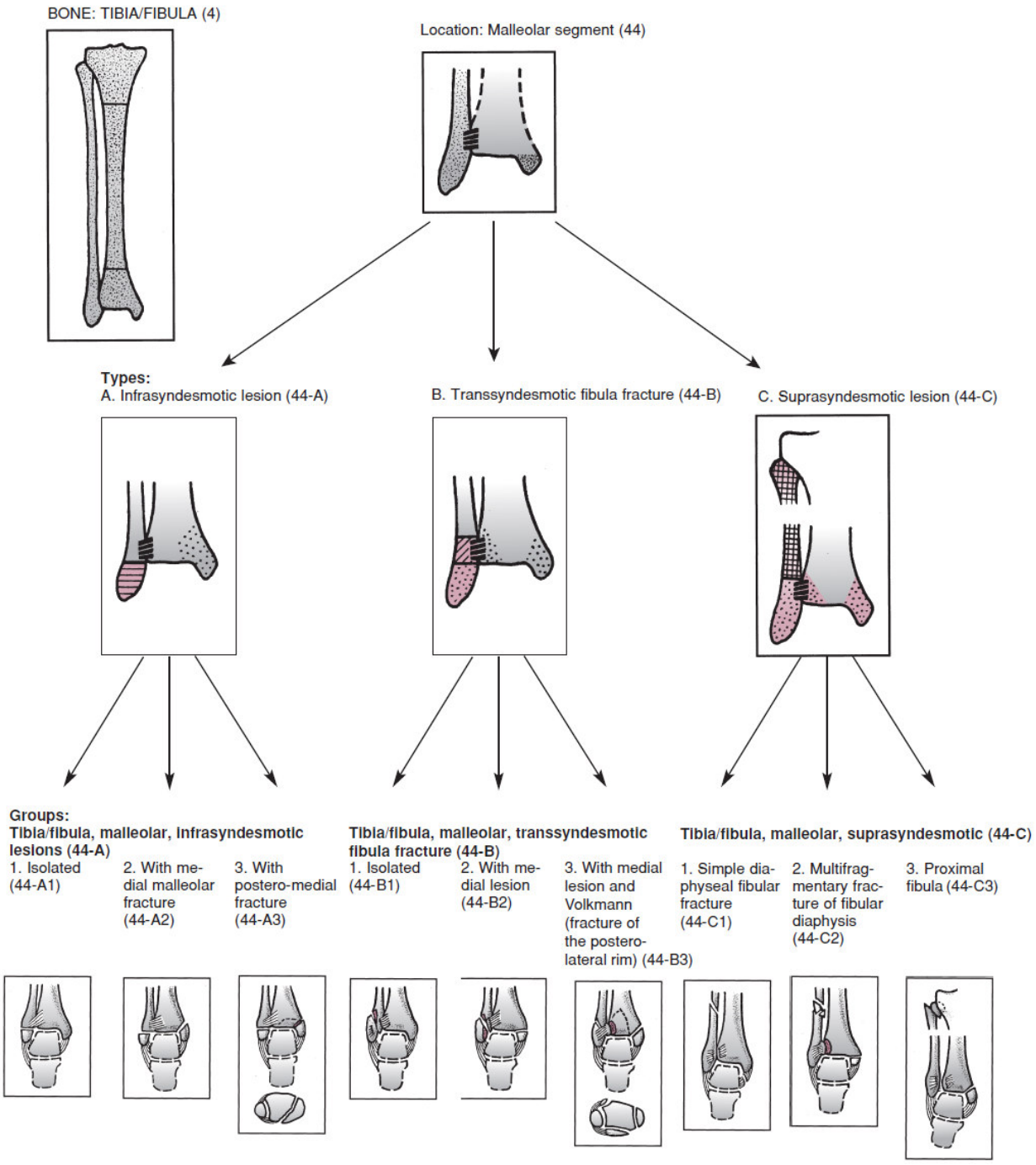
Classification of ankle fractures may be undertaken on the basis of anatomy, injury mechanics, or stability. Multiple classification systems have been developed, only a few remain in frequent use. Pott provided the first known detailed description of ankle fractures in 1769, prior to the discovery of medical radiographs in 1895, but the classification system based on the number of fractured malleoli that is commonly ascribed to him may have been first described by Cooper[26]. Fractures can be classified as " unimalleolar, bimalleolar, or trimalleolar based on the combined fractures of the lateral, medial, and posterior malleoli." As the number of fractured malleoli increases the prognosis worsens.[27] Because of the simplicity of the system it remains in widespread use.

DANIS–WEBER AND AO/OTA CLASSIFICATIONS

An alternative classification developed by Danis [28] and modified by Weber,[29] describes the injury based on the location of the lateral malleolar fracture. Fractures may be classified as A, B, or C with a fracture below, at the level of, or above the syndesmosis respectively.

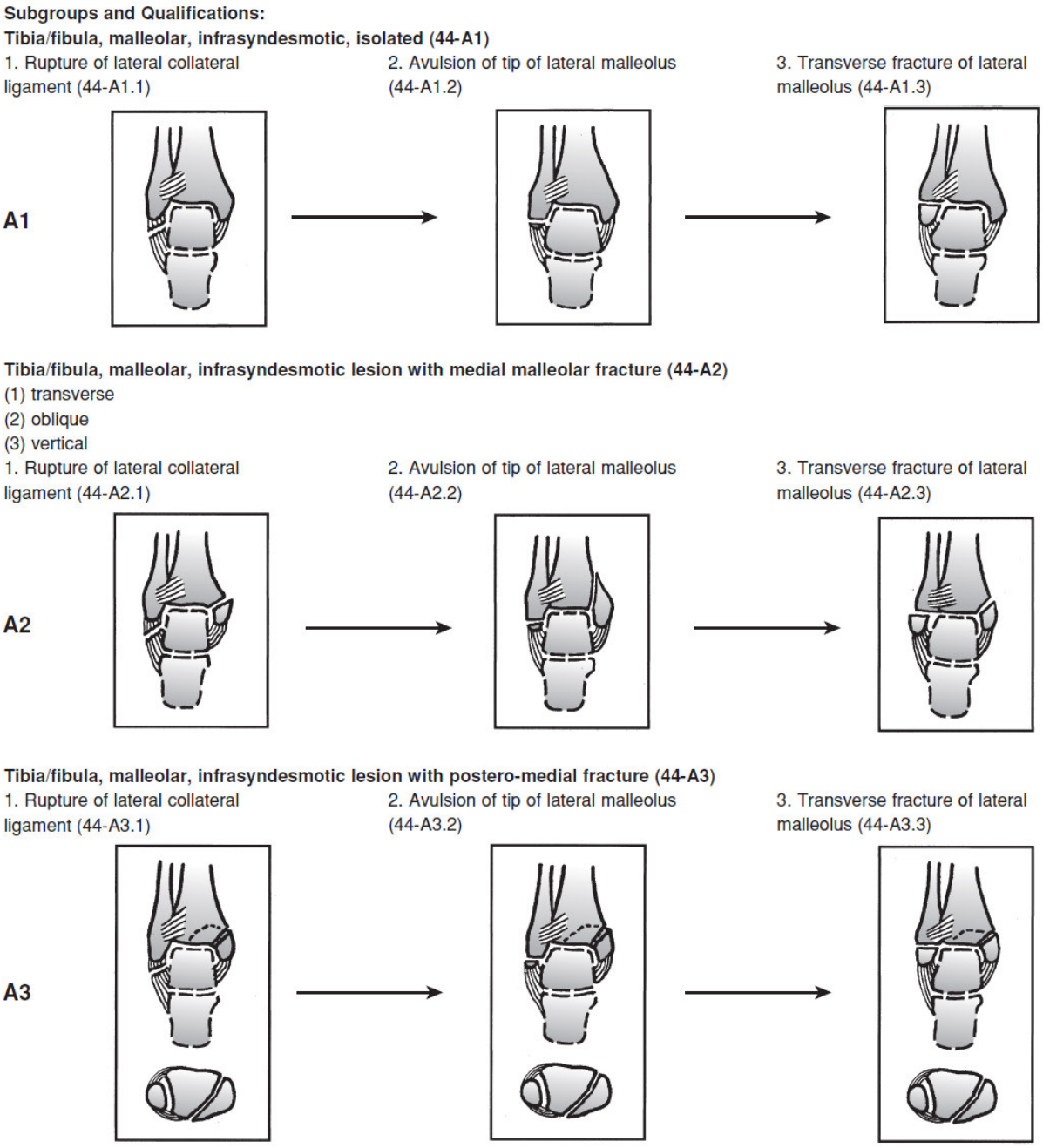
This classification remains popular and has been shown to have substantial inter- and intra observer reliability. Although there is a general relationship with fracture stability, it does not accurately predict the presence or level of syndesmotic injury, and it does not address the presence (or absence) of injury to the medial side of the ankle, and the classification does not provide prognostic information.[30]

Further work on the Danis –Weber system by the AO/ASIF group lead to the development of the AO classification of ankle fractures which has also been adopted by the Orthopedic Trauma Association (OTA). This classification is encompassing with a total of 27 different subtypes describing injury to the bony and soft tissue structures of the ankle.[31] Acceptable inter observer reliability and ease of application have been reported. Arthroscopic investigation of ankle fractures has shown that the degree of articular cartilage damage present corresponds with the AO/ OTA subgroups from 1 to 3, and therefore this extended classification may have some prognostic significance.



THE AO-OTA CLASSIFICATION.

Based upon the location of fracture lines and degree of comminution and serves to describe the severity and degree of instability associated with a particular fracture pattern. It expands on the Danis–Weber Classification scheme, and the basic fracture types are shown.



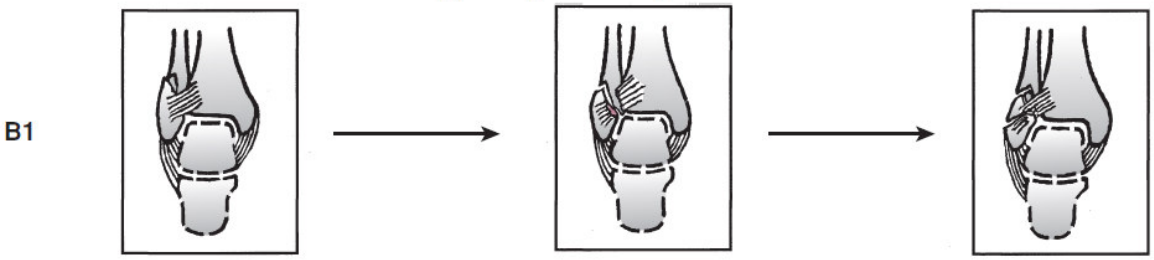
Subtypes of "A-type" ankle fractures

Tibia/fibula, malleolar, transsyndesmotic, isolated (44-B1)

1. Simple (44-B1.1)

2. Simple with rupture of anterior syndesmosis (44-B1.2)
(1) in substance
(2) Chaput (anterior tibia)
(3) Lefort (anterior fibula)

3. Multifragmentary (44-B1.3)

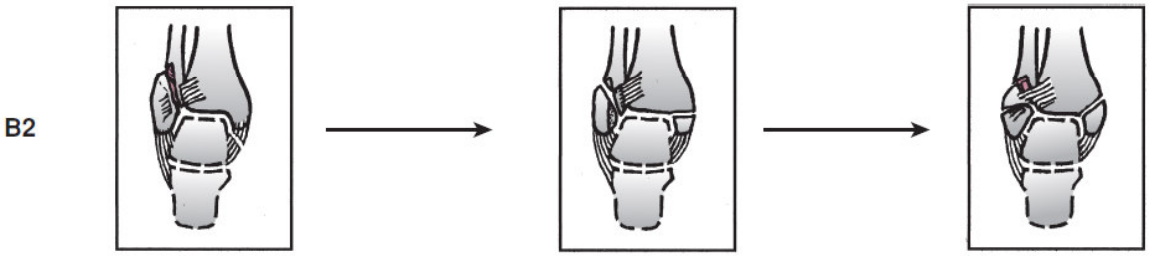


Tibia/fibula, malleolar, transsyndesmotic fracture with medial lesion (44-B2)

1. Simple, rupture of medial collateral and anterior syndesmosis (44-B2.1)
(1) in substance
(2) Chaput
(3) Lefort

2. Simple with fracture of medial malleolus and rupture of anterior syndesmosis (44-B2.2)
(1) in substance
(2) Chaput
(3) Lefort

3. Multifragmentary (4-B2.3)
(1) rupture of medial collateral ligament
(2) fracture of medial malleolus

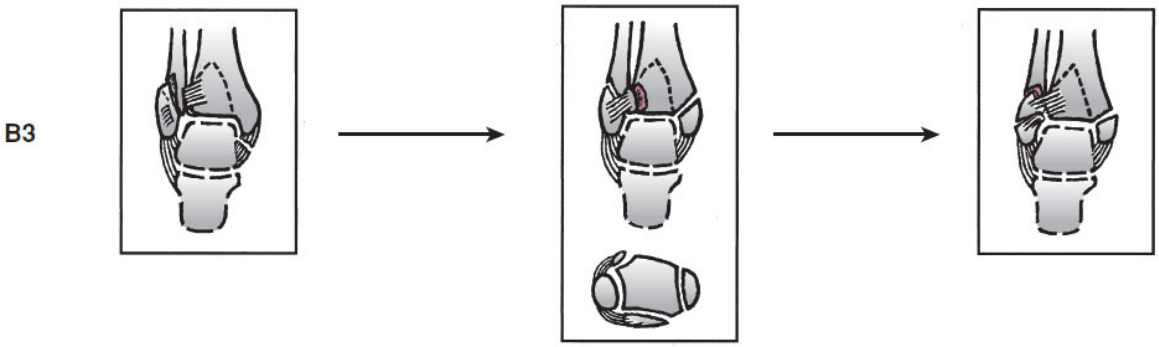


Tibia/fibula, malleolar, transsyndesmotic with medial lesion and a Volkmann (fracture of posterolateral rim) (44-B3)
(1) extra-articular avulsion
(2) peripheral articular fragment
(3) significant articular fracture

1. Fibula simple with medial collateral ligament rupture (44-B3.1)

2. Simple fibula fracture with fracture of medial malleolus (44-B3.2)

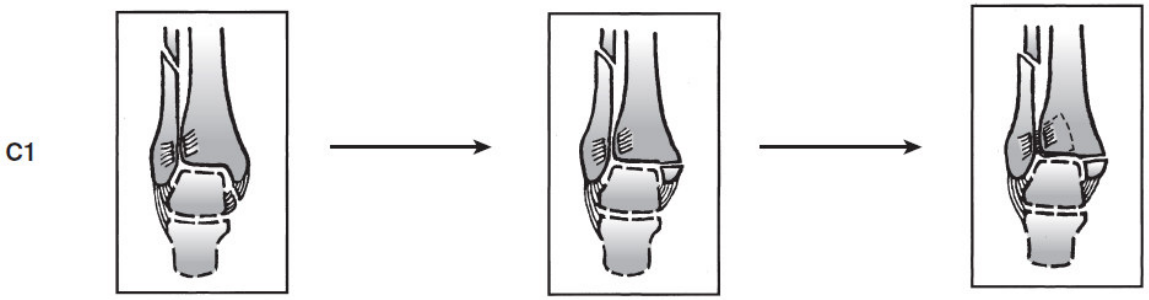
3. Multifragmentary with fracture of medial malleolus (44-B3.3)



Subtypes of “B-type” ankle fractures

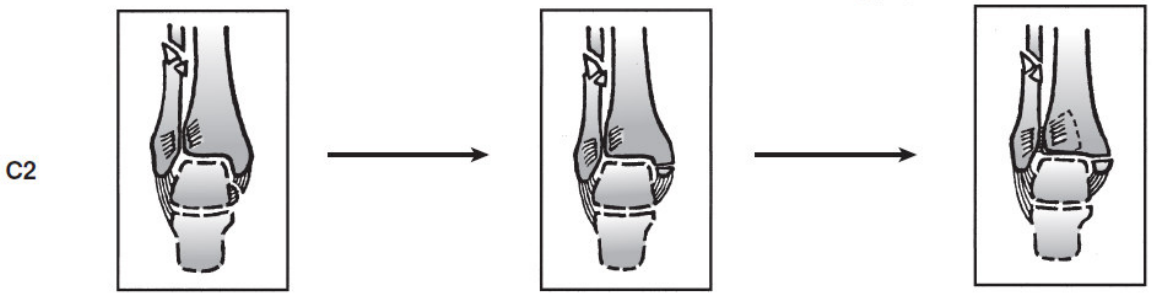
Tibia/fibula, malleolar, susprasyndesmotic, simple diaphyseal fracture of fibula (44-C1)

1. Rupture of medial collateral ligament (44-C1.1)
2. With fracture of medial malleolus (44-C1.2)
3. With fracture of medial malleolus and a Volkmann (Dupuytren) (44-C1.3)
   (1) extra-articular avulsion
   (2) peripheral articular fragment
   (3) significant articular fragment



Tibia/fibula, malleolar, suprasyndesmotic, multifragmentary fibular diaphyseal fracture (44-C2)

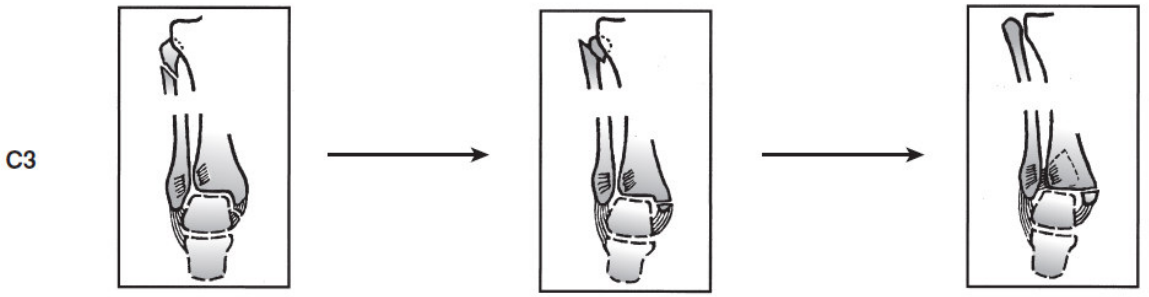
1. With rupture of medial collateral ligament (44-C2.1)
2. With fracture of medial malleolus (44-C2.2)
3. With fracture of medial malleolus and a Volkmann (Dupuytren) (44-C2.3)
   (1) extra-articular avulsion
   (2) peripheral articular fragment
   (3) significant articular fragment



Tibia/fibula, malleolar, suprasyndesmotic, proximal fibular lesion (44-C3)

(1) fracture through neck
(2) fracture through head
(3) proximal tibiofibular dislocation
(4) rupture of medial collateral ligament
(5) fracture of medial malleolus
(6) articular fragment

1. Without shortening, without Volkmann (44-C3.1)
2. With shortening, without Volkmann (44-C3.2)
3. Medial lesion and a Volkmann (44-C3.3)



Subtypes of “C-type” ankle fractures

LAUGE-HANSEN CLASSIFICATION

An alternative classification system based on causative mechanism of injury was proposed by Ashurst and Bromer in 1922, and expanded by Lauge-Hansen in 1950 following cadaveric investigations.[32] It employs two words and a number. “The position of the foot at the time of fracture (supination or pronation) is described by the first word and, the deforming force at the ankle (abduction, adduction, internal rotation, or external rotation) is by the second word.”

There are four classes of injury:

- “Supination external rotation (SER),
- pronation external rotation (PER),
- supination adduction (SAD), and
- pronation abduction (PAB).”

The number then refers to the progression through stages of bony and soft tissue injury. The most common pattern of injury is SER (60%) followed by

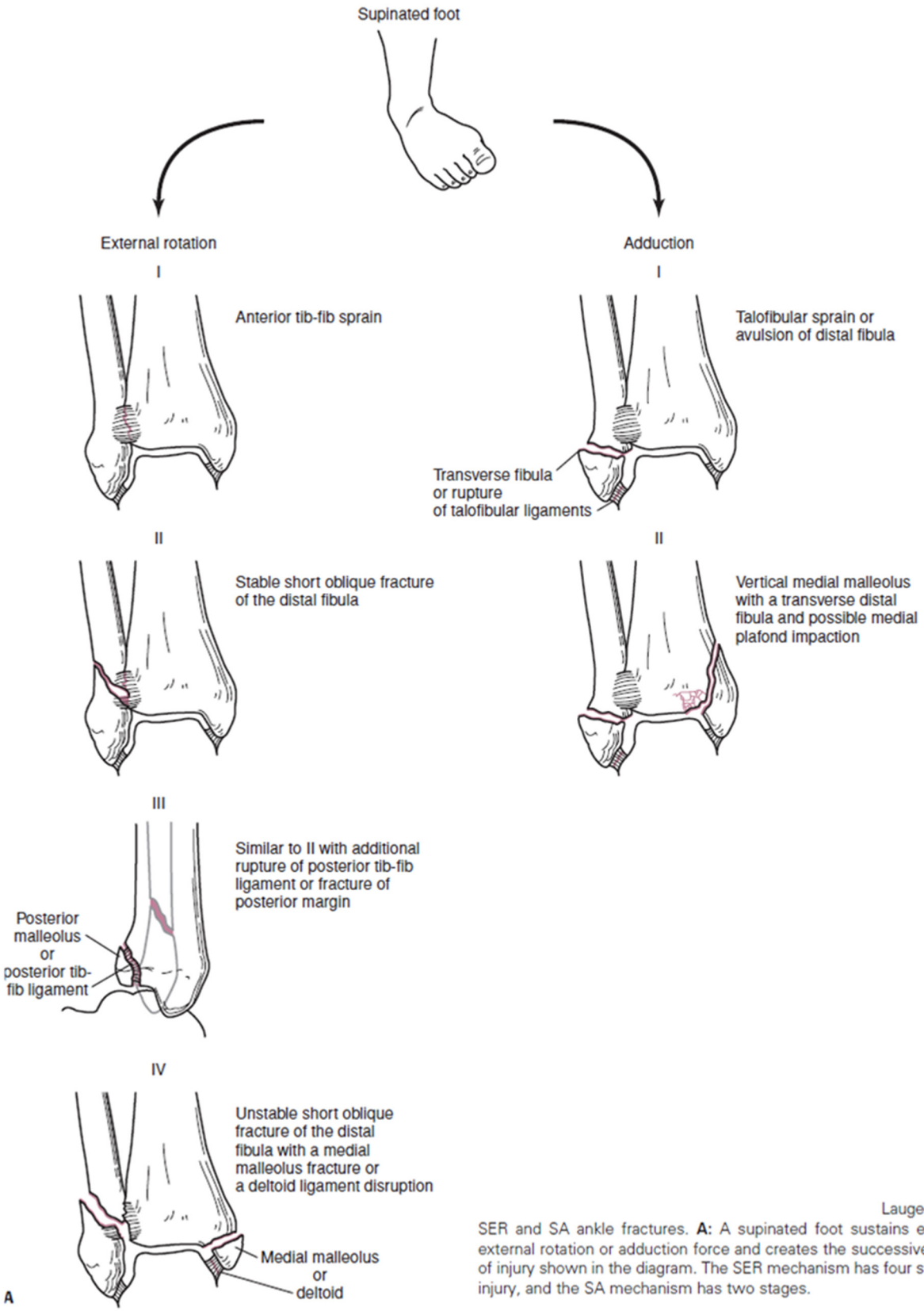
SAD injuries (20%) and then those occurring in pronation (20%). PAB fractures and PER fractures comprise 8% and 12% of ankle fractures respectively.

The Lauge-Hansen classification historically indicated the process of closed manipulation required to reverse displacement and reduce the fracture, but in the era of surgical fixation this classification system remains helpful in directing management.

Supination External Rotation Fractures.

In the first stage of this injury (SER 1), the talus rotates within the mortise, pushing the tibia and fibula apart, and causing a rupture of the anterior-inferior tibiofibular ligament (AITFL). This represents a stable ankle sprain. In the second stage (SER 2), the fibula fractures at the level of the syndesmosis resulting in an oblique fracture line with a classic long posterior spike . This is the equivalent of the AO/OTA type B fracture . The ankle remains stable because the medial structures are intact, the lateral malleolar fracture is typically minimally displaced, and thus SER 2 fractures are treated nonoperatively. In the third stage (SER 3), the posterior tibiofibular ligament ruptures or a posterior malleolar fracture occurs. In the fourth and final stage (SER 4), the medial aspect of the ankle is injured and the ankle becomes unstable. This may be either a rupture of the deltoid ligament, or an oblique fracture of the medial malleolus . Occasionally, both elements may be

injured, the line of injury passing through both the deep deltoid ligament (attached to the posterior colliculus of the medial malleolus, which itself is left intact), and then through bone, resulting in an anterior colliculus fracture. SER 4 fractures are generally managed operatively. The oblique or spiral configuration of the fibula fracture lends itself to lag screw compression protected with a neutralization plate, or alternatively to nail stabilization. The oblique medial fracture is then most commonly treated with two parallel partially threaded cancellous lag screws placed orthogonal to the fracture. The integrity of the syndesmosis should be assessed and if found to be unstable, stabilized with a syndesmosis screw.



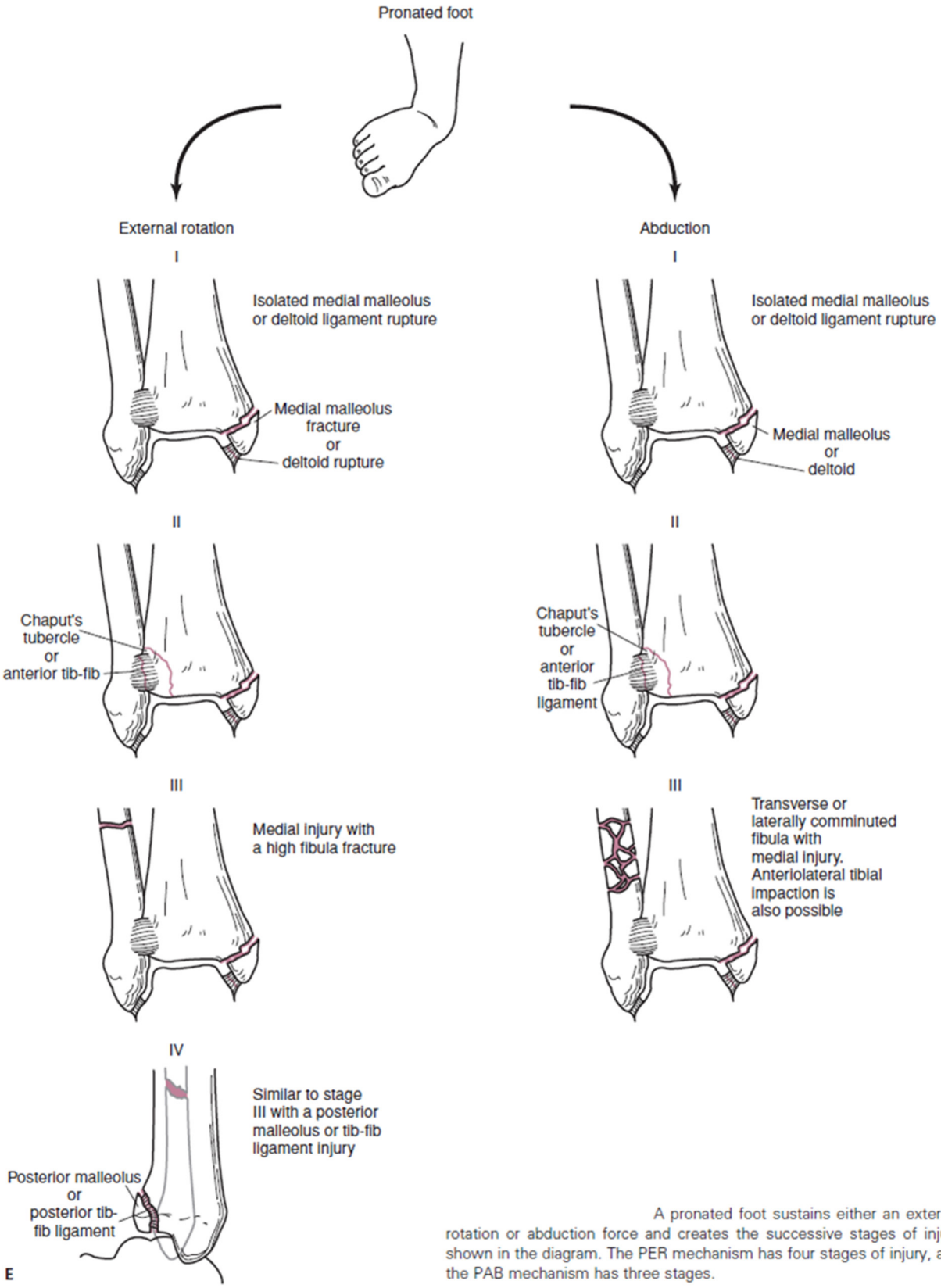
Lauge-Hansen

SER and SA ankle fractures. **A:** A supinated foot sustains either an external rotation or adduction force and creates the successive stages of injury shown in the diagram. The SER mechanism has four stages of injury, and the SA mechanism has two stages.

Supination Adduction Fractures.

In the first stage (SAD 1), the adduction of the hindfoot results in either a talofibular ligament rupture (ankle sprain) or a transversely orientated

avulsion fracture of the distal fibula, this being equivalent to an AO/OTA type A fracture . This is a stable injury. In the second stage (SAD 2) the medial malleolus is sheared off resulting in a diagnostic vertical fracture line . This is an unstable injury. The medial plafond may suffer impaction from the talus and radiographs should be scrutinuized carefully for this additional injury. In contradistinction to the other patterns of ankle fracture, surgical stabilization of an SAD 2 fracture begins with initial exposure of the medial malleolus. The area of impaction is exposed through the fracture and the joint is irrigated to remove osteochondral fragments. The impacted articular segment is reduced with a lever or punch and the defect is filled with graft or graft substitute if required. The shear fracture is then typically stabilized with a buttress plate. The fibular fracture may subsequently be stabilized with a plate, a nail, or a tension band construct



A pronated foot sustains either an external rotation or abduction force and creates the successive stages of injury shown in the diagram. The PER mechanism has four stages of injury, and the PAB mechanism has three stages.

Pronation Abduction Fractures.

In the first stage (PAB 1), the abducting talus avulses the medial malleolus (resulting in a transverse fracture line) or causes a deltoid ligament rupture. In the second stage (PAB 2) the fibula is pushed laterally resulting in rupture of the AITFL or an avulsion fracture of the tubercle of Chaput. In the third stage (PAB 3) the fibula fractures under compression and bending, resulting in a comminuted fracture at or above the level of the syndesmosis . Operative treatment of this fibular fracture differs from that of an SER 4 fracture in that lag screw fixation of the comminuted region is often not possible, and an alternative strategy of bridge plating with a small fragment DCP or equivalent, rather than a 1/3 tubular plate, or an intramedullary nail may be required. The medial fracture can be addressed with orthogonal cancellous lag screws as for the SER fracture, or with a tension band construct if the fragment is small. The integrity of the syndesmosis should be assessed.

Pronation External Rotation Fractures.

In the first stage (PER 1), an isolated medial malleolar fracture (or deltoid rupture) is produced. In the second stage (PER 2), either the AITFL is ruptured or a tubercle of Chaput fracture occurs. In the third stage (PER 3), a

fracture of the fibula occurs through torsion resulting in an oblique or spiral fracture. This differs from the SER fracture in that it is typically supra-syndesmotic

(equivalent to an AO/OTA type C fracture) and that the long spike at the proximal extent of the fracture is anterior (i.e.,the fracture line passes from distal posteriorly to proximal anteriorly). A PER 3 fracture is unstable and there is a high associated incidence of syndesmosis injury. The classic variant is the so-called Maisonneuve fracture , which may not be diagnosed correctly unless suspected and looked for.

Surgical stabilization of the fibular fracture is with a plate if it occurs within 5 or 6 cm of the syndesmosis, with or without a syndesmosis screw. Fractures above this level are most commonly treated with syndesmosis screw(s) alone. The medial

malleolar fracture is commonly treated with cancellous lag screws. Despite the utility of the Lauge-Hansen classification system, later investigators have not been able to replicate the stages of injury described in the original experiments. In common with other classification systems, it does not does not provide

reliable information regarding the presence or absence of syndesmotic rupture. Like most detailed classification systems, reproducibility is modest with inter observer variability of between 43% and 60% and intra observer variability of between 64 and 82%. However, the classification system does have prognostic

significance: The degree of articular damage has been shown to correlate with the stage of injury.[33]

MANAGEMENT

Initial Evaluation

Every open injury is an orthopedic emergency and the management should be started at the emergency room itself by a thorough initial evaluation. Thirty percent of patients with open injuries have more than one injury and the temptation to focus attention on the bleeding wound must be avoided and should undertake a thorough evaluation as per ATLS protocols.

The patient must be thoroughly assessed for airway, breathing, and circulation. There may be a number of injuries that are missed and there is a role for whole-body trauma series x rays .

An estimate of the blood loss must be undertaken quickly and, if necessary, resuscitation measures immediately instituted. Inadequate resuscitation is an important cause of avoidable deaths and later comorbidities such as infection, delayed wound healing, and pulmonary complications.

Acidosis, hypothermia, and coagulopathy, the deadly triad in injured patients, are often present in patients with open injuries and these must be identified and corrected quickly.

EXAMINATION

Once the patient stabilized a thorough physical examination of the patient is important. The patient should be adequately undressed so that any more significant injury in other parts of the body can be identified which may be indicated by the presence of contusions and bruises. This is especially important in patients who are not fully conscious or under the influence of alcohol. The complete neurovascular examination of all four limbs must be done.

The vascularity of an injured limb should not get compromised by a gross deformity or shortening, so it must be reduced gently and splinted. Tenting of the skin by sharp bone fragments or dislocated joints may lead to avascularity and further loss of skin and these fractures must be considered as impending open fractures even when no wound is present. Persistent dislocation of the joints, especially the knee and ankle joints, may also cause vascular compromise and these joints require urgent reduction in the emergency room. The limb must also be examined for any signs of compartment syndrome.

In the emergency room examination of the wound should include the size and location of the wound, the orientation of the wound, to define if it is longitudinal, transverse or irregular, the wound depth and whether bone, tendons, and muscle are exposed.

The status of the skin adjacent to the wound should be examined carefully. If there is extensive damage or contusions to the skin around the wound there may be significant skin avascularity and therefore skin loss during debridement. Following the initial assessment and documentation, the wound must be quickly covered with a sterile dressing after a saline wash.

ROLE OF CULTURES IN THE EMERGENCY ROOM

Infection is the major complication that leads to the need for secondary procedures, non unions, failure of flaps, and even amputations. This fact stimulated surgeons to try to identify the bacteria that cause wound contamination. The clinical correlation between the presence of positive cultures and subsequent rate of clinical infection is not shown by many studies. There is disparity between the organisms grown on the initial wound swabs and the organisms grown subsequently after the development of wound infection The commonly isolated organisms from established infection are Staphylococcus aureus, Pseudomonas,

and Escherichia coli. These organisms are frequently due to hospital contamination and are never isolated from the environment where the accidents occur. The practice of obtaining routine cultures from the wound either pre- or post-debridement is no longer advocated.

TETANUS PROPHYLAXIS

The majority of open fractures are either contaminated or infected at the time of presentation, attention to tetanus history and current tetanus status is of paramount importance. It is important to implement appropriate tetanus prophylaxis prior to the management of open fractures.

ANTIBIOTICS

Once the limb is properly splinted, bleeding has been controlled and the wound should be covered with adequate dressing made of normal saline and appropriate intravenous antibiotics should be administered. Since all open fractures are contaminated to a varying extent, first or second generation cephalosporins should be administerd i.v .as a therapeutic measure not as a prophylactic dose in the emergency room itself before the patient leaves the room. In Gustilo type III injuries an aminoglycoside is also administered . In patients with wounds of gross organic contamination a penicillin and a metronidazole is

also added .The development of resistant organisms is of major concern in prolonged use of antibiotics, hence should be avoided .[34]

RADIOGRAPHIC IMAGING

The extent and type of injury can be identified by the plain radiography itself and it will be helpful to plan treatment and sufficient in majority of cases . Radiographs of the injured limb in two planes (Antero posterior and lateral) with inclusion of the joints above and below the fracture is required, since open injuries are often high-velocity injuries and the extension of fracture into the adjacent joints or an associated injury of the articular surfaces can be detected by the inclusion of one joint above and below the fracture.

The cervical and thoracolumbar spines must be ruled out from injury in high velocity injuries by X rays. In open fractures the following must be seen radiologically " the presence of air in subcutaneous tissues, inter muscular planes and joint cavities and any evidence of foreign bodies." In cases with punctured wound or small lacerations if the X ray shows gas shadows in subcutaneous plane it indicates severe degloving injury. In cases of significant contamination presence of mud, metal and glass pieces can be seen radiologically.

The presence of radiographic " gas shadows in the muscular planes should arose suspicion of an established infection by gas producing organisms such as Clostridium perfringens or Escherichia coli in patients presenting late."

A CT scan may be taken in intra-articular fractures of the ankle and knee joint in stabilized patients which will show the three dimensional orientation of the fracture planes and the articular margins clearly. The plan for skeletal stabilization following wound debridement can be made at this stage with the help of a CT scan. A detailed CT scan of the joints can be performed later in unstable patients for whom a temporary external fixator must be applied based on plain radiography.

TREATMENT

DEBRIDEMENT AND LAVAGE

Thorough debridement is important if the risk of infection is to be minimized. Debridement is an active surgical procedure and not just wound washing. All foreign material and tissues that are contaminated or suspected to be avascular are systematically removed so that whatever is left behind is vascularized living tissue, devoid of contamination. A secondary aim of debridement is also to minimize risk factors for infection such as dead space or hematoma so that the incidence of infection is reduced.

Debridement should be done as soon as possible after injury and the traditional teaching was that it preferably be completed within 6 hours. The aim was to prevent contamination from becoming infection and early debridement will prevent colonization of the bacteria within the tissues. The 6-hour rule has been challenged by many recent studies. Performing debridement within 6 hours compared to debridement performed between 6 and 24 hours after injury has no proven added advantage as evidenced by the studies[35]. The delay debridement >24 hours, the clinical effects are however not yet clear. Although debridement must be done as soon as safely possible, the thoroughness of debridement seems to be more important than the timing. There are also other local and systemic factors that influence infection and wound healing.

An experienced team containing orthopedic and plastic surgeons should perform the debridement. Thorough washing with copious amounts of saline is indicated in heavily contaminated wounds before draping the limb.

LAVAGE

Lavage is used before and after debridement as it clears the debris and hematoma and provides optimal exposure and reduces bacterial colony count and contamination significantly. Adequate quantity of lavage fluid must be used for

cleaning on the principle that the “solution for pollution is dilution.” In grade III B injuries more than 9 litres of saline may be needed to clear the contamination.

SUPERFICIAL DEBRIDEMENT

The wounds must be extended using proper incisions for proper inspection of the deeper tissues irrespective of the initial presentation. In more severely contaminated wounds and wounds over a joint a longer incision may be needed to allow proper inspection of all parts of the joint.

Without separating the skin from the deep fascia the skin incisions must be extended, as this may decrease viability and increase hematoma formation. All skin must be gradually trimmed at the margins and nonviable shredded skin must be removed so that only healthy skin remains. Indiscriminate removal of skin flaps must be avoided during the removal of nonviable skin as viable skin flaps can be used to cover exposed bone and the soft tissue reconstruction that is required can be limited to certain extent.

It is better to retain the skin flaps with doubtful viability for debridement during the secondary procedure. The debridement of the fascia must be done with special caution as retaining nonviable fascia often causes infection. A detached, shredded, or even doubtfully nonviable fascia must be excised.

DEEP DEBRIDEMENT

Classically muscle viability is assessed by the four C's: " Contractability, Color, Consistency, and Capacity to bleed[36]". A great care is needed during debridement of the muscles and deeper structures. A retained necrotic muscle is a major growth medium for bacteria especially a life threatening anaerobic infection, an aggressive approach should be followed during debridement . Accurate judgment comes with experience but where there is doubt it is better to excise than retain dubiously vascularized muscle.

SKELETAL STABILIZATION

The next step in line of management will be " to alleviate pain and prevent further soft tissue damage". This can be achieved by rigid skeletal stabilization. The limb length must be restored as nearly as possible "to restore the correct tension to the soft tissues, decreases swelling, improves circulation, and aids venous and lymphatic return." The comfortness of the patient will be more during wound inspection, early rehabilitation and movement of joints in the post operative period.

The stabilization method is preferred depending upon the morphology of the fracture and the later planned reconstructive procedures.

Generally our preference is to use a temporary external fixator device followed by secondary internal fixation at a later operation in high-energy injuries associated with severe contamination,

primary internal fixation can be considered in situations where there is a good soft tissue envelope or in situations where soft tissue cover could be achieved within 48 to 72 hours.

EXTERNAL SKELETAL FIXATION

The workhorse for skeletal stabilization in open fractures is an external fixation, especially half pin unilateral frames. Not only it provides a versatile method of providing stability it also avoids the need for additional exposure or periosteal striping even in demanding situations.

External fixators should be converted to internal fixation at an appropriate time as it provides only temporary stabilization and it also has its own complications. “The most common being pin loosening, infection, and mal union. Pin tract infection is the most frequent complication with external fixation and occurs in up to 32% of patients. Utmost care should be exercised in the placement of the pins and during follow-up.” [37]

MATERIALS AND METHODS

This is a prospective and retrospective study of open ankle fractures conducted at INSTITUTE OF ORTHOPEDICS AND TRAUMATOLOGY , RGGGH , MADRAS MEDICAL COLLEGE , CHENNAI -3 between mar 2016 to Aug 2016 .Institutional ethical committee clearance obtained for the above study and written informed consent obtained from all patients who were selected according to the following inclusion and exclusion criteria.

INCLUSION CRITERIA

The following open ankle fractures were included in the study

Gr I , Gr II , Gr IIIA & Gr IIIB (Gustilo – Anderson) open fractures of

1) Medial malleoli
2) Lateral malleoli
3) Bi malleolar
4) Tri malleolar
5) Ankle fracture dislocations

EXCLUSION CRITERIA

The following fractures were excluded

1) GR III C open fractures
2) Associated crush injuries of the foot & Mangled extremities
3) Open distal tibial pilon injuries
4) Talus fractures – which were highly comminuted

METHODOLGY

All the patients who were admitted in the trauma ward are resuscitated as per ATLS protocol. Patients were stabilized and revived from hemodynamic shock if present with administration of i.v fluids and blood if needed.

Complete examination of the injured extremity done following resuscitation and assessment of open wound grading and nature of contamination noted. Immediately a preliminary wound wash given with normal saline in the emergency room itself and sterile dressing applied. All patients were then administered with a dose of cephalosporin (inj. Cefotaxime 1 g iv) and if the contamination and the grade of open wound is more , aminoglycoside (inj . amikacin) and inj .metronidazole were added. Tetanus prophylaxis given and if

the wound is highly contaminated inj. Anti tetanus immunoglobulins administered immediately.

After the initial resuscitation and evaluation, a complete trauma evaluation done with a routine trauma series radiography (x rays of cervical spine , chest , pelvis with both hips , abdomen , lumbar & dorsal spine taken) in addition to the x ray of the involved extremity. After examining the x rays of the ankle (AP& Lateral and mortice views) if needed , a CT scan of the ankle is taken .

Patients then completely evaluated with all routine blood investigations and prepared for emergency wound debridement and skeletal stabilization.

We did Open reduction and internal fixation with cancellous screws and 1/3 tubular plate for all Gr I open fractures. Gr II fractures were managed with ORIF or external fixation with internal fixation depending upon the wound status.

Gr III A & Gr III B fractures were managed with minimal internal fixation and external fixation or external fixation alone .check radiographs were taken.

Patients were managed in ward with routine inspection of the wound status and antibiotics continued for prescribed time. If a wound shows any signs of infection a culture is taken and antibiotics changed according to the sensitivity

reports. Depending upon the wound status, a spilt thickness skin graft (SSG) or flap cover done if needed.

The patients were followed up at 3 weeks, 6 weeks and 2 months. During the follow up the wound status and fracture healing status assessed and external fixators removed if the wound has healed and patients were put on below knee casts for 3 to 4 weeks.

Patients functional outcome analysed with Olerud and Molander ankle score (OMAS) , Baird and Jackson ankle score and AOFAS (American orthopedic foot and ankle society score) scores .

The further analysis of 23 patients shows, two patients had associated calcaneal fractures, two patients had metatarsal fractures, one patient had fracture L1 and one patient had type 1 tibial plateau fracture.

Radiographic assessment done with 3 standard radiographic projections – Antero posterior , lateral and ankle mortice views for fracture union , alignment of ankle mortice and arthritic changes - Kellgren-Lawrence Grading Scale for osteo arthritis of ankle.

“OLERUD AND MOLANDER ANKLE SCORING (OMAS)

PARAMETER	DEGREE	SCORE
pain	none while walking on uneven surface while walking on even surface outdoor While walking indoor Constant and severe	**25** **20** **10** **5** **0**
stiffness	None stiffness	**10** **0**
swelling	None Only evenings constant	**10** **5** **0**
Stair climbing	no problems impaired impossible	**10** **5** **0**
Running	Possible impossible	**5** **0**
Jumping	Possible impossible	**5** **0**
Squatting	No problems impossible	**5** **0**
Support	None Taping, wrapping Stick or crutches	**10** **5** **0**
Work , activities of daily life	Same as before injury Loss of tempo Change to a simple job / part time Severly impaired work capacity	**20** **15** **10** **0**

Excellent >90, good 61-90, fair – 31-60, poor <30”

“BAIRD AND JACKSON SCORING SYSTEM

Pain scoring	a. No Pain b. Mild pain with strenuous activity c. Mild pain with activities of daily living d. Pain with weight bearing e. Pain at rest	15 12 8 4 0
Stability of ankle	a. No clinical instability b. Instability with sports activites c. Instability with activites of daily living ability to walk	15 5 0
Able to walk	a. Able to walk desired distances without limp or pain b. Able to walk desired distances with mild limp or pain c. Moderately restricted in ability to walk d. Able to walk short distances only e. Unable to walk	15 12 8 4 0
Able to run	a. Able to run desired distances without pain b. Able to run desired distances with slight pain c. Moderate restriction in ability to run with mild pain d. Able to run short distances only e. Unable to run	10 8 6 3 0
Ability to work	a. Able to perform usual occupation without restrictions b. Able to perform usual occupation with restrictions in some strenuous activities c. Able to perform usual occupation with substantial restriction d. Partially disabled;selected jobs only	10 8 6 3

	e. Unable to work	0
Motion of the ankle	a. Within 10 of uninjured ankle b. Within 15 of uninjured ankle c. Within 20 of uninjured ankle d. <50 of uninjured ankle, or dorsiflexion <5	10 7 4 0
Radiographic result	a. Anatomical with intact mortice(normal medial clear space, normal 25 superior 25joint space, no talar tilt) b. Same as a with mild reactive changes at the joint margins c. Measurable narrowing of the superior joint space, d. superior joint space 2mm, or talar tilt >2mm e. Moderate narrowing of the superior joint space, f. with superior space between 2 and 1mm. g. Severe narrowing of the superior joint space,with superior joint space <1mm, widening of the medial clear space, severe reactive changes h. (Sclerotic subchondral bone and osteophyte formation)	25 15 10 5 0

Excellent 96-100

Good 91-95

Fair 81-90

Poor 0-80

Maximum possible score-100”

“AOFAS score (American orthopedic foot and ankle society score)

PARAMETER	DEGREE	SCORE
pain	none mild ,occasional moderate ,daily severe, almost always	**40** **30** **20** **0**
Function Activity limitation, support requirement	No limitation,no support No limitation of daily activities, limitation of recreational activity,no support Limited daily and recreational activity ,cane Severe limitation of daily and recreational activities , walker , crutches , wheel chair	**10** **7** **4** **0**
Maximum walking distance ,blocks	>6 4-6 1-3 Less than 1	**5** **4** **2** **0**
Walking surface	No difficulty on any surface Some difficulty on uneven terrain, stairs, ladders Severe difficulty on uneven terrain, stairs, ladders	**5** **3** **0**

Gait abnormality	None ,slight Obvious marked	**8** **4** **0**
Sagittal motion (flexion and extension)	Normal or mild restriction(30 degrees or more) Moderate restriction(15 - 29 degrees) Severe restriction (less than 15 degrees)	**8** **4** **0**
Hind foot motion (inversion and eversion)	Normal or mild restriction(75 -100% normal) Moderate restriction(25-74% normal) Marked restriction (less than 25 % normal)	**6** **3** **0**
Ankle – hindfoot stability(AP , varus – valgus)	Stable Definitely unstable	**8** **0**
ALIGNMENT	Good , plantigrade foot, mid foot well aligned Fair , planti grade foot ,some degree of mid foot mal alignment, no symptoms Poor , non plantigrade foot , severe mal alignment , symptoms	**15** **8** **0**

Total = 100 points

90-100 = excellent, 80-90 =good”

KELLGREN-LAWRENCE GRADING SCALE

"Grade 1: doubtful narrowing of joint space and possible osteophytic lipping

Grade 2: definite osteophytes, definite narrowing of joint space

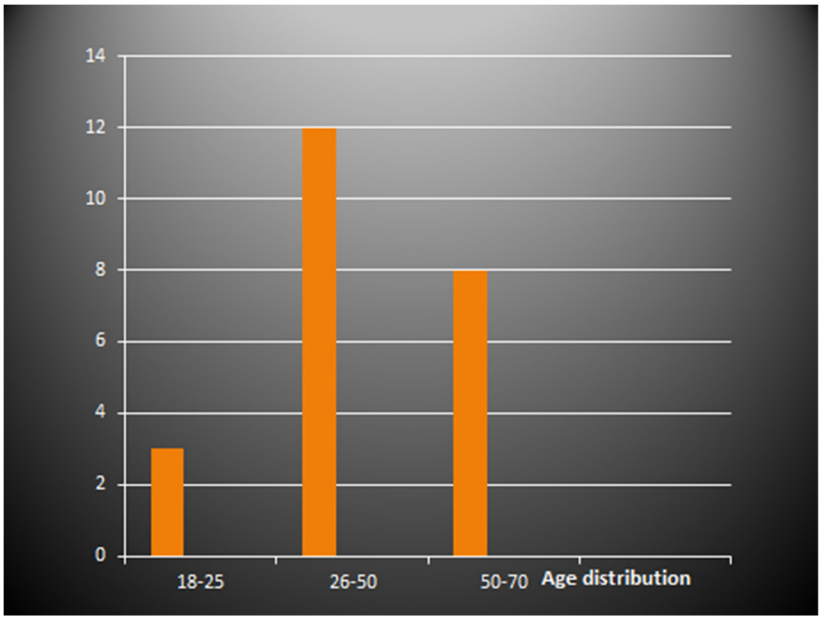
Grade 3: moderate multiple osteophytes, definite narrowing of joints space, some sclerosis and possible deformity of bone contour

Grade 4: large osteophytes, marked narrowing of joint space, severe sclerosis and definite deformity of bone contour"

OBSERVATION AND RESULTS

The observations and results from our study as follows

AGE DISTRIBUTION



In our study the most common age group is middle age (26-50yrs) followed by older age.

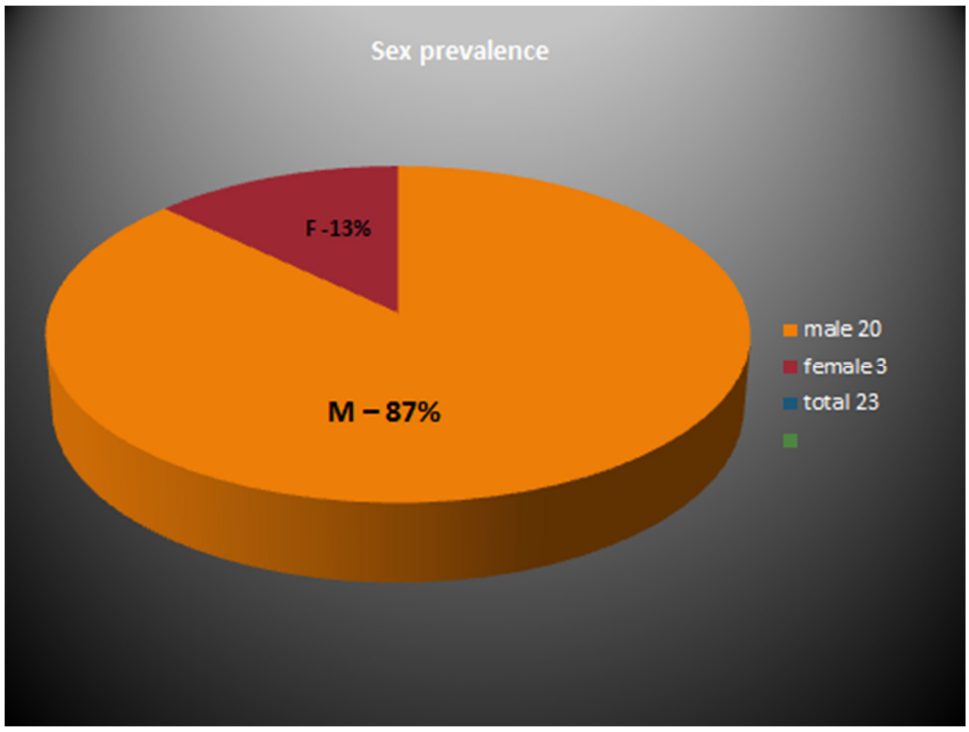
Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
AGE	23	18	70	41.74	15.220
OMS	23	40	90	67.83	13.300
BAIRD jackson score	23	45	95	75.26	11.921
AOFAS	23	54	89	77.65	10.764
Valid N (listwise)	23				

The mean age in our study is 41.74 yrs.

SEX

Male patients were predominant in our study



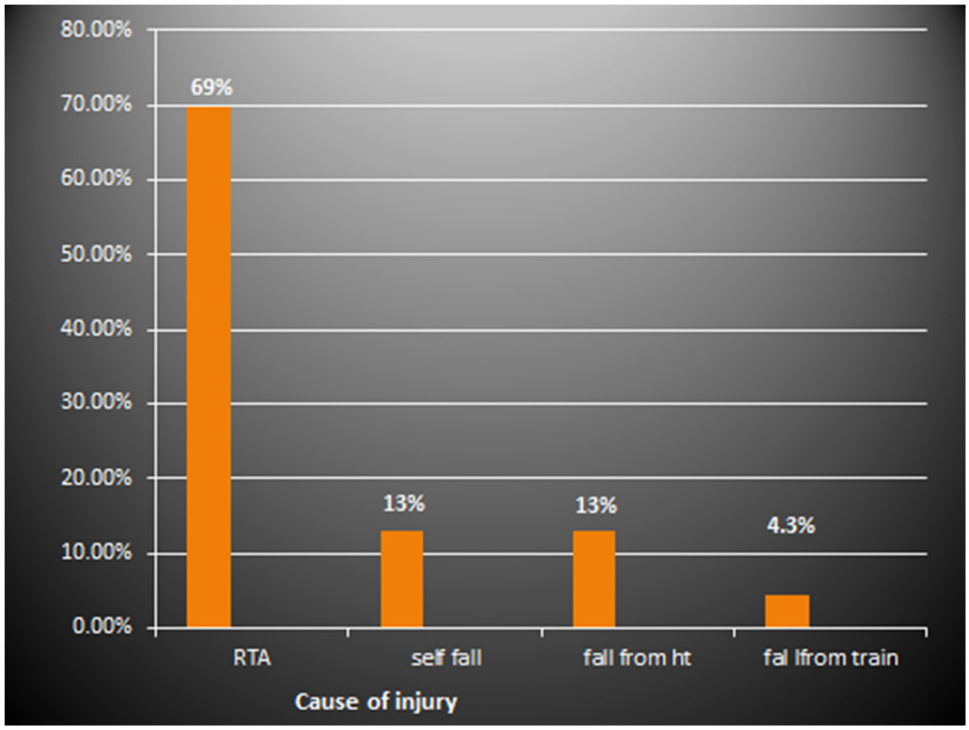
SEX

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	MALE	20	87.0	87.0	87.0
	FEMALE	3	13.0	13.0	100.0
	Total	23	100.0	100.0	

Out of 23 patients only 3 are female patients (13.0%)

CAUSE OF INJURY

RTA (Road traffic accident is the leading cause of injury) followed by self fall and fall from height .



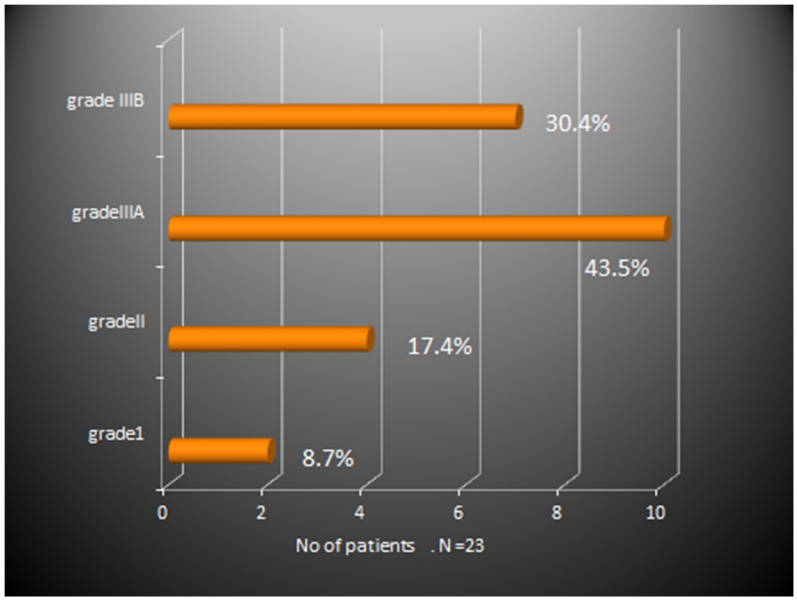
CAUSE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	RTA	16	69.6	69.6	69.6
	Self fall	3	13.0	13.0	82.6
	Fall from ht	3	13.0	13.0	95.7
	Fall from train	1	4.3	4.3	100.0
	Total	23	100.0	100.0	

69.6% of cases of open ankle fractures in our study (16 patients) are due to road traffic accidents and one patient had a fall from train .

OPEN FRACTURE GRADE

Gr III A open fractures of the ankle are more prevalent followed by gr III B open fractures.



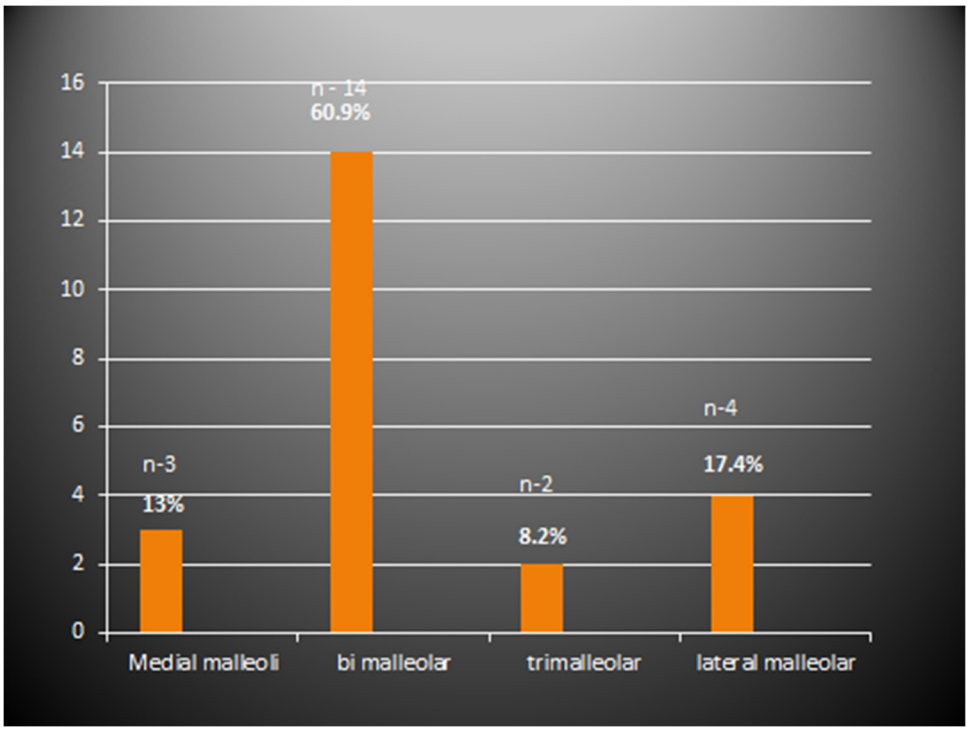
GRADE OF OPEN WOUND (GUSTILLO - ANDERSON)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	GRADE I	2	8.7	8.7	8.7
	GRADE II	4	17.4	17.4	26.1
	GRADE III A	10	43.5	43.5	69.6
	GRADE III B	7	30.4	30.4	100.0
	Total	23	100.0	100.0	

73.9% of cases present to us as GrIIIA& GrIIIB open ankle fractures since the most common cause in our study is high velocity injuries (RTA) and also our institute is a tertiary care referral centre .

TYPE OF FRACTURE

Open bi malleolar are more prevalent in our study .

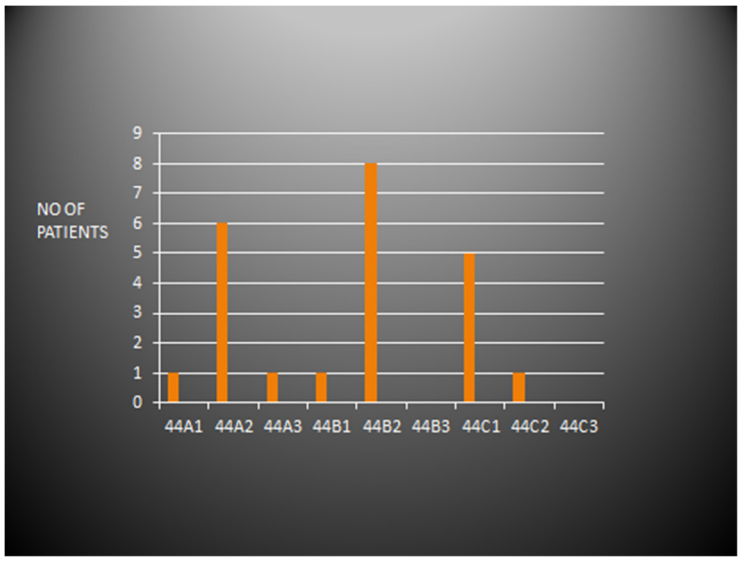


DIAGNOSIS

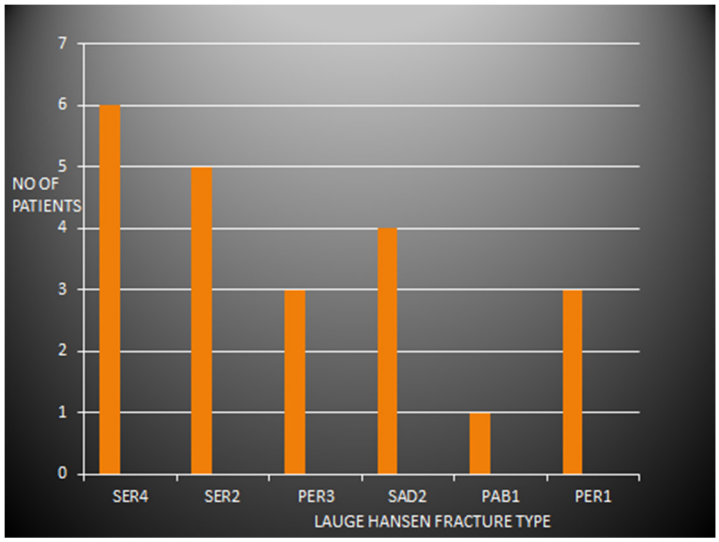
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Medial malleoli	3	13.0	13.0	13.0
	Bi malleolar	14	60.9	60.9	73.9
	Trimalleolar	2	8.7	8.7	82.6
	Lateral malleoli	4	17.4	17.4	100.0
	Total	23	100.0	100.0	

Involvement of single malleoli alone (7 cases) in 1/3 cases.(30.4%).More than one malleoli involved in 16 cases .(69.6%)

FRACTURE PREVALENCE – AO /OTA &LAUGE HANSEN CLASSIFICATION



44B2 (AO/ OTA) is the most prevalent type(8 cases) in our study followed by 44A2 (6 cases)



SER 4 (supination external rotation) is the most prevalent type – Lauge hansen

METHOD OF FIXATION

FIXATION

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	EX FIX&K WIRE	11	47.8	47.8	47.8
	TBW&KWIRE	2	8.7	8.7	56.5
	Screw & 1/3 tubular palte	3	13.0	13.0	69.6
	Ex fix	4	17.4	17.4	87.0
	Exfix / TBW & 1/3 tubular plate	2	8.7	8.7	95.7
	Exfix & 1/3 plate for fibula	1	4.3	4.3	100.0
	Total	23	100.0	100.0	

Most commonly , ankle spanning external fixator combined with a minimal internal fixation using k wire is being used as a method of fixation (47.8%)since we get more number of gr IIIA&IIIB open fractures(73.9%) with soft tissue loss

WOUND MANAGEMENT

WOUND

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Primary	6	26.1	26.1	26.1
	Secondary	9	39.1	39.1	65.2
	SSG	7	30.4	30.4	95.7
	SSG & FLAP COVER	1	4.3	4.3	100.0
	Total	23	100.0	100.0	

Majority of the wounds in our study healed by secondary intention (39.1%) .

34.7 % of patients required a plastic procedure in the form of SSG and flap cover.

OUTCOME ANALYSIS

OLERUD AND MOLANDER SCORE

OMS Outcome

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Good	14	60.9	60.9	60.9
	Fair	9	39.1	39.1	100.0
	Total	23	100.0	100.0	

BAIRD – JACKSON SCORE

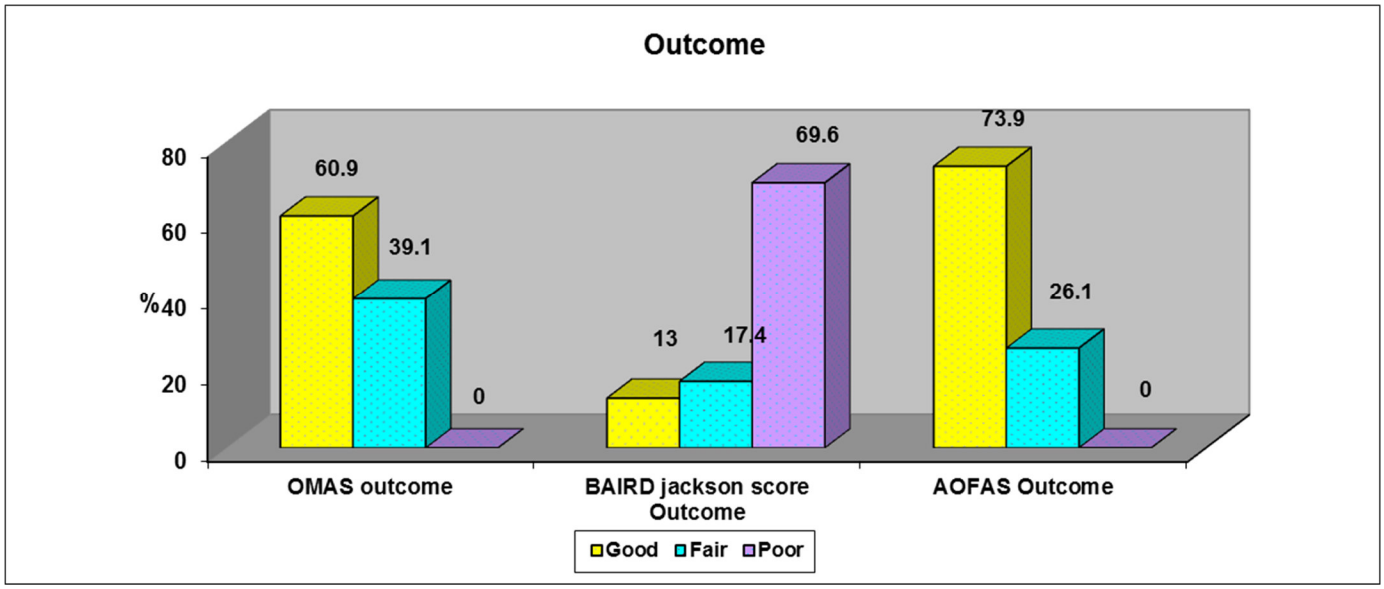
BAIRD jackson score Outcome

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Good	3	13.0	13.0	13.0
	Fair	4	17.4	17.4	30.4
	Poor	16	69.6	69.6	100.0
	Total	23	100.0	100.0	

AOFAS SCORE

AOFAS Outcome

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Good	17	73.9	73.9	73.9
	Poor	6	26.1	26.1	100.0
	Total	23	100.0	100.0	



The mean of the above scores

OMAS score - 67.83

Baird &Jackson score- 75.26

AOFAS score- 77.65

Even though the mean score of Baird &Jackson score is high compared to OMAS score, still the mean of Baird &Jackson score is below its good outcome score

(i.e more than 80) , where as in OMAS score the good outcome score is 60-80 .

Baird &Jackson score also includes radiological criteria in its outcome compared to the other two, which also contributes to more number of poor outcome while analyzing outcome in this score.

OUT COME IN REALATION TO THE GRADE OF OPEN WOUND

GRADE OF OPEN WOUND (GUSTILO - ANDERSON) AND OMAS OUTCOME

Crosstab

			OMS Outcome		Total
			Good	Fair	
GRADE OF OPEN WOUND (GUSTILLO - ANDERSON)	GRADE I	Count	2	0	2
		% of Total	8.7%	.0%	8.7%
	GRADE II	Count	3	1	4
		% of Total	13.0%	4.3%	17.4%
	GRADE III A	Count	6	4	10
		% of Total	26.1%	17.4%	43.5%
	GRADE III B	Count	3	4	7
		% of Total	13.0%	17.4%	30.4%
Total		Count	14	9	23
		% of Total	60.9%	39.1%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.578[a]	3	.461
Likelihood Ratio	3.269	3	.352
Linear-by-Linear Association	2.436	1	.119
N of Valid Cases	23		

a. 7 cells (87.5%) have expected count less than 5. The minimum expected count is .78.

Functional outcome using OMAS score shows,

- Out of 10 patients (43.5%) of Gr III A open fractures 6 patients had good outcome and 4 patients had fair outcome .Among Gr IIIB open fractures (7 patients) 3 patients had good outcome and 4 patients had fair outcome.
- Gr I open fractures – good outcome in 2 patients and Gr II – 3 good, 1-fair outcome.

GRADE OF OPEN WOUND (GUSTILO - ANDERSON) - BAIRD JACKSON SCORE OUTCOME

Crosstab

			BAIRD jackson score Outcome			
			Good	Fair	Poor	Total
GRADE OF OPEN WOUND (GUSTILLO - ANDERSON)	GRADE I	Count	2	0	0	2
		% of Total	8.7%	.0%	.0%	8.7%
	GRADE II	Count	0	1	3	4
		% of Total	.0%	4.3%	13.0%	17.4%
	GRADE III A	Count	1	1	8	10
		% of Total	4.3%	4.3%	34.8%	43.5%
	GRADE III B	Count	0	2	5	7
		% of Total	.0%	8.7%	21.7%	30.4%
Total		Count	3	4	16	23
		% of Total	13.0%	17.4%	69.6%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.967[a]	6	.014
Likelihood Ratio	12.173	6	.058
Linear-by-Linear Association	4.293	1	.038
N of Valid Cases	23		

a. 11 cells (91.7%) have expected count less than 5. The minimum expected count is .26.

While using Baird &Jackson score, Gr I open fractures (2 cases) had good outcome. Out of 4 Gr II fractures 3 had poor outcome, 1 fair outcome, and out of 10 Gr IIIA fractures 8 had poor outcome, 1 fair and 1 good outcome.

Gr IIIB fractures – 5 had poor outcome and 2 had fair outcome.

GRADE OF OPEN WOUND (GUSTILO - ANDERSON) - AOFAS OUTCOME

Crosstab

			AOFAS Outcome		
			Good	Poor	Total
GRADE OF OPEN WOUND (GUSTILLO - ANDERSON)	GRADE I	Count	2	0	2
		% of Total	8.7%	.0%	8.7%
	GRADE II	Count	3	1	4
		% of Total	13.0%	4.3%	17.4%
	GRADE III A	Count	7	3	10
		% of Total	30.4%	13.0%	43.5%
	GRADE III B	Count	5	2	7
		% of Total	21.7%	8.7%	30.4%
Total		Count	17	6	23
		% of Total	73.9%	26.1%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.810[a]	3	.847
Likelihood Ratio	1.311	3	.727
Linear-by-Linear Association	.416	1	.519
N of Valid Cases	23		

a. 6 cells (75.0%) have expected count less than 5. The minimum expected count is .52.

While using AOFAS score , out of 10 Gr III A patients 7 had good outcome and 3 had poor outcome. Gr IIIB – 5 good outcome and 2 poor outcome(total 7 patients)

Gr I – 2 patients good outcome , Gr II – 3 patients good , 1 – poor outcome

METHOD OF FIXATION AND OUTCOME

FIXATION AND OMAS OUTCOME

Crosstab

			OMS Outcome		
			Good	Fair	Total
FIXATION	EX FIX&K WIRE	Count	8	3	11
		% of Total	34.8%	13.0%	47.8%
	TBW&KWIRE	Count	1	1	2
		% of Total	4.3%	4.3%	8.7%
	Screw & 1/3 tubular palte	Count	3	0	3
		% of Total	13.0%	.0%	13.0%
	Ex fix	Count	0	4	4
		% of Total	.0%	17.4%	17.4%
	Exfix / TBW & 1/3 tubular plate	Count	1	1	2
		% of Total	4.3%	4.3%	8.7%
	Exfix & 1/3 plate for fibula	Count	1	0	1
		% of Total	4.3%	.0%	4.3%
Total		Count	14	9	23
		% of Total	60.9%	39.1%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.641[a]	5	.086
Likelihood Ratio	12.353	5	.030
Linear-by-Linear Association	1.124	1	.289
N of Valid Cases	23		

a. 11 cells (91.7%) have expected count less than 5. The minimum expected count is .39.

The 4 patients (17.4%) (Gr III open fractures) treated with external fixation alone had fair outcome in OMAS score. In other group of Gr III open fractures treated with external fixation with minimal internal fixation (k wires) improves the outcome significantly(34.8%- good , 13% - fair)

FIXATION AND BAIRD JACKSON SCORE OUTCOME

Crosstab

			BAIRD jackson score Outcome			
			Good	Fair	Poor	Total
FIXATION	EX FIX&K WIRE	Count	1	2	8	11
		% of Total	4.3%	8.7%	34.8%	47.8%
	TBW&KWIRE	Count	0	0	2	2
		% of Total	.0%	.0%	8.7%	8.7%
	Screw & 1/3 tubular palte	Count	2	1	0	3
		% of Total	8.7%	4.3%	.0%	13.0%
	Ex fix	Count	0	0	4	4
		% of Total	.0%	.0%	17.4%	17.4%
	Exfix / TBW & 1/3 tubular plate	Count	0	1	1	2
		% of Total	.0%	4.3%	4.3%	8.7%
	Exfix & 1/3 plate for fibula	Count	0	0	1	1
		% of Total	.0%	.0%	4.3%	4.3%
Total		Count	3	4	16	23
		% of Total	13.0%	17.4%	69.6%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	13.947[a]	10	.175
Likelihood Ratio	14.526	10	.150
Linear-by-Linear Association	.004	1	.951
N of Valid Cases	23		

a. 17 cells (94.4%) have expected count less than 5. The minimum expected count is .13.

69.6% of patients shows poor outcome while analyzing using Baird &Jackson score whatever be the method of fixation , indicating perfect anatomical alignment of ankle mortice , which is possible only by open reduction and internal fixation (which may not be possible in all open fractures) to get better outcome using this score.

FIXATION AND AOFAS OUTCOME

Crosstab

			AOFAS Outcome		
			Good	Poor	Total
FIXATION	EX FIX&K WIRE	Count	9	2	11
		% of Total	39.1%	8.7%	47.8%
	TBW&KWIRE	Count	1	1	2
		% of Total	4.3%	4.3%	8.7%
	Screw & 1/3 tubular palte	Count	3	0	3
		% of Total	13.0%	.0%	13.0%
	Ex fix	Count	1	3	4
		% of Total	4.3%	13.0%	17.4%
	Exfix / TBW & 1/3 tubular plate	Count	2	0	2
		% of Total	8.7%	.0%	8.7%
	Exfix & 1/3 plate for fibula	Count	1	0	1
		% of Total	4.3%	.0%	4.3%
Total		Count	17	6	23
		% of Total	73.9%	26.1%	100.0%

Chi-Square Tests

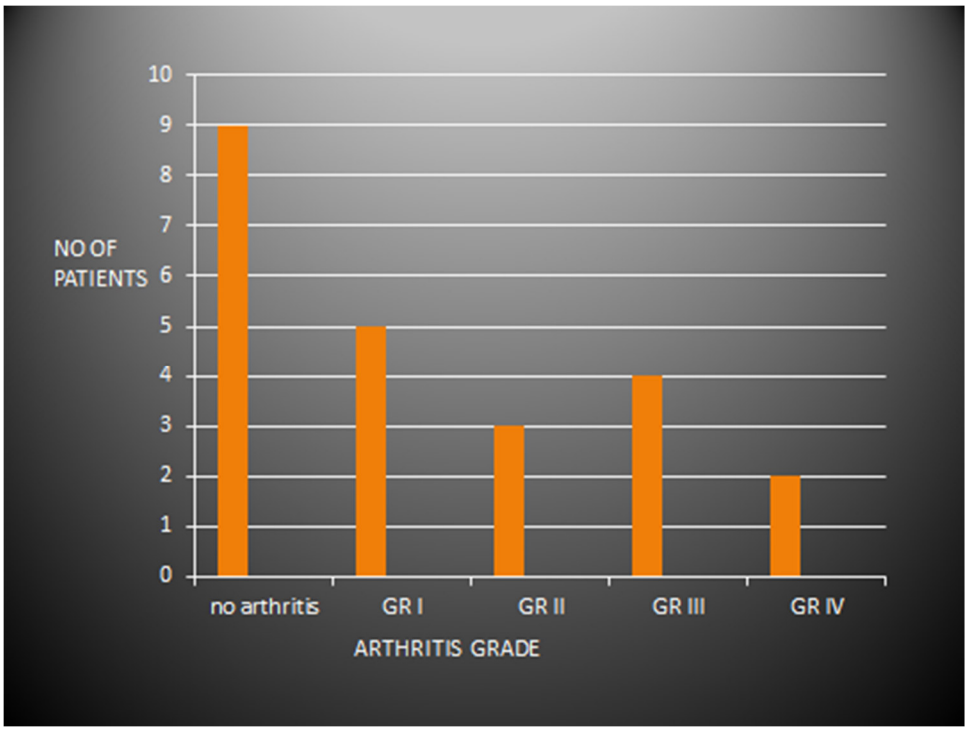
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.031[a]	5	.155
Likelihood Ratio	8.700	5	.122
Linear-by-Linear Association	.161	1	.688
N of Valid Cases	23		

a. 11 cells (91.7%) have expected count less than 5. The minimum expected count is .26.

AOFAS score also shows poor outcome in patients treated with external fixation alone (3 had poor outcome out of 4) , indicating a stable ankle for better outcome in open ankle fractures.

POST TRAUMATIC OSTEOARTHRITIS OF ANKLE (PTOA)

The prevalence of post traumatic arthritis in our study as follows



39.1 % of patients (9 patients) show gr II , gr III& gr IV osteoarthritic changes and 21.7% of patients (5 patients) show gr I arthritis and 39.1% (9 patients) show no arthritic changes.

The overall analysis and results shows,

- Open ankle fractures predominant in male (87%) compared to female (13%)
- The most common cause in our study is road traffic accidents(69%) , followed by self fall (13%) and fall from height(13%)
- Majority of the patients presents as Gr III A open fractures (gustilo – Anderson) 43.5 % followed by Gr III B open fractures (30.4%) and bi malleolar fractures are common (60.9%)
- Based on the observations of the Lauge – Hansen and AO/OTA classifications , supination external rotation type 4 (SER 4) and type 44B2 (AO) are more prevalent .
- 34 % of the patients required the plastic procedures in the form of SSG & flap cover and 39 % wounds healed with secondary intention and 26.1% patients wound healed with primary closure
- Outcome analysis based on Olerud Molander score 61% of patients show good results and 39% patients show fair results
- Based on Baird – Jackson scoring system 69.67% patients show poor results as this criteria includes radiological criteria in to the scoring .13% of patients show good results and 17% show fair results.

- AOFAS (American orthopedic foot and ankle society score) – out come score shows 73% patients with good results and 26% with poor results.
- Out of 23 patients , fracture united in 19 patients , mal united in 4 patients .
- None of the fracture went for non-union.
- On radiographic analysis 39.1 % of patients (9 patients) show Gr II , Gr III& Gr IV osteoarthritic changes and 21.7% of patients (5 patients) show gr I arthritis and 39.1% (9 patients) show no arthritic changes.

DISCUSSION

The presence of open fractures requires thorough evaluation of the soft tissues to assess their viability in light of the additional trauma of major surgery. Meticulous wound debridement is mandatory and is the cornerstone of open ankle fracture treatment.

In our study of 23 patients with open fractures of the ankle , the mean age is 41.74 years .In a study of epidemiology of ankle fractures by Charles M Court-Brown et al [2] the mean age group was 45 years (In the 3-year study period, 1,500 ankle fractures were treated in the Edinburgh Orthopaedic Trauma Unit.)

In our study male patients are predominantly involved (87%) and the most common cause being road traffic accidents(69.6%) , followed by self fall(13%) and fall from height(13%) .

The epidemiology appears to be varying with time: Between

1950 and 1980 an increase in incidence amongst younger males and elderly females was seen – BENGNER et al [38](Acta Orthop Scandinavia) .

However more recently the incidence amongst younger males has appeared to remain static whilst the increase in elderly women has continued-

THUR CK et al [39](epidemiology of ankle fractures – Acta orthop 2012) & KOVAL KJ et al[40] (J orthop trauma 2005)

The mechanism of injury has also changed with a reduction in fractures occurring because of severe trauma between 1950 and 1980 and a concomitant increase in the proportion of fractures caused by sporting activity in males .

The already high incidence of ankle fractures is increasing sharply in line with the ageing demographic of most Western populations. Kannus et al[41]. reported an increase of 319% in the overall annual number of low-energy ankle fractures in elderly patients admitted to hospital over the three decades between 1970 and 2000. From this data they predicted that the number of low-energy ankle fractures could be expected to triple by 2030. They forecast a higher rate of increase in females.

The epidemiology of the specific fracture patterns does however vary. Patients with an AO/OTA type C fracture more commonly sustain their injury because of a fall from a height or a motor vehicle accident than patients with AO/OTA type A or B fractures in which the most common cause is a simple fall – COURT BROWN CM et al [1].

In our study RTA is the predominant mode of injury with AO fracture types 44B2 and 44 A2 more prevalent followed by 44C1.

With regard to the grade of open fractures , we get more number of Gr III A open fractures (43.5%) and GrIII B fractures (30.4%) than Gr I(8.7%) and GrII(17.4%) fractures , since our institute is the tertiary care referral centre . This is also attributed the increase in the number of high vlocity road traffic accidents . UMRAZ KHAN et al (Management of Severe Open Ankle Injuries)[42] –" If

the viability cannot be guaranteed and there are other impediments to wound healing (e.g., diabetes, high alcohol intake, intravenous drug abuse), one should delay internal fixation until the skin has declared itself to be viable."

All the fractures were debrided and skeletal stabilisation done within 24 hours , most common method of fixation in our study(47.8%) , ankle spanning external fixation with k wires (minimal internal fixation). The wound healing is by secondary intention 39.1% of cases, and a plastic procedure in the form of SSG or Flap cover needed in 34.3% of cases. Internal fixation was done in 21.7% cases

(5 cases) – Gr I – 2 cases and Gr III – 3 cases .

The functional outcome shows 69.1% good results and 39.1 % fair results (OMAS score) and 13% good , 17.4% fair , 69.6% poor (baird jackson score) and 73.1% good and 26.1% poor results (AOFAS score) , in which baird jackson score includes radiological parameters also in scoring .

The incidence of PTOA has been reported as high as 70% with ankle fractures due to rotational forces being the most common cause - HORISBERGER M et al [43](J OrthopTrauma 2009;23:60.7.) It occurs following a failure of restoration of normal anatomy due to mal/nonunion and is the most common indication for ankle arthrodesis. When there is a significant displacement, anatomical reduction is more likely to be achieved through surgical means thus reducing long term risk of developing PTOA. This is especially true in cases of the lateral talar displacement

where 1 mm displacement has been shown to reduce the tibio.talar contact area by an average of 42% resulting in peak loads - RAMSEY PL et al[22] (J Bone Joint Surg Am 1976;58:356.7.)

It has been shown the latency time between injury and developing end stage ankle OA is 20.9 years. Given the high incidence of Ankle fractures in young patients, ankle arthrodesis in middle age patients is a very real consequence of PTOA. A patient journey to arthrodesis involves chronic pain leading to functional impairment, both of which significantly contribute to morbidity.

In our study arthritic changes observed in 39.1 % of patients

(GrII,III,IV) , but so far we have not done ankle arthrodesis in our patients.

COMPARISON WITH OTHER STUDIES

	TYPE OF STUDY	# TYPE	GUSTILLO	PROTOCOL	RESULTS
Bray et al	Retrospective n- 31	Uni malleolar 13 Bimalleolar 12 Trimalleolar6	I: 12 II: 9 III: 10	Group I (’73–’79): debridement, closed reduction, immobilization or delayed ORIF, delayed closure. Group II(’79–’84) : debridement, irrigation, AB, immediate ORIF, delayed primary closure	Pain/function of both groups are same. Group II: better ROM
Franklin et al	Retrospective N – 38	Uni malleolar 8 Bi malleolar 24 Trimalleolar10	I:12,II:14,III:16	Debridement, irrigation, AB, immediate ORIF, delayed primary closure, NWB 6 weeks	Function: Excellent, 26; fair/poor: 9
Jacque – maire et al	Retrospective n- 26	Bi malleolar 26	I-5,II-16, III-5	I: debridement, closed reduction immobilization II: debridement and immediate ORIF	Good: 17, average/bad: 9
JOSHI et al	Prospective N - 30		I-11, II – 12, IIIA-5 , IIIB-2	Debridement, irrigation, AB, immediate ORIF, soft tissue management according to fracture grade	Functional (Ketenjian): Excellent 22 Good 8 Fair: 2
LEE et al	Retrospective 47	AO type B2	I-26,II-21,	Debridement, irrigation, AB, immediate ORIF, primary wound closure	Baird& Jackson ankle score: excellent/good: 90%
WHITE et al	Retrospective 14 (all DM)	Unimalleolar – 1 Bimalleolar -4 Trimalleolar-4	I-1,II-5,IIIA-4,IIIB-4	Debridement, irrigation, AB, Immediate ORIF/Flx ex. 1 cast, 2 amputations. Delayed closure/SSG/Xaps	Good – 9 Poor - 5

OUR STUDY	**Prospective &retrospective n-23**	**Uni malleolar-7 Bi malleolar-14 Trimalleolar - 2**	**I-2,II-4,IIIA-10, IIIB - 7**	**Debridement, irrigation, , immediate ORIF gr I & gr II , ex fix & minimal internal fixation for gr IIIA& gr IIIB, soft tissue management according to fracture grade**	**OMAS – good 14 Fair-9 B&J - good-3 Fair-4 Poor-16 AOFAS – good-17 Poor 6**

CONCLUSION

The complexity of the open ankle fractures warrents treatment by orthopaedic surgeons who are experienced in this fractures.

Emergency wound debridement , adequate wound management , rigid skeletal stabilisation improves the outcome significantly.

Open reduction and internal fixation in Gr I and GrII open ankle fractures reults in excellent patient outcome.

Gr III open fractures managed with external fixation and minimal internal fixation provides better results compared with external fixation alone emphasise the importance on stable skeletal fixation in the management of these open fractures.

Post traumatic osteoarthritis of the ankle (PTOA) , the most common indication for ankle arthrodesis occurs in significant number in our study(around 39.1%) , contribute significantly to the poor outcome.

CASE ILLUSTRATIONS – CASE I

Name : Mr. Senthil kumar Ip no:128563

Age : 32yrs unit: Prof. M.S/ ortho IV

Sex: male

Address : c/o valarmathi ,24 manja kollai st DOA:30/11/15

Aminiji karai , Chennai 29 DOD:24/12/15

Phone no:9791161040, 9941232189

Cause of injury: fall from height

Mode of injury: twisting force

Associated injuries: nil

Grade of open wound: Gr II

Type of fracture: SER IV ,44B3

Fixation method: ORIF with k wire for fibula and TBW for medial malleoli

Pin tract infection/loosening: nil

Wound management: primary closure

pre op

Immediate post op

6 weeks follow up

After implant exit (9 months)

CASE II

Name : Mrs.Shantha Ip no:116624

Age : 54yrs unit: prof. vsv/ ortho II

Sex: female

Address : 10/21, Dr.natesan st, DOA:28/10/15

Triplicane , Chennai -05 DOD:18/12/15

Phone no: 8056233078

Cause of injury: RTA

Mode of injury: 4 Wheeler vs 2 wheeler

Associated injuries: # 5 th MT

Grade of open wound: Gr IIIA

Type of fracture: SER II, 44c1

Fixation method: ex fix and k wire

Pin tract infection/loosening: superficial pin tract infection

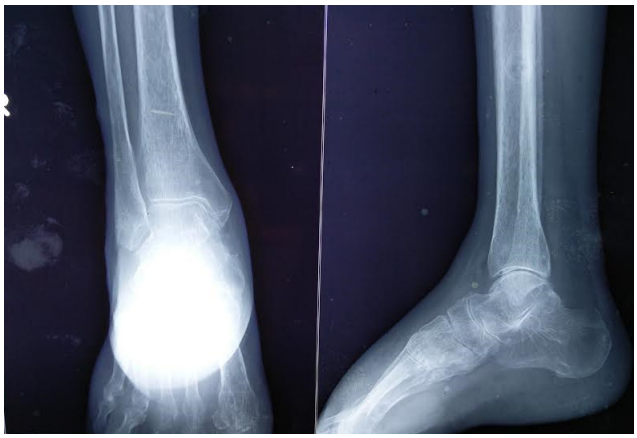
Wound management: SSG

Pre op

IMMEDIATE POST OP

6 WEEKS FOLLOW UP

AFTER IMPLANT EXIT



10 MONTHS FOLLOW UP

CASE III

Name : Mr. Pabithran Ip no:74025

Age : 20yrs unit: prof .M.S/orthoIV

Sex: male

Address : 3/14,perumal koil st, borex nagar, DOA:07/07/16

Peravallur, ponneri tk, thiruvallur DOD:13/07/16

Phone no: 9025086030

Cause of injury: self fall

Mode of injury: twisting force

Associated injuries:nil

Grade of open wound: Gr I bi malleolar

Type of fracture: PER III, 44c1

Fixation method:1/3 tubular plate for fibula, 4.0 mm cancellous screw for medial malleolus

Pin tract infection/loosening: nil

Wound management: primary closure

Pre op

Immediate post op

3 months post op

CASE IV

Name : Mr. Vadivelu Ip no:58139

Age : 45yrs unit: Prof. M.S/ ortho IV

Sex: male

Address : 4/42, thaiyur, perima nagar DOA :29/05/16

Kelambakkam , Chennai DOD:21/06/16

Phone no: 9500176072

Cause of injury: RTA

Mode of injury: two wheeler vs four wheeler

Associated injuries: no

Grade of open wound: Gr III B compound bi malleolar

Type of fracture: SER IV , 44B2

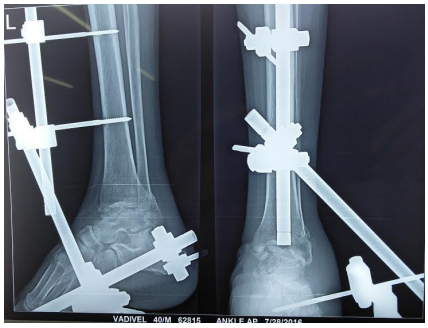
Fixation method: external fixation

Pin tract infection/loosening: yes

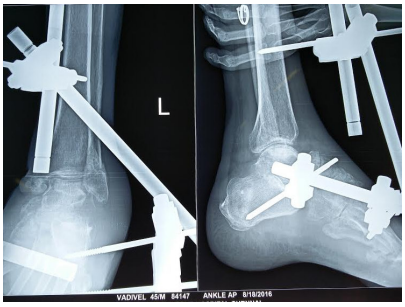
Wound management: secondary intention

Pre op

Immediate post op



2 months post op



3 months post op after implant exit

COMPLICATIONS

SUPERFICIAL WOUND INFECTIONS

DEEP INFECTIONS

LOSS OF FIXATION

AFTER CORRECTION

AFTER EXFIX REMOVAL

POST TRAUMATIC OSTEOARTHRITIS OF ANKLE(PTOA)

NAME	AGE /SEX	IP NO	DIAGNOSIS	CAUSE	#TYPE LH/ AO	FIXATION	WOUND	OMAS OUT COME	Baird jackson	AOFAS	X RAY/ OA	EX FIX REMOVAL/ IMPLANT EXIT	ASSOCIATED INJURY
1)Mr.Senthilkumar	32/ M	128563	GR II Tri malleolar	Self fall	SER4 44B2	TBW&KWIRE	Primary closure	70 good	72 poor	82 good	Union Gr II	9 MONTHS implant exit	no
2)Mr.Mohan sha	70/ M	32779	GR IIIB bi malleolar	RTA	PER3 44C1	EX FIX&K WIRE	Secondary intention	70 good	82 fair	82 good	Mal union lat.malleoli Gr III	50 days	no
3)Mr.natarajan	64/ M	50453	GR IIIA medial malleoli	RTA	PAB1 44A2	Ex fix & k wire	Secondary intention	50 fair	69 poor	66 poor	Union GR II	2 months	#calcaneum
4)Mr.Pabithran	20/ m	74025	Gr I bi malleolar	Self fall	PER3 44C1	Screw & 1/3 tubular palte	Primary closure	75 good	95 good	87 good	Union NO OA	_	no
5)Mrs.Parveen	28/f	30819	Gr IIIA lateral malleoli	Fall from ht	SER2 44A1	Ex fix & k wire	Primary closure	55 fair	60 poor	54 poor	Union GR IV	65 days	#L1
6)Mrs.Shantha	54/f	116624	GrIIIB lateral malleoli	RTA	SER2 44c1	EX FIX & k wire	SSG	90 good	95 good	88 good	Union GR I	3 months	# 5th MT
7)Mr.Selvaprabhu	27/ m	27944	Gr I bi malleolar	Fall from ht	SER4 44B2	Screw & 1/3 tubular plate	Primary closure	85 good	92 good	89 good	Union GR I	_	no
8)Mr.Perumal	40/ m	28031	Gr III A bi malleolar	Fall from train	SER4 44A2	Ex fix	SSG	60 fair	65 poor	56 poor	Union GRIV	2 months	#tibial plateau
9)Mr.Venkatesan	32/ m	76963	Gr IIIB bi malleolar	RTA	SER4 44B2	Exfix / kwire for fibula &screw for medial malleoli	Secondary intention	60 fair	77 poor	82 good	Non Union Lat.malleoli NO OA	2 months	no
10)Mr.Vadivelu	45/ m	58139	Gr IIIB bi malleolar	RTA	SER4 44B2	Ex fix	Secondary intention	55 fair	58 poor	73 poor	Mal Union GRIII	70 days	No

NAME	AGE /SEX	IP NO	DIAGNOSIS	CAUSE	#TYPE LH/ AO	FIXATION	WOUND	OMAS OUT COME	Bairdjackson	AOFAS	X RAY/ OA	EX FIX REMOVAL/ IMPLANT EXIT	ASSOCIATED INJURY
11)Mrs.Lakshmi	48/f	73897	Gr III A bi malleolar	RTA	SER2 44C1	Exfix & 1/3 plate for fibula	Secondary intention	75 good	73 poor	82 good	Union noOA	3 months	no
12)Mr.Subramani	59/ m	86037	Gr II bi malleolar	RTA	SER4 44B2	Screw & 1/3 tubular plate	Primary closure	75 good	82 fair	82 good	Union noOA	-	no
13)Mr.Mani	57/ m	57973	Gr IIIB bi malleolar	RTA	SAD2 44B2	Ex fix	SSG & FLAP COVER	40 fair	45 poor	59 poor	Mal union GR III	4 months	no
14)Mr.Ashok kumar	20/ m	106100	Gr IIIA medial malleolus	RTA	PER1 44A2	Ex fix &k wire	SSG	85 good	77 poor	82 good	Union noOA	2 months	no
15)Mr.Vasudevan	56/ m	74563	Gr IIIA bi malleolar	Self fall	PER3 44C1	Ex fix & k wire	Primary closure	70 good	77 poor	86 good	Union GR I	45 days	no
16)Mr.Selvam	45/ M	73664	GrIIIA lateral malleoli	RTA	SER2 44C2	Ex fix	SSG	60 fair	78 poor	82 good	Union GR I	70 days	no
17)Mr.Mahesh	26/ m	12434	GRIII A bi malleolar	RTA	SAD2 44A2	Exfix / TBW & 1/3 tubular plate	SSG	75 good	83 fair	83 good	Union noOA	2 months	no
18)Mr.Shanmugam	50/ m	14238	Gr II lateral malleolus	RTA	SAD2 44B1	Ex fix & k wire	Secondary intention	70 good	77 poor	82 good	Union noOA	2 months	no
19) Mr.Uma maheswaran	53/ m	93260	GR III a bi malleolar	RTA	PER1 44A2	Ex fix & k wire	Secondary intention	85 good	79 poor	83 good	Union noOA	3 months	no
20) Mr.Chinnan	46/ m	59732	GRIII b bi malleolar	RTA	SAD2 44A3	Ex fix & k wire	SSG	75 good	73 poor	82 good	Union noOA	75 days	#2nd MT

NAME	**AGE /SEX**	**IP NO**	**DIAGNOSIS**	**CAUSE**	**#TYPE LH/ AO**	**FIXATION**	**WOUND**	**OMAS OUT COME**	**Baird jackson**	**AOFAS**	**X RAY/ OA**	**EX FIX REMOVAL/ IMPLANT EXIT**	**ASSOCIATED INJURY**
21)Mr.Murali	27/ m	87709	Gr III B medial malleolus	RTA	PER1 44A2	Ex fix & k wire	Secondary intention	75 good	83 fair	83 good	Union Gr I	3 months	#calcaneum
22)Mr.Surya	18/ m	45617	Gr IIIB bi malleolar	RTA	SER2 44B2	Ex fix & k wire	SSG	60 fair	78 poor	82 good	Union No OA	75 days	no
23)Mr.Prabakaran	38/ m	47406	GrII Tri malleolar	Fall from ht	SER 4 44B2	Cancellous screw fixation	Secondary intention	45 Fair	61 Poor	59 Fair	Union Gr II OA	-	#talar neck

Abbreviations

LH – Lauge hansen classification

SER- supination external rotation

PER- pronation external rotation

SAD – supination adduction

AO – AO Classification

OMAS – Olerud and molander ankle score

Baired- Jackson ankle outcome score

AOFAS – American Orthopedic foot and ankle society score

OA – osteoarthritis grade

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ANNEXURE - I

INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE, CHENNAI 600 003

EC Reg.No.ECR/270/Inst./TN/2013
Telephone No.044 25305301
Fax: 011 25363970

CERTIFICATE OF APPROVAL

To
Dr.D.Santhana Kumaran
Post Graduate in M.S. (Orthopaedics)
Inst. of Orthopaedics & Traumatology
Madras Medical College
Chennai 600 003

Dear Dr.D.Santhana Kumaran,

The Institutional Ethics Committee has considered your request and approved your study titled**"OUTCOME ANALYSIS OF OPENFRACTURES OF THE ANKLE "- NO. (II) 33032016.**

The following members of Ethics Committee were present in the meeting hold on **22.03.2016** conducted at Madras Medical College, Chennai 3

1.Dr.C.Rajendran, MD.,	:Chairperson
2.Dr.R.Vimala,MD.,Dean,MMC,Ch-3	:Deputy Chairperson
3.Prof.Sudha Seshayyan,MD., Vice Principal,MMC,Ch-3	: Member Secretary
4.Prof.P.Raghumani,MS, Dept.of Surgery,RGGGH,Ch-3	: Member
5.Dr.Baby Vasumathi, Director, Inst. of O&G,Ch-8	: Member
6.Prof.M.Saraswathi,MD.,Director, Inst.of Path,MMC,Ch-3:	Member
7.Prof.Srinivasagalu,Director,Inst.of Int.Med.,MMC,Ch-3	: Member
8.Tmt.J.Rajalakshmi, JAO,MMC, Ch-3	: Lay Person
9.Thiru S.Govindasamy, BA.,BL,High Court,Chennai	: Lawyer
10.Tmt.Arnold Saulina, MA.,MSW.,	:Social Scientist

We approve the proposal to be conducted in its presented form.

The Institutional Ethics Committee expects to be informed about the progress of the study and SAE occurring in the course of the study, any changes in the protocol and patients information/informed consent and asks to be provided a copy of the final report.

MADRAS MEDICAL COLLEGE
31 MAR 2016

Member Secretary – Ethics Committee

MEMBER SECRETARY
INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE
CHENNAI-600 003

ANNEXURE – II

INSTITUTE OF ORTHOPAEDICS & TRAUMATOLOGY, RGGGH, MMC, CHENNAI-03

PROFORMA - OPEN ANKLE FRACTURES

Name :

IP No:

Age :

Unit :

Sex :

D.O.A. :

Address :

D.O.D. :

Phone No. :

Cause of injury

Mode of Injury

Associated Injuries

Grade of open fracture

Type of Fracture (Classification)

Fixation Method

Post op Antibiotics

Pin Tract Infection / Pin Loosening

Wound maneagement – SSG/Primary Closure / Healed by secondary intention

Exfix removal done on

Implant removal done on

Wt.bearing started on

ANNEXURE – III

ஆராய்ச்சி தகவல் தாள்

ராஜீவ் காந்தி அரசு பொது மருத்துவமனைக்கு வரும் நோயாளிகளிடம் திறந்த காயத்துடன் கூடிய கணுக்கால் எலும்பு முறிவு குறித்த ஆராய்ச்சி நடைபெறுகிறது.

முடிவுகளை அல்லது கருத்துகளை வெளியிடும்போதோ அல்லது ஆராய்ச்சியின் போதோ தங்களது பெயரையோ அல்லது அடையாளங்களையோ வெளியிட மாட்டோம் என்பதையும் தெரிவித்துக் கொள்கிறோம்.

இந்த ஆராய்ச்சியில் பங்கேற்பது தங்களுடைய விருப்பத்தின் பேரில் தான் இருக்கிறது. மேலும் நீங்கள் எந்நேரமும் இந்த ஆராய்ச்சியிலிருந்து பின்வாங்கலாம் என்பதையும் தெரிவித்துக் கொள்கிறோம்.

இந்த சிறப்பு சிகிச்சையின் முடிவுகளை ஆராய்ச்சியின்போது அல்லது ஆராய்ச்சியின் முடிவின் போது தங்களுக்கு அறிவிக்கப்படும் என்பதையும் தெரிவித்துக் கொள்கிறோம்.

ஆராய்ச்சியாளர் கையொப்பம் **பங்கேற்பாளர் கையொப்பம்**

நாள் :
இடம் :

ஆராய்ச்சி ஒப்புதல் கடிதம்

ஆராய்ச்சி தலைப்பு

திறந்த காயத்துடன் கூடிய கணுக்கால் எலும்பு முறிவு குறித்த ஆராய்ச்சி

ராஜீவ் காந்தி அரசு பொது மருத்துவமனைக்கு வரும் நோயாளிகளிடம் திறந்த காயத்துடன் கூடிய கணுக்கால் எலும்பு முறிவு குறித்த ஆராய்ச்சி நடைபெறுகிறது.

பெயர்	:	தேதி	:
வயது	:	உள் நோயாளி எண்	:
பால்	:	ஆராய்ச்சி சேர்க்கை எண்	:

இந்த ஆராய்ச்சியின் விவரங்களும் அதன் நோக்கங்களும் முழுமையாக எனக்கு தெளிவாக விளக்கப்பட்டது.

எனக்கு விளக்கப்பட்ட விஷயங்களை நான் புரிந்துகொண்டு எனது சம்மதத்தை தெரிவிக்கிறேன்.

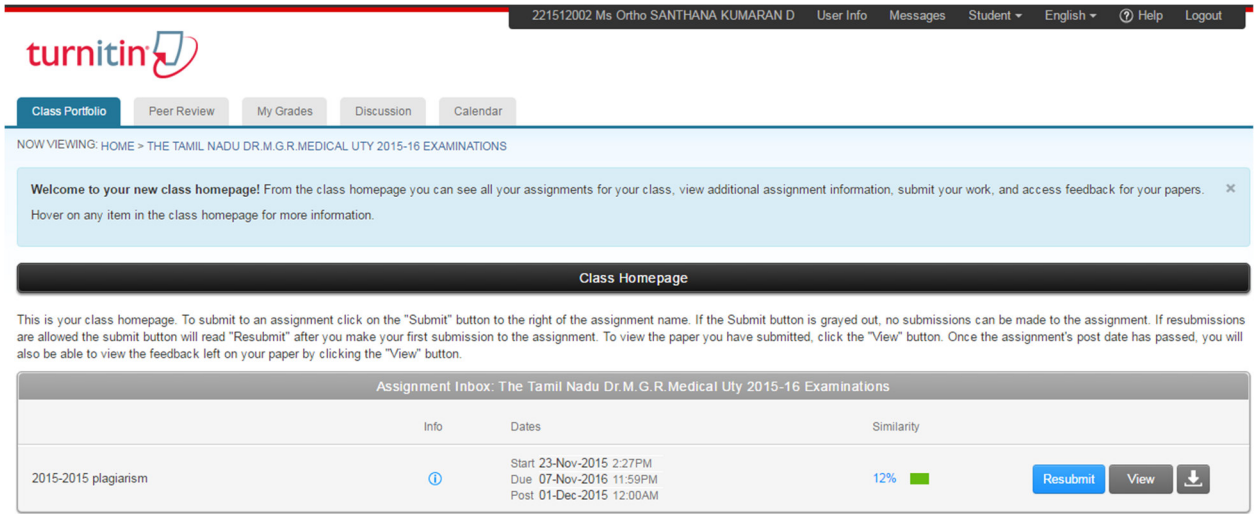
இந்த ஆராய்ச்சியில் பிறரின் நிர்பந்தமின்றி என் சொந்த விருப்பத்தின்பேரில் பங்கு பெறுகின்றேன். இந்த ஆராய்ச்சியில் இருந்து நான் எந்நேரமும் பின்வாங்கலாம் என்பதையும் அதனால் எந்த பாதிப்பும் ஏற்படாது என்பதையும் நான் புரிந்துகொண்டேன்.

நான் இந்த ஆராய்ச்சியின் விபரங்களைக் கொண்ட ஆராய்ச்சித் தகவல் தாளைப் பெற்றுக் கொண்டேன்.

இதன் மூலம் எந்த பின்விளைவும் ஏற்படாது என்று மருத்துவர் மூலம் தெரிந்து கொண்டு, நான் என்னுடைய சுய நினைவுடனும் மற்றும் முழு சுதந்திரத்துடனும் இந்த மருத்துவ ஆராய்ச்சியில் என்னை சேர்த்துக்கொள்ள சம்மதம் தெரிவிக்கிறேன்.

கையொப்பம்

ANNEXURE IV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This is your class homepage. To submit to an assignment click on the "Submit" button to the right of the assignment name. If the Submit button is grayed out, no submissions can be made to the assignment. If resubmissions are allowed the submit button will read "Resubmit" after you make your first submission to the assignment. To view the paper you have submitted, click the "View" button. Once the assignment's post date has passed, you will also be able to view the feedback left on your paper by clicking the "View" button.
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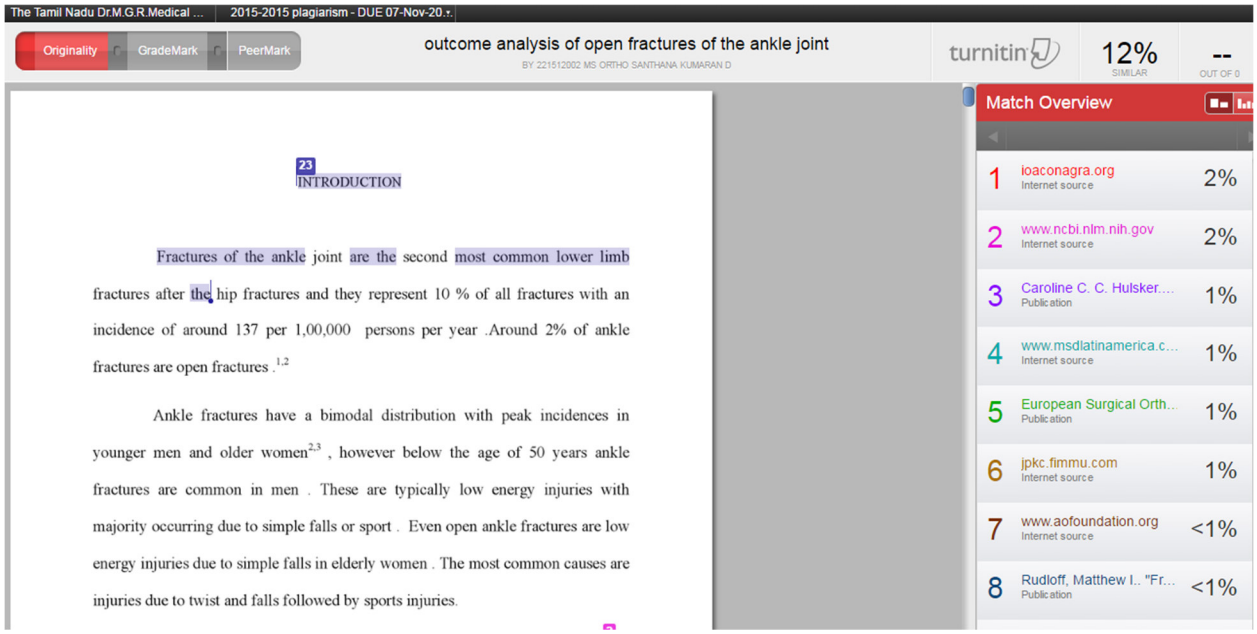
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outcome analysis of open fractures of the ankle joint
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INTRODUCTION
Fractures of the ankle joint are the second most common lower limb fractures after the hip fractures and they represent 10 % of all fractures with an incidence of around 137 per 1,00,000 persons per year .Around 2% of ankle fractures are open fractures .[1,2]
Ankle fractures have a bimodal distribution with peak incidences in younger men and older women[2,3] , however below the age of 50 years ankle fractures are common in men . These are typically low energy injuries with majority occurring due to simple falls or sport . Even open ankle fractures are low energy injuries due to simple falls in elderly women . The most common causes are injuries due to twist and falls followed by sports injuries.
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