FUNCTIONAL OUTCOME OF MEDIAL DISTAL TIBIAL LOCKING COMPRESSION PLATE FIXATION IN DISTAL TIBIAL FRACTURES – A PROSPECTIVE STUDY

Dissertation submitted for

M.S DEGREE EXAMINATION

BRANCH II-ORTHOPAEDIC SURGERY

INSTITUTE OF ORTHOPAEDICS AND TRAUMATOLOGY

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CHENNAI-600032

APRIL-2013

CERTIFICATE

This is to certify that this dissertation in **“FUNCTIONAL OUTCOME OF MEDIAL DISTAL TIBIAL LOCKING COMPRESSION PLATE FIXATION IN DISTAL TIBIAL FRACTURES – A PROSPECTIVE STUDY”***is a bonafide work done by Dr. DHANASEKARAN P.Runder my guidance during the period 2010–2013. This has been submitted in partial fulfilment of the award of M.S. Degree in Orthopedic Surgery (Branch–II) by The Tamilnadu Dr.M.G.R. Medical University, Chennai.***

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DECLARATION

I, **Dr. DHANASEKARAN P.R,** solemnly declare that the dissertation titled **"FUNCTIONAL OUTCOME OF MEDIAL DISTAL TIBIAL LOCKING COMPRESSION PLATE FIXATION IN DISTAL TIBIAL FRACTURES – A PROSPECTIVE STUDY"** was done by me at the Rajiv Gandhi Government General Hospital, Chennai-3, during 2011-2013 under the guidance of my unit chief **Prof. N.DEEN MOHAMED ISMAIL, M.S(Ortho), D.Ortho.**

The dissertation is submitted in partial fulfilment of requirement for the award of M.S. Degree (Branch –II) in Orthopaedic Surgery to **The Tamil Nadu Dr.M.G.R.Medical University.**

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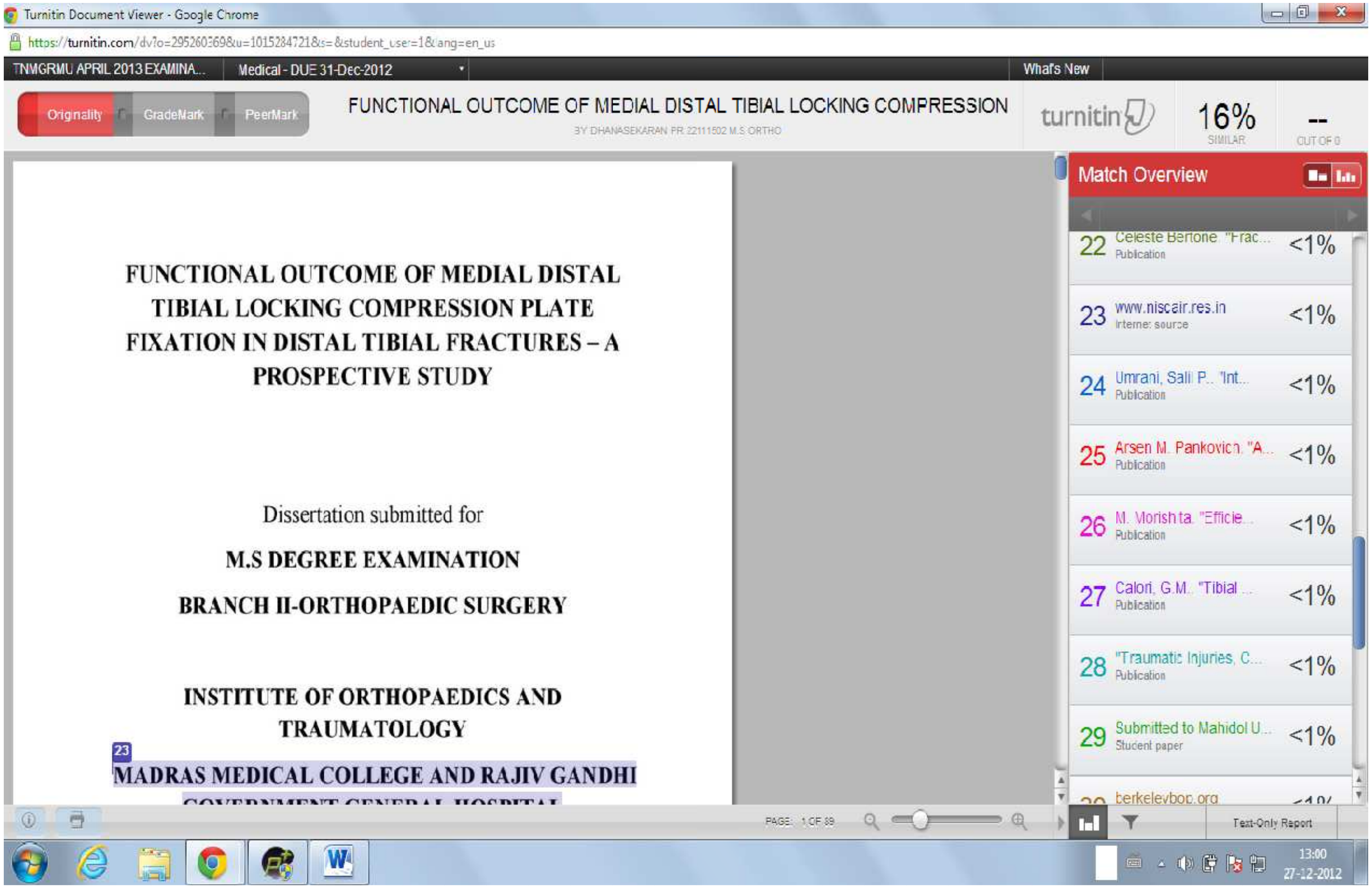
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CONTENTS

INTRODUCTION

Fractures of the distal tibia can be challenging to treat because of limited soft tissue, the subcutaneous location and poor vascularity[19,25]. Fractures of distal tibia remain a controversial subject despite advances in both non-operative and operative care. The goal in expect care is to realign the fracture, realign limb length and early functional recovery[32].

Fractures of distal tibia remains one of the most challenging for treatment because of high complication rates both from initial injury and also from treatment[42,43]. All these fractures are severe injuries. They are increased in frequency because of higher incidences of Road Traffic Accidents.

Accounts to 1% of all lower extremity fractures, 10% of tibial fractures and bilateral in 0-8% and compartment syndrome in 0-5%.

The mechanism of injury is axial loading due to talus hitting hard the lower end of the tibia[7]. The axial loading on the distal tibia determines the articular surface injury, metaphysealcomminution, joint impaction and severe associated soft tissue injuries[8,10]. Although the mechanism of injury may be complex, the predominant force is vertical compression. The location of the articular portion of the fracture is determined by the position of the foot at the moment of impact[3,4,6].

Fractures involving the distal third of tibia involve the metaphyseal flare which poses the difficulty of decreased implant contact leading to less stability and increased malalignment. Even minor malalignment in this region causes gross mechanical alternation of the ankle thereby leading to increased pain and functional disability.

Surgical fixation of distal tibial fractures can be difficult, and require careful preoperative planning. Fracture pattern, soft tissue injury, and bone quality critically influence the selection of fixation technique. Several techniques have emerged – conservative, hybrid external fixation, external fixation with limited internal fixation, percutaneous plate osteosynthesis and intramedullary nailing.

Non-surgical treatment is possible for stable fractures with minimal shortening, but malunion, shortening of affected leg, limitation of range of movement and early OA of ankle have all been reported following treatment of these fractures particularly pilon fractures[21,25,26].

External fixation can be useful in open fractures with soft tissue injury which preclude nail or plate fixation, but may result in inaccurate reduction, a relatively high rate of malunion, or nonunion and pin tract infection[33,34]. With regards to Intramedullary nail, a stable fixation with nail in distal tibia may be difficult to achieve because the hourglass shape of the intramedullary canal prevents a tight endosteal fit and compromises torsional and angular stability.

Secondary displacement of the fracture on insertion of nail, breakage of nail and locking screws and malunion of the tibia are potential risks. Classic open reduction and internal plate fixation require extensive soft tissue dissection and periosteal stripping even in expert hands, with high rates of complications, including infection and delayed union and nonunion[29,35].

Several minimally invasive plate osteosynthesis techniques have been developed, with union rates ranging between 80% and 100%. These techniques aim to reduce surgical trauma and to maintain a more biological favorable environment for fracture healing. Nevertheless, complications such as angular deformities greater than 7°, hardware failure and non-unions have been reported.

A new advance in this field is represented by the “locked internal external fixators”. These devices consist of plate and screw systems where the screws are locked in the plate at a fixed angle. Screw locking minimizes the compressive forces exerted by the plate on the bone because the plate does not need to be tightly pressed against the bone to stabilize the fracture[17,18].

The system works as flexible elastic fixation that putatively stimulates callus formation. The anatomical shape prevents primary displacement of the fracture caused by inexact contouring of a normal plate, and allows a better distribution of the angular and axial loading around the plate. As the plate is not compressed against the bone the periosteal supply is not disturbed which favors bone healing.

Despite with advances in identification, understanding and treatment of soft tissue injury and with the liberal use of Computed Tomography scanning, advances in implant design which includes locking plate technology, still the management of these challenging fractures remains elusive[39].

AIM AND OBJECTIVE

To Study and analyze the functional outcome of Distal Tibial fractures treated by Medial Distal Tibial Locking Compression Plate in our Institute of Orthopaedics and Traumatology, Madras Medical College and Rajiv Gandhi Government General Hospital Chennai over a period of May 2011 to November 2012.

HISTORY AND REVIEW OF LITERATURE

First described by French radiologist **Destot** in the year 1911, as ankle fractures that involve the weight bearing distal tibial articular surfaces are known as pilon fractures. This term was coined by Etienne Descot to describe fractures occurring within 5 cm of the ankle joint.

The term pilon was derived from French language and refers to a pestle, which is a club shaped tool used for mashing or grinding substance in mortar, or a large bar which is moved vertically to stamp.

Maisonneuve (1840), compares ankle with a mortise and tenon.

Sir Robert Jones described that, the most injured joint of the body was that of ankle, but it was treated least.

Bonin J.G. (1950): Coined the term Plafond which means ceiling in French. Though both can used interchangeably, pilon is a descriptive term which suggests, the talus acts as a hammer or pestle, that impacts and injures the tibial plafond.

In 1968 it was **Reudi** who published a paper on this topic, describing the fracture, principles of treatment and a classification system. His experience with immediate fixation of tibial fractures demonstrated durable results and few complications[41,42].

Kellamand **Waddeli**divided pilon fractures in two types based by the mechanism of injury as either rotational or axial loading or both[22].

Ovadiaand **Beal's** concluded that the final functional result correlates well with the accuracy of articular reduction. **Elter** and **Ganz** reported ninety five percent good results with open reduction. An anatomical reduction with good early clinical results did not guarantee against development of arthritis and pain[32].

Bone et.al and colleagues used combined internal and external fixation as their treatment for high energy tibial plafond fractures.

Wrysch et.al reported that fractures resulting from axial compression forces result in severe articular comminution and an increased severity of soft tissues[43].

Tornetta et.al described combined open stabilization of the articular fractures and neutralization of the metaphyseal fractures with hybrid external fixation without spanning the ankle joint[49].

Teeny SM, Wiss DA (1993) stated that percentage of complications and failures rise dramatically once a wound complication occurs[47].

Pugh and colleagues and **Angen**found that the use of external fixation was not a panacea, as they had more of malunion, nonunion and lower clinical scores and slower return to function when they compared with their own ORIF group[37].

Schatzker and Tile (1996): Developed a distinction between the soft tissue that is adequate for immediate fixation and the soft tissue that is not suitable for surgery because of swelling. In the second group a delay of 7 to 10 days was suggested prior to surgery, for the skin and soft tissues to return to a reasonable state[43].

Mast et.al recommended that if the definitive surgery cannot be performed within 8 to 12 hours, plan for a temporary treatment and definitive procedure is delayed till the resolution of the swelling. He also recommended that for length stable injuries casting is enough temporarily and for fractures with shortening calcaneal traction was applied to restore the length, before any definitive procedures[26].

McDade (1975) and **Yablon** et al (1977) stressed the importance of anatomical reduction and internal fixation of the lateral malleolus in their study.

Helfet DL et.al (2004): Developed the minimally invasive percutaneous plate osteosynthesis for distal tibia with low profile plate, following better understanding of the osseous fracture anatomy.

EVOLUTION OF LOCKING COMPRESSION PLATE

1890-1910	Lane (Open Fracture treatment)[23] Lane plate Lambotte's series W.Sherman (Metal alloys) Hey-Groves (Locking Screws)
1950-1960	Danis (Osteosynthesis)[23]
1980	Internal fixator system (Polish Surgeon)[23]
1990-2000	Blatter and weber (Wave plate)[23] Minimally invasive percutaneous osteosynthesis Schuhli nut Locking Plate
2000-2010	Locking and minimally invasive percutaneous plate osteosynthesis[23]

DEVELOPMENT OF LOCKING COMPRESSION PLATE

During the last two decades tremendous advances are made in the internal fixation of fractures by plating. The internal fixator system was first developed by a group of Polish surgeon in the 1980's. They developed the **ZESPOL** system. They based the design of their implant on a number of principles[23].

1. The screw should be fixed to the plate.
2. Compression between the plate and the bone should be eliminated.
3. The number of screws necessary for stable fixation should be reduced.
4. Plate stability and Inter fragmentary compression should be preserved.

The following devices lead to the development of the so called locked internal fixator.

1. **Schuhli locked plate**: This was devised by J. Mast. Schuhli nuts keep the plate away from the bone. It has three sharp projections. As it makes less direct contact between the plate and bone it acts low profile internal fixator. In addition, if in case of missing cortical bone, Schuhli nuts can act as proximal cortices and bicorticalfixation is feasible.[23]
2. **Point contact fixator (PC-FIX)**: These devices preserve the blood supply of the periosteum by point contact. These fixators are secured by monocortically inserted screws and hence have minimal contact. The

tapered head of the screw ensures that it lodges firmly in the plate hole and provides the required angular stability. PC-FIX was the first plate in which angular stability was achieved. PC-FIX was the basis for the further development of LISS[23.]

3. The angled blade plate devised by AO is the strongest implant providing that fixed angles gives improved stability.
4. Interlocking nail used in comminuted diaphyseal fracture proved that open anatomical reduction of the fragment is not necessary and close treatment of the comminuted fragments with splinting by intramedullary nail produces abundant callus and solid healing. These four developments, Schuhli nut, point contact plate, fixed angled blade plate and locked intramedullary nail naturally lead to the development of internal fixator by locked head plate[23].
5. During the last two decades bridge plating and less invasive and minimally invasive surgery was important development. Finally **M. Wagner and R.Frigg** developed the locking compression plate (LCP), which combine both locking and conventional plate. This development revolutionized operative fracture fixation[16,17,18,53].

PRINCIPLES OF LCP

Locked plates rely on a different mechanical principle to provide fracture fixation and in so doing they provide different biological environments for healing.

In conventional plates the strength of fixation, depends on the frictional force between the plate bone interface and the axial stiffness or pull out strength of the screw bone interface of the single screw farthest away from the fracture site during axial loading. Conventional plate creates contact stress at bone plate interface, compromising the periosteal blood supply.

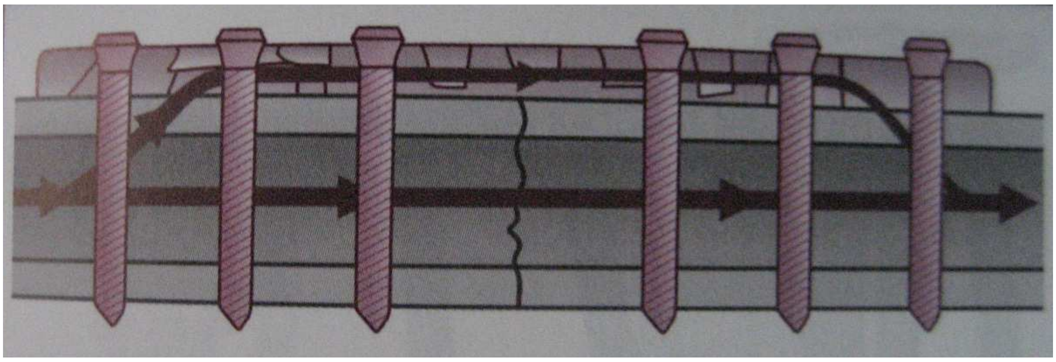
Under axial load, there is secondary loss of fixation post-operatively due to toggling of the screws in the plate as screws are not locked to the plate.

In the locked plates, they behave biologically and mechanically differently from that of conventional plate.

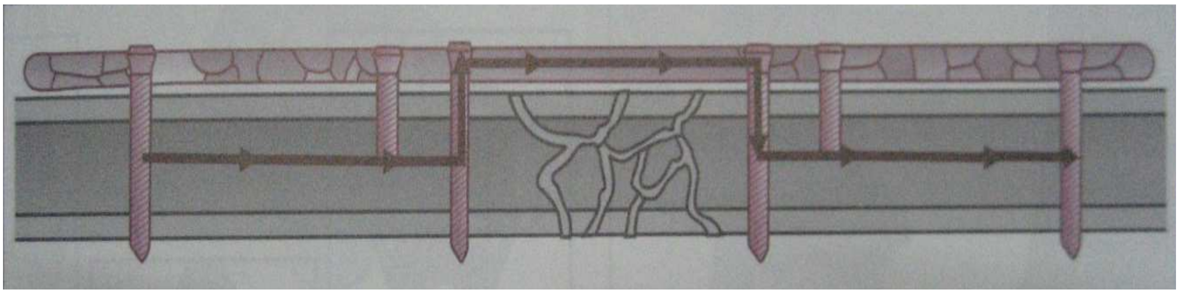
<u>Single Beam Construct:</u>

Locked plate is a single beam construct by design. Plate and screw act a single unit. Locked plate controls the axial orientation of the screw to the plate, thereby enhancing the screw-plate-bone construct by creating a single beam construct. In this construct there is no motion between the components of the beam that is the plate or the screw or the bone. This construct is 4 times stronger than load sharing construct which allows motion between the components of the beam[2,23].

Load transfer in conventional plate:



Load transfer in locking compression plate:

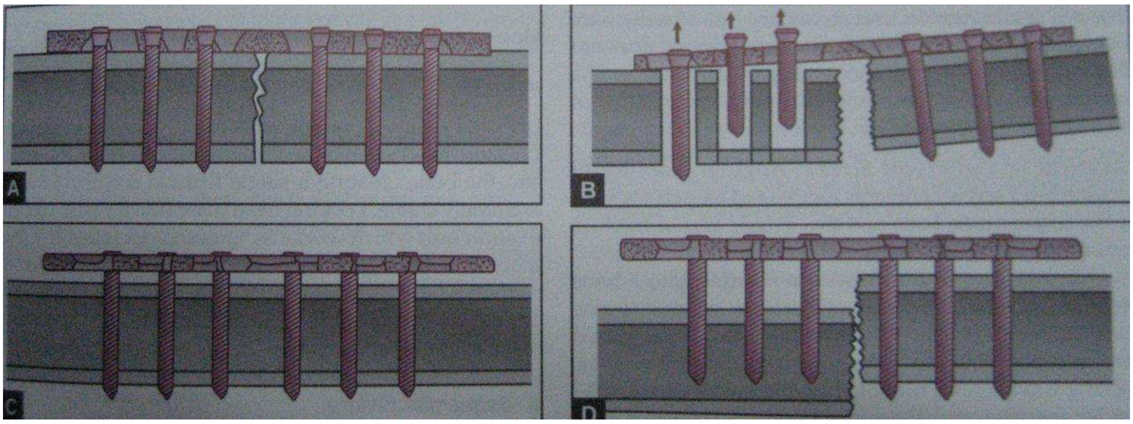


Fixed angled device:

The basic and important principle of locked fixator is its angular stability. It doesn't rely on compression of the screws. As the bone fragments are connected to the fixator through all screws, stability is gained. Each screw acts as fixed angled blade plate. So this multiple fixed angular stability system is very stable. The primary anchorage of the screw in the bone is therefore ensured even in poor bone quality[13,16,17,18].

In the locked head plate load transfer from one fragment of bone occurs through the locked screw head to the plate and from the plate to screw of other fragment and finally to the opposite fragment without loading the bone, not like that of the conventional plate.

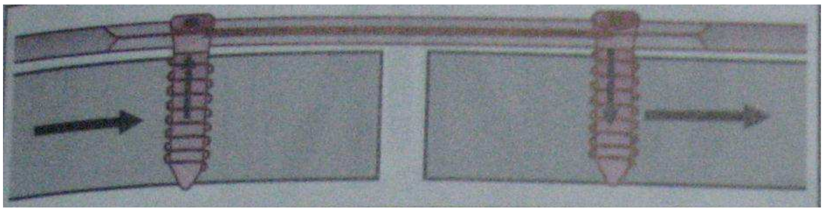
Conventional screws fail one by one



Locking head screws fails en bloc

Load Transfer:

In the locked head plate the principle load transferring element are the screws[2,16,53].



Load transfer through screws and not through bone in LCP

En block fixation:

In locked plates, the strength of fixation is equals to the sum of all screw-bone interfaces compared to that of the single screw's axial stiffness or pull-out resistance as seen in the conventional plates[13,16,23].

Internal Fixator:

Locked plate acts as "internal-external fixator" and are extremely rigid because of their close proximity to the bone. In the external fixator closer the bar to bone, more rigid is the construct[2,23].

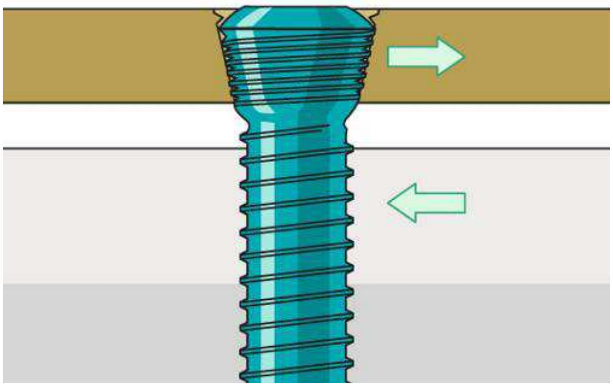
Elastic Fixation:

Locked head plate increase the elasticity when uni-cortical screws are used. Strain is optimized at the fracture site. Hence secondary bone healing occurs with callus formation[23].

As an "internal fixator" locked head plate no longer relies on the frictional force between the plate and the bone to achieve absolute stability and compression. As the plate is away from the bone, the periosteal blood supply is not disturbed, which allows rapid bone healing. Hence the infection rate decreases, bone resorption decreases and also there is no secondary loss of reduction.

No Contact Plate:

In locked head plate as the screw gets locked into the hole, there is no contact between the plate and the bone. Hence there is no necrosis of the bone underneath the plate, whereas in the compression plate, there is necrosis and leads to increased infection rates[23].

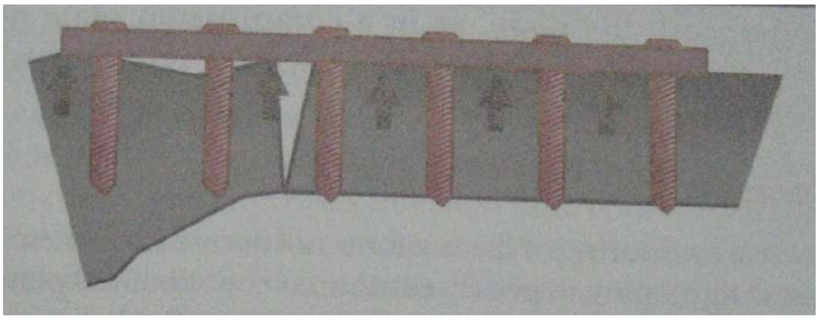


Contouring:

Precise contouring of the plate is not necessary. These plate are anatomical plate which are available for that specific bones.

Primary Displacement:

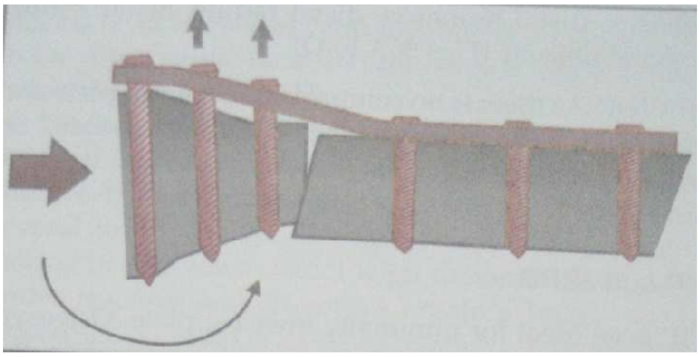
As these plates are precontoured and doesn't require any further contouring, these fixator is away from the bone. Hence primary displacement does not occur. Whereas in conventional plates, if the plate is not contoured to that of the bone, primary displacement occurs[40,53].



Primary loss of reduction due to improper contouring of conventional plate

Secondary Displacement:

As the screws are locked to the plate which provides fixed angular stability, toggling doesn't occur and therefore, secondary displacement does not occur[40,53].



Secondary loss of reduction due to toggling

ADVANTAGES OF LOCKED INTERNAL FIXATOR[17,40,53]

1. As they require no precontouring, primary displacement does not occur.
2. Internal fixator is a biological plate and is an elastic fixation. Therefore, natural healing allows abundant callus and faster healing at the fracture site.
3. The screws are incapable of sliding, togging or becoming dislodging. Therefore there is no loss of secondary reduction.
4. Locking the screws ensures angular, as well as axial stability and eliminates any unwanted movement of the screws.
5. Blood supply to the bone is preserved as the plate is away from bone.
6. Ideally suited in osteoporotic bones, with less pull-out of screws.
7. Screws with multiple angular stability in the epiphyseal and metaphyseal fragments make the construct very stable.
8. Locked internal fixators are noncontact plates, hence no disturbances in periosteal blood supply, and therefore there is no risk of refracture after removal of plate.

9. No need to contour the plate and also no need to the compress the plate to bone.
10. Also there is no need for reconstruction of the opposite deficient cortex.
11. Polyaxial screws have an advantage. It can be angled in any desired direction.

RULES OF SCREW PLACEMENT IN A LOCKING COMPRESSION PLATE[17,40,53]

1. Conventional screws are inserted before any locking screws.
2. Conventional screws will reduce the bone to the plate.
3. Conventional screws can be used to lag fracture fragment through plate or individually.
4. Locking screws will not reduce the bone to the plate.
5. Locking screws form a fixed angle construct with plate to increase the stability in osteoporotic bone.
6. Lag before lock. After placing locking screws no additional compression or reduction of the fragments are possible.
7. Locking screws should be placed as the final step of osteosynthesis.

ANATOMY

Tibia serves as a weight bearing support to body and also a conduit for neurovascular supply of foot. It with its asymmetric surrounding soft tissues, determines the shape of the leg. The location of the tibia and the fact that its anteromedial border is subcutaneous renders the bone susceptible to injury. The length of tibia varies from 28 cm to 45 cm, its intramedullary diameter ranges from 8 mm to 14 mm.

The **Osseous anatomy**[40] of distal tibia includes the tibial pilon, the distal fibula and the talus. A deep socket or box like mortise is formed when the distal ends of tibia and fibula meets the superior dome of the talus. The articular surface of distal tibia is wider anteriorly compared to posterior surface. Also the articular surface is more concave from anterior to posterior. The central concave surface demonstrates anterior and posterior extensions[40].

The medial malleolus which project from the medial aspect of the weight bearing surface is distal and slightly anterior. The chondral surface is oriented 90 degrees to the horizontal tibia plafond and articulates with medial aspect of talar body[40].

The distal end of fibula which terminates as the lateral malleolus articulates with the lateral aspect of the talus. Also the distal end of fibula articulates with the posterolateral aspect of the distal tibia forming the distal tibiofibularsyndesmosis. The subchondral bone of the distal tibia represents the strongest cancellous bone and provides an optimal area for fixation devices[40].

Regarding the anatomic axis of tibia, the tibial plafond is oriented in slight valgus in the frontal plane (2 degrees), and the anatomic axis passes just medial to midline of the talus. The tibial plafond is slightly extended in sagittal plane (approximating 5 to 10 degrees) and the mid-diaphyseal line of the tibia plasses through the lateral process of the talus[40].

Knowledge about the **ligamentous attachments at the ankle joint** is useful for understanding the fracture anatomy and displacement patterns[40].

The irregular convex surface of the medial aspect of distal fibula meets the irregular concave surface on the lateral aspect of tibia to form the distal tibiofibularsyndesmosis. The fibula is secured to distal tibial firmly in its distal portion by the anterior tibiofibular ligament, posterior tibiofibular ligament and the strong interosseoustibiofibular ligament[40].

The posterior tibiofibular ligament has superficial and deep component, the latter is called as the transverse tibiofibular ligament. This ligament projects below the margin of distal tibia to form a labral articulation for the posterolateral talus.

The deltoid ligament is a strong, flat broad triangular band composed of superficial and deep set of fibers. The superficial fibers pass distally from the medial malleolus to navicularsustentaculumtali of calcaneus and the medial tubercle of talus. The clinically important of deltoid ligament is the deep portion, which consists of posterior band and deep posterior talotibial ligament which originates from posterior colliculus and travels posterolaterally and inserts to the entire nonarticular medial surface of the talus[40].

For uncomplicated approaches and safe dissection plane, basic knowledge about **muscular and tendinous anatomy of distal tibia** is required. The anterior tibial compartment contains, from medial to lateral, the Tibialis anterior, Extensor hallucislongus, Extensor digitorumlongus and peroneus tertius muscles. These muscle receive nerve supply from the deep peroneal nerve. The anterior compartment is relatively unyielding compartment bounded by the tibia medially, fibula laterally and interosseous membrane posteriorly and tough crural fascia anteriorly[40].

The lateral compartment of the leg contains the peroneus longus and peroneus brevis muscles. They protect fibula from direct injury. These muscles are innervated by superficial peroneal nerve which runs in the intermuscular septum between peroneal muscles and extensor digitorum longus[40].

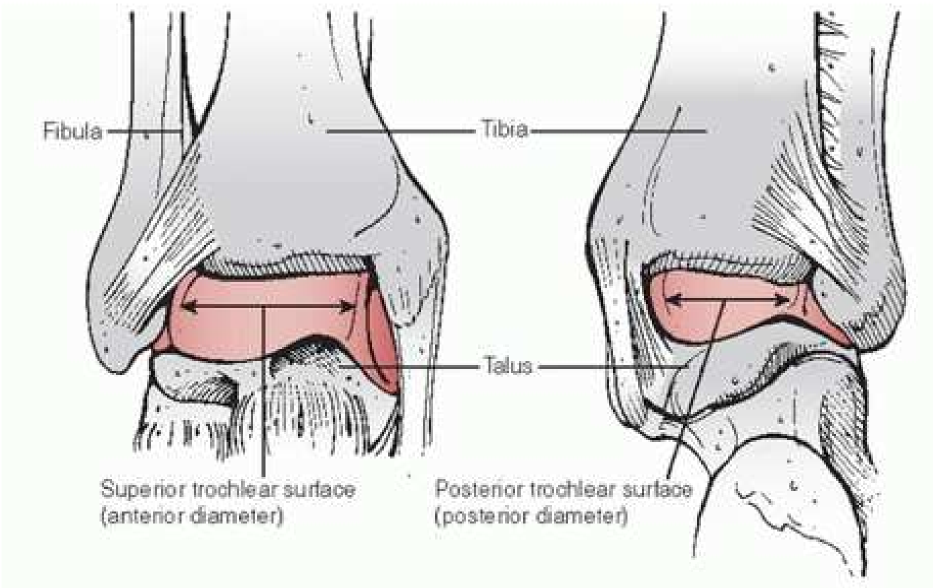
A posterior septum intervenes between the superficial and deep posterior compartments. The superficial posterior compartment contains the gastrocnemius, soleus and planteris muscle. It also serves as a source for local muscle flap for covering soft tissue defects. These muscles are innervated by the tibial nerve[40].

The deep posterior compartment is largely tendinous and includes Tibialis posterior, Flexor digitorumlongus and the Flexor hallucislongus muscle. All these muscles are innervated by the tibial nerve[40].

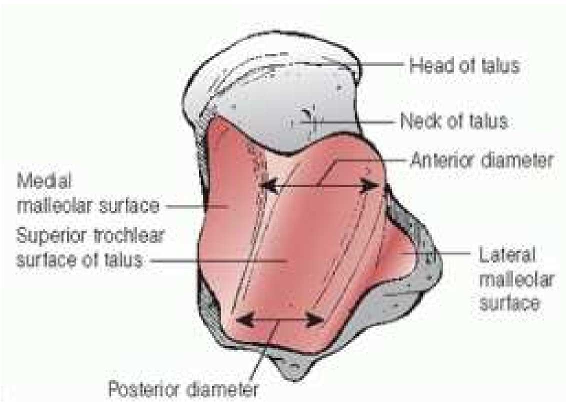
In the distal third of the leg, the superficial peroneal nerve is purely sensory, which pierces the lateral compartmental fascia, and travels in the subcutaneous fascia from posterior to anterior, typically encountered during the anterolateral surgical exposure[40].

OSSEOUS ANATOMY[40]

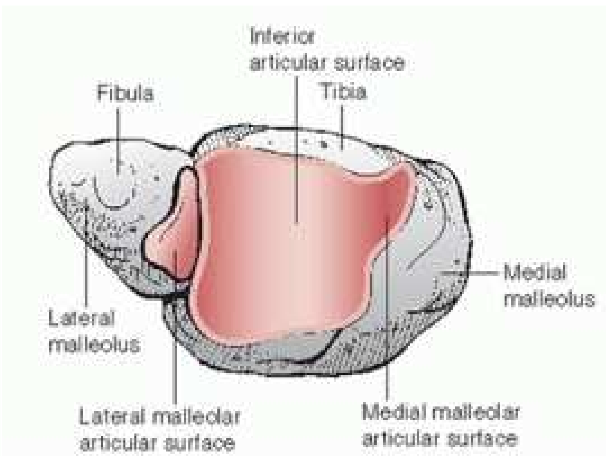
ANTERIOR AND POSTERIOR VIEW



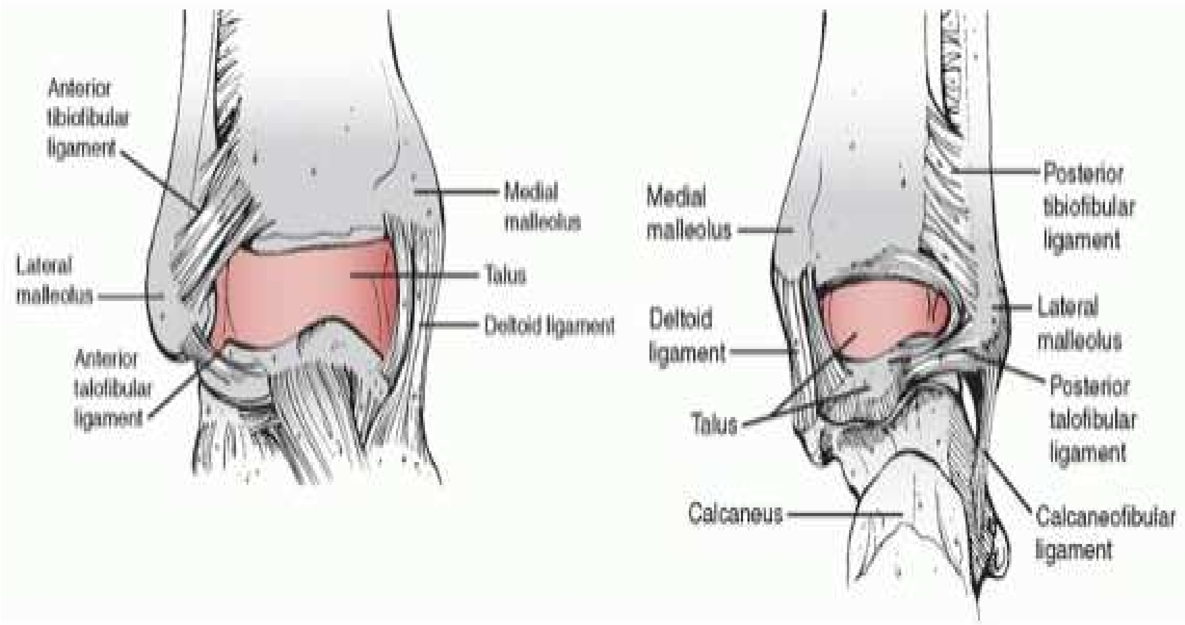
SUPERIOR VIEW



UNDERSURFACE VIEW



LIGAMENTOUS STRUCTURES: ANT AND POST VIEW



CLASSIFICATION

There are many classification system followed from the early days such as Mast, Speigl and Pappas, Bohler classification, Weber classification, Ruedi and Allgower and AO/OTA types.

Of all the classification systems we are now routinely following Ruedi and Allgower and AO/OTA classification.

MAST, SPEIGL, & PAPPAS CLASSIFICATION[28]

Type-1: Supination-external rotation fracture with vertical loading at the time of injury.

Type-2: Spiral extension fracture

Type-3: Vertical compression fracture

AO/OTA CLASSIFICATION[1,28]

The AO/OTA classification system provides a comprehensive description of distal tibial fractures. The tibia is assigned numeric code of 43. Injuries of the tibial plafond are then categorized as extra-articular (43 type A), partial articular (43type B) and total articular (43type C).

Type A – fractures are extra-articular distal tibial fractures

A1 – Metaphyseal simple

A2 – Metaphyseal wedge

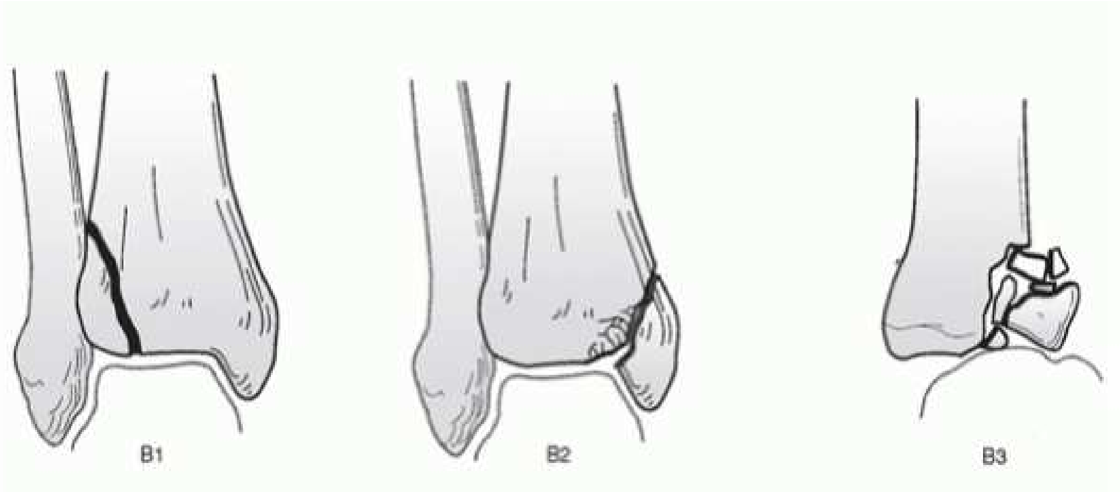
A3 – Metaphyseal complex

Type B – Partial articular fractures in which a portion of the articular surface remains in continuity with the shaft

B1 – Pure split

B2 – Split depression

B3 – Multi fragmentary depression

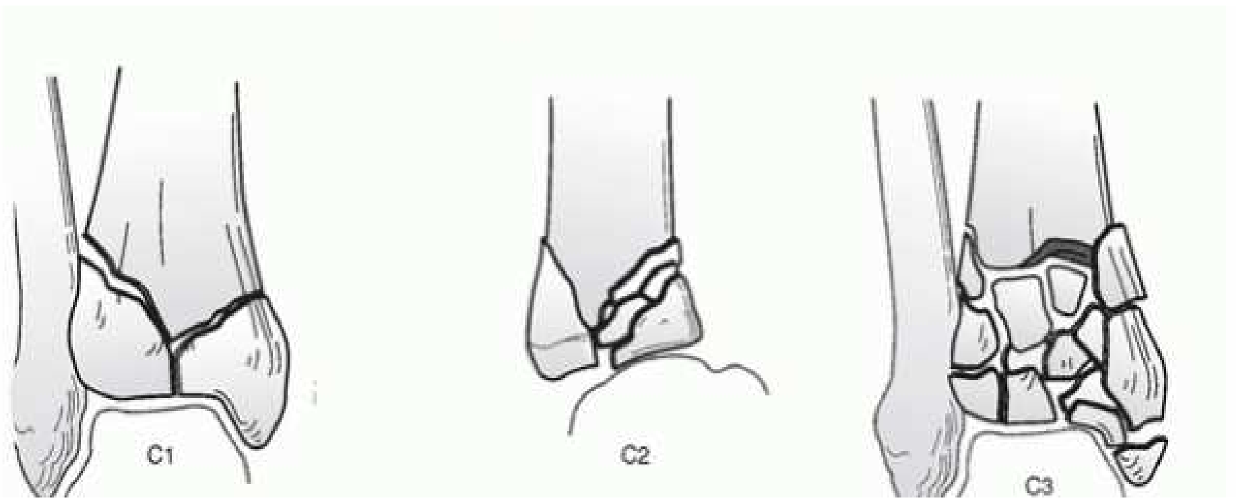


Type C – fractures are complete metaphyseal fractures with articular involvement.

C1 – Simple articular with simple metaphyseal fracture

C2 – Simple articular with multifragmentarymetaphyseal fracture

C3 – Articular multifragmentary



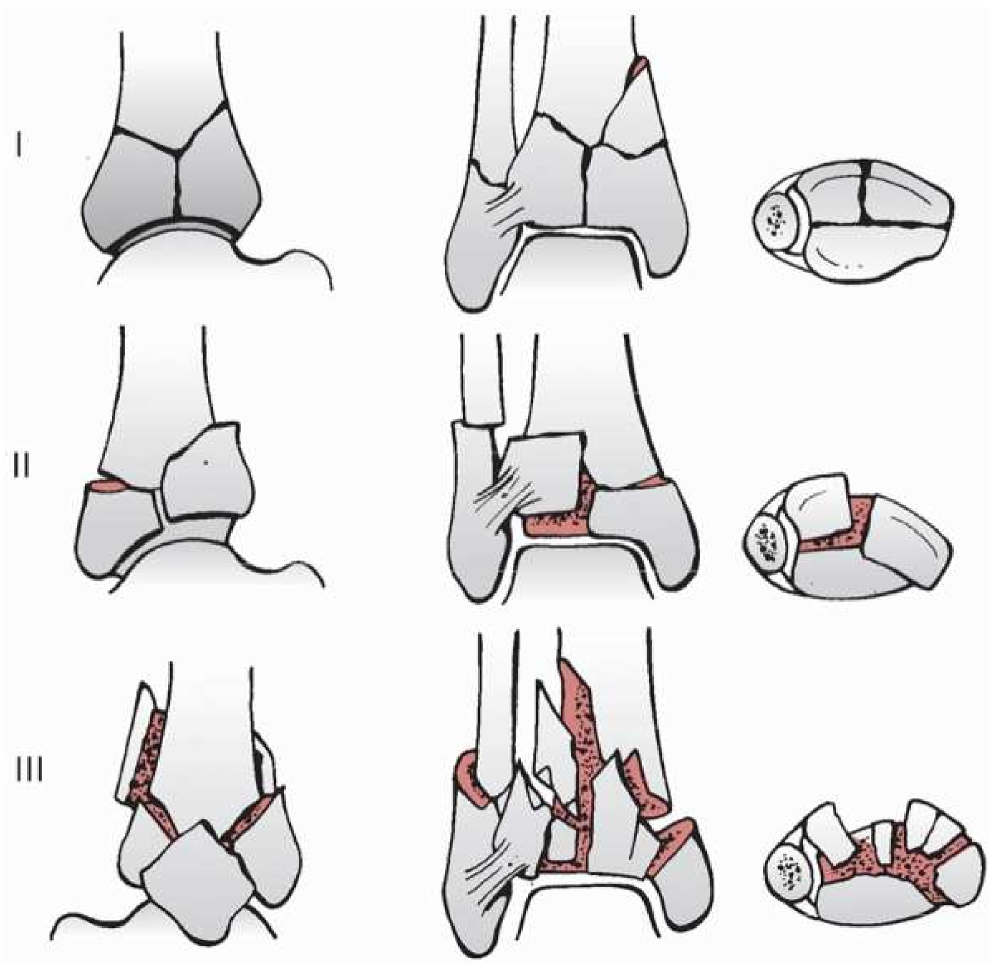
RUEDI AND ALLGOWER CLASSIFICATION[41,42,43]

Ruedi and Allgower, divided plafond fractures into three categories.

Type I: Nondisplaced cleavage fractures that involve the joint surface

Type II: Cleavage-type fracture lines with displacement of the articular surface, but minimal comminution

Type III: Metaphyseal and articular comminution.



Reudi and Allgower Classification was modified by Ovadia and Beals

Type I: Undisplaced articular fracture

Type II: Minimally displaced articular fracture

Type III: Displaced articular with large fragments

Type IV: Displaced articular fracture with multiple fragments and large Metaphyseal defect

Type V: Displaced articular fracture with severe comminution

CLINICAL EVALUATION

Physical examination of the injured ankle is carried out depending on the type of injury. The status of the skin, soft tissue and neurovascular structures, as well as the bones and ligaments are examined. The ankle should be inspected circumferentially for open or impending wounds.

The vascular examination includes inspection for edema and venous engorgement and palpation of the skin temperature, dorsalispedis and posterior tibial arteries and capillary filling. The nerves that cross the ankle are assessed by testing light touch and pain sensation in each of their sensory areas. Functions of the tendons crossing the ankle are to be assessed. It is necessary to assess the strength generated and not just the apparent motion of the part.

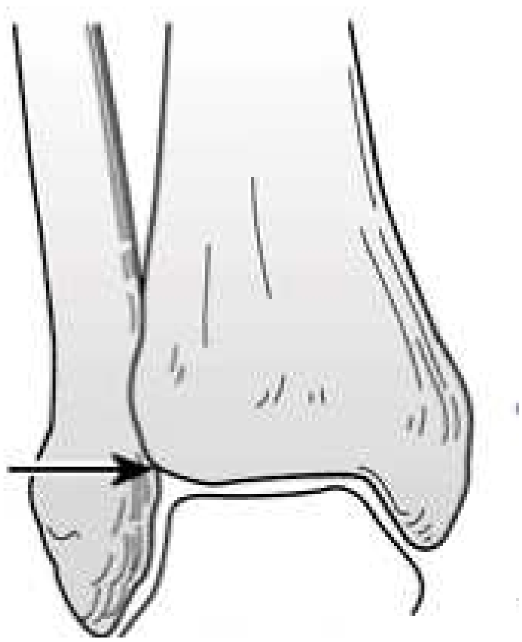
Systematic palpation to localize tenderness is an important part of examining the less severely injured ankle. A combination of tenderness, swelling or ecchymosis over the bone, ligament, or joint line suggests an injury.

Examination of the proximal joint (knee joint) to rule out associated injuries and also distal tibiofibularsyndesmotic joint is necessary.

RADIOLOGICAL EVALUATION

X-RAYS[11,40]

Routine studies for the ankle include anteroposterior, lateral and internally rotated mortise views. Full-length view of fibula is essential if proximal tenderness is noted. Additional radiographic studies include 45 degree oblique radiograph to identify and assess articular involvement and anatomic details of fractures affecting the distal tibial metaphysis[29].

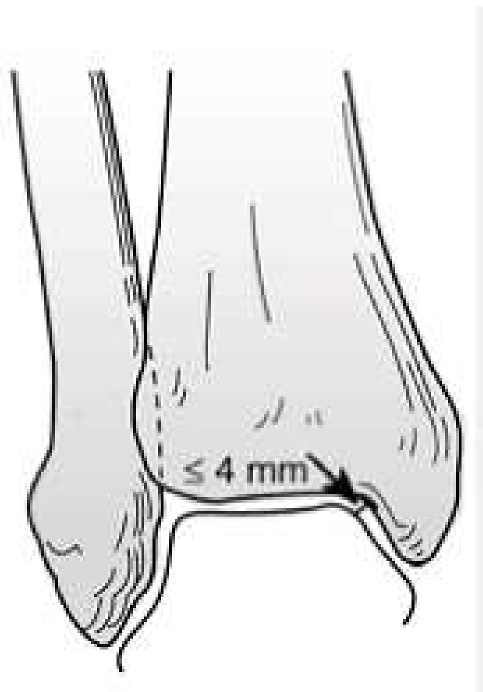


MORTISE VIEW[11,40]

It is taken by internally rotating the leg up to 15 to 20 degrees, so that x-ray beam passes nearly perpendicular to the intermalleolar line. This view helps in to evaluate the lateral talar shift (the medial clear space), fibular shortening and fibular rotation (tibiofibular line)[29].

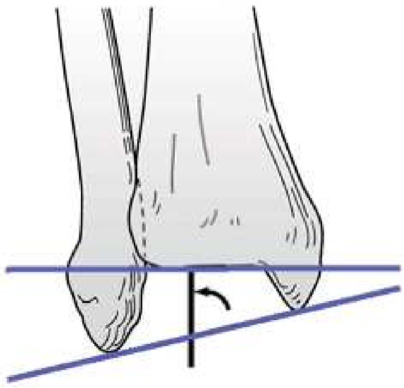
MEDIAL CLEAR SPACE[11,40]

On mortise view, the distance between the medial border of the talus and the lateral border of the medial malleolus (the medial clear space) should be equal to the superior clear space between the talus and the distal tibia. A space greater than 4 mm is considered abnormal and indicated a lateral shift of the talus[29].



THE TALOCRURAL ANGLE:

The talocurual angle is approximately 83 degrees. When the opposite side is used as a control, the talocrural angle of the injured side should be within a few degrees of the noninjured side. It helps in measuring the fibular shortening.



TILT MEASUREMENT[11,40]

Talar tilt is measured by taking mortise view by drawing one line parallel to articular surface of the distal tibia and the second line drawn parallel to talar surface. It should be parallel to each other in normal ankle. Any increase in the distance indicated significant talar tilt. Normal talar tilt is 0 degrees (range 1.0 to 1.5 deg).

In AP view talar tilt is measured by the difference in width of superior clear space between medial and lateral sides of joint and it should by <2 mm. These are the static measurements of the talar position in normal ankle and the talus may tilt up to 5 degrees with respect to inversion stress.

TIBIOFIBULAR LINE:

It is a line formed by subchondral bone of distal tibia and medial aspect of the fibula. It should be continuous and it indicates that the articular surface of the talus should be congruous with that of distal fibula. Any disruption indicates shortening, rotation and lateral displacement of the fibula and also tear in syndesmotic ligaments.

EVALUATION OF SYNDESMOSIS:

The simplest approach is to measure the distance between the medial wall of the fibula and incisural surface of the tibia. This tibiofibular clear space should be less than 6 mm on both AP and Mortise views.

CT SCAN[40]

Standard tomography is helpful in documenting articular surface deformity, fracture comminution and osteochondral lesion of the talus. Computerized Tomography is important in all cases that are evaluated for open reduction and internal fixation as it can give complete delineation of the position, size and shape of the various ligaments.

MRI SCAN

This investigation with its direct multiplanar capabilities and excellent soft-tissue contrast resolution, has proved to be superior to CT for evaluation of ankle tendons and ligaments. The pathologic conditions of the tendons and ligaments are demonstrated by discontinuity of the anatomic structures, the presence of high signal intensity within the tendon substance on T2 weighted images.

METHODS OF TREATMENT

NON-OPERATIVE TREATMENT

Certain minimally displaced type I fractures or type C1 fractures may be treated in a cast. Casting is reserved for truly non-displaced fractures and for those patients who have significant or absolute contraindication to surgical management. True axially loading fractures of the distal tibia with metaphyseal and articular displacement are rarely indicated for this type of treatment.

OPERATIVE TREATMENT

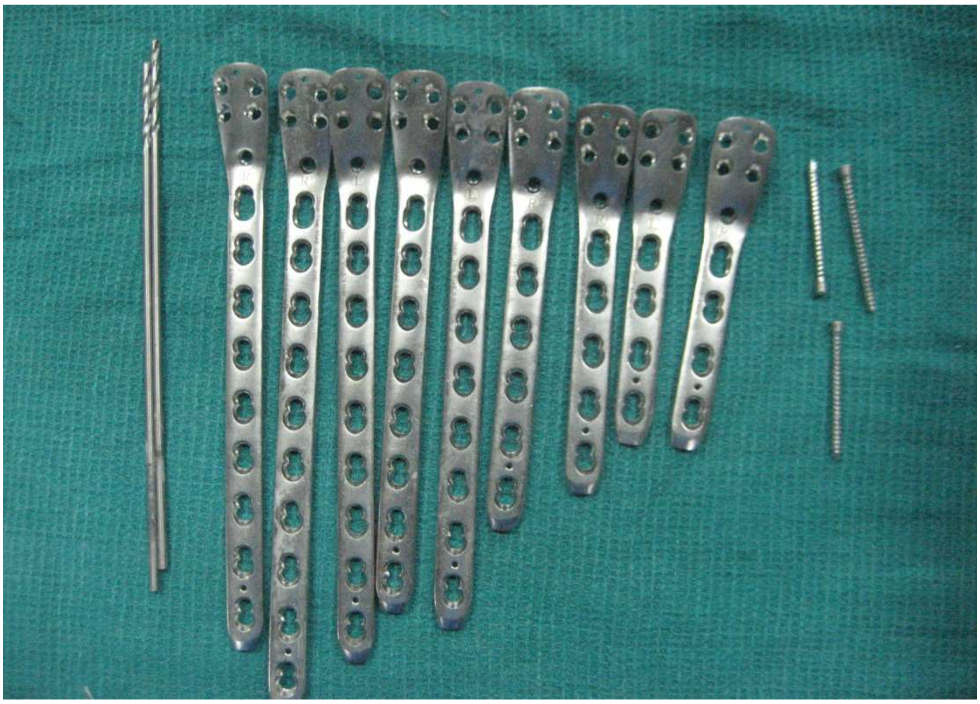
The principles of operative treatment are anatomic restoration of articular surface, stable fixation of fractures, early mobilization of joints and proper alignment of tibia and ankle joint. The majority of displaced pilon fractures are managed operatively, particularly those with displaced intra-articular fracture fragments. The fracture pattern and the condition of local soft tissue envelope are the major determinant factor for the surgical technique chosen[4,6,8,10,32].

PLATES AND SCREWS:

The 3.5 mm Medial Distal tibial LCP[13,20,21]

Fixation with the 3.5 mm Medial Distal tibial LCP has many similarities to the traditional plate fixation methods, with a few important improvements. The technical innovation of locking screws provides the ability to create a fixed angle construct while using familiar AO plating techniques. Locking capability is important for fixed angle constructs in osteopenic bone or multifragmentary fractures where screw purchase is compromised. These screws do not rely on plate to bone compression to resist patient load, but function similarly to multiple, small, angled blade plates. The fixation of this implant can be done in both MIPPO or routine open reduction technique.

IMPLANTS



SURGICAL APPROACHES[46]

Surgical incisions and approaches to reduce and fix fractures of tibial plafond have been modified to decrease the incidence of wound complications. Extensile incisions are avoided in the anteromedial border of the tibial particularly if a plate is planned for this area.

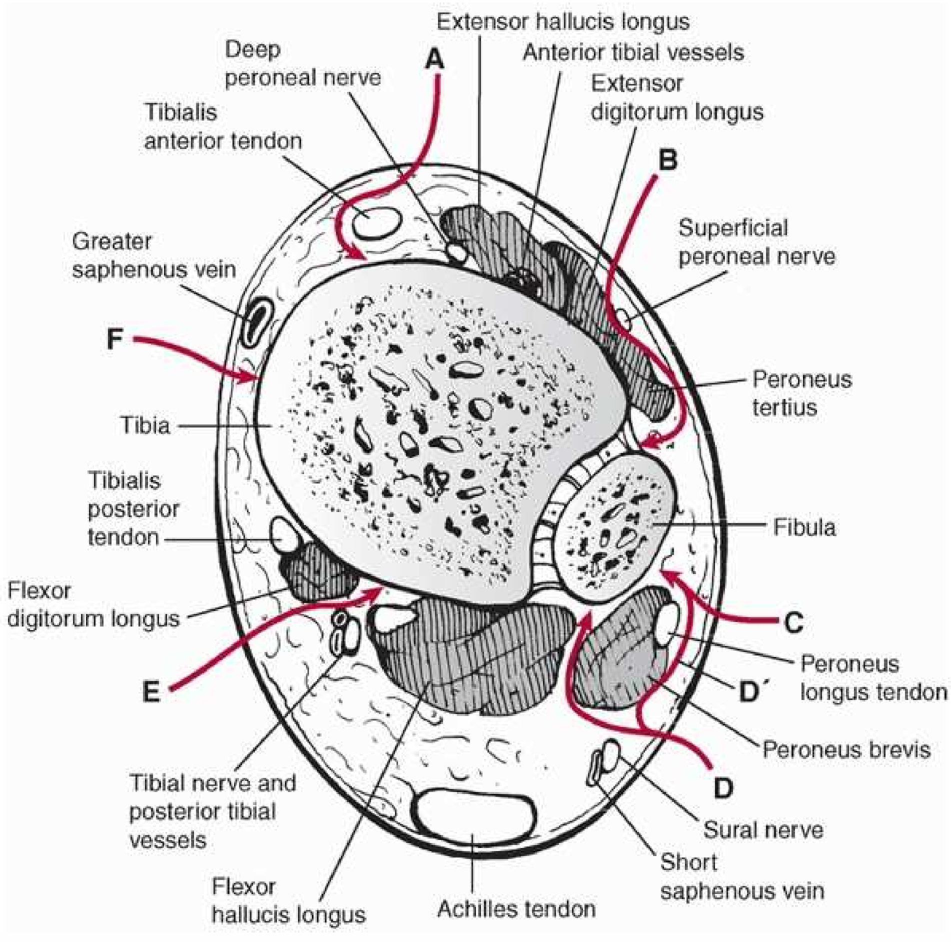
Although the indications to fix the fibula internally have been modified in recent years, with some techniques such as tibial plating, it is still an integral part of fixing tibial plafond fractures.

TIBIA

Surgical approaches[40,46] include

1. Anteromedial
2. Anterolateral
3. Modified anteromedial
4. Posterolateral
5. Posteromedial

SURGICAL APPROACHES



Modified anteromedial approach was commonly used in our study. The exposure begins approximately 1 cm lateral to tibial crest and follows the course of tibialis anterior tendon to the level of ankle joint. The incision ends just distal to the tip of the medial malleolus. The plane of dissection is just medial to tibialis anterior tendon.

<u>FIBULA:</u> (LATERAL APPROACH)[40,46]

The incision is directly over the fibula. The soft tissues must be very carefully protected because there is some risk that the fibular wound will break down. The incision should be a little more posterolateral than for isolated fibula fractures, which allows access to the posterior malleolus, and provides a larger skin bridge between this incision and the tibial incision. A 7 cm skin bridge was routinely recommended. Howard recently demonstrated minimal soft tissue complications with skin incision bridges between 5 and 6 cm when treating tibial plafond fractures.

SURGICAL TECHNIQUE

Positioning:

- Regional Anaesthesia
- Supine position on an appropriate table with a radioluent extension. A small soft supportive bump or towel roll is placed beneath the ipsilateral buttock, flank and shoulder region to minimize the tendency to externally rotate.

Surgical Exposure:

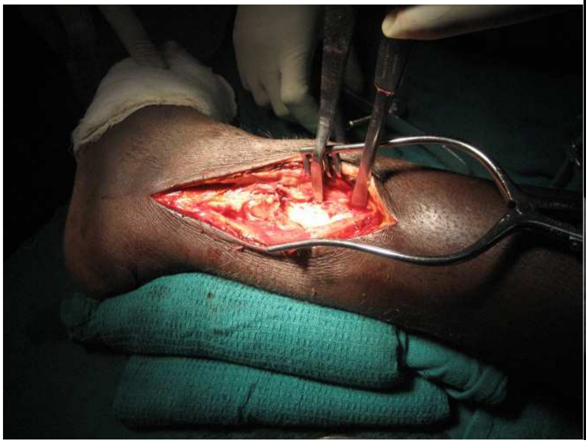
Fibula: Fibular reduction and fixation is performed using the lateral approach to the fibula, with 1/3 rd tubular plate and 3.5 mm cortical screws.

FIBULA FIXATION:

POSITION

INCISION

EXPOSURE



FIXATION

CLOSURE

Tibia:

We used Modified Anteromedial approach routinely. Skin incision is approximately 1 cm lateral to tibial crest and follows the course of tibialis anterior tendon. At the level of ankle joint, the skin incision continues distally and medially, ending at the distal tip of medial malleolus. The plane of dissection is medial to anterior tibial tendon[40].

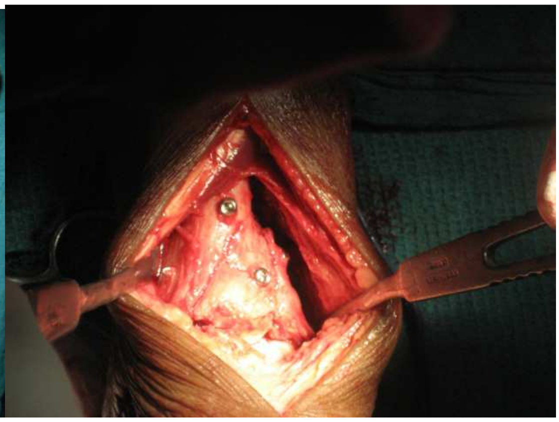
Fracture fragments identified, reduced and fixed with temporary k – wires and then definitive fixation with 3.5 mm medial distal LCP with locking screws[20].

For AO type A fractures we used the technique of MIPPO. Here the incision was just proximal to the medial malleolus either transverse or longitudinal. The fracture was reduced indirectly and the plate was inserted through the incision. Through stab incision screws were inserted in the proximal fragment[17,26].

For AO type C fractures we did open reduction of the fracture fragments and then fixed with LCP[14,36].

TIBIA FIXATION:

POSITION *EXPOSURE AND FIXATION*



LCP USING MIPPO

CLOSURE

Post-operative protocol[37,39]

- Drain removal after 48 hrs.
- Suture removal on 12 post op day.
- Radiological examination once in every 6 weeks
- After removal of sutures ankle mobilization was started with non-weight bearing walking with walker.
- Once radiological union started partial to full weight bearing was allowed.
- All cases were assessed using the IOWA ankle score andTeeny wiss radiological scoring .

IOWA ANKLE EVALUATION SCORE

Function [40]

1. Does housework or job without difficulty(8)
2. Climb stairs(10)
3. Carries heavy objects, such as suitcase(4) __/40
4. Is able to run, or work at heavy labour(4)
5. Walk enough to be independent(8)
6. Does yard work, gardening , lawn moving(4)
7. Has no difficulty getting in or out of an automobile(6)

Freedom from pain: [40]

1. No pain[40]
2. Pain only with fatigue or prolonged use[30]
3. Pain with weight bearing[20] __/40
4. Pain with motion[10]
5. Pain with rest or continuous motion[0]

Gait: [10]

1. No limp[10]

2. Antalgic gait[8] __/10

3. Use cane or one crutch[2]

4. Uses wheelchair or can't walk[0]

Range of motion [10]

1. Dorsiflexion and plantarflexion __/10

   (2 points for every 20 degrees)

TOTAL SCORE: __/100

1. EXCELLENT:100-90

2. GOOD :89-80

3. FAIR :79-70

Scoring criteria for quality of reduction according to Teeny and Wiss[47]

Anatomical site	Score		
Quality of reduction	1	2	3
Lateral malleolus displacement	0-1 mm	2-5 mm	5 mm
Medial malleolus displacement	0-1 mm	2-5 mm	5 mm
Posterior malleolus displacement	0-0.5 mm	0.5-2 mm	2 mm
Mortise widening	0-0.5 mm	0.5-2 mm	2 mm
Fibular widening	0-0.5 mm	0.5-2 mm	2 mm
Talar tilt	0-0.5 mm	0.5-2 mm	2 mm
Articular gap	0-0.5 mm	2-4 mm	4 mm

Rating	Points
Anatomic	**8**
Good	**9-11**
Fair	**12-15**
Poor	**> 15**

MATERIALS AND METHODS

This prospective study analyses the functional outcome of Medial distal tibial LCP for treatment of distal tibial fracture depending on the type of fracture and to find out their prognosis.

The study included patients who were treated in Rajiv Gandhi Government General Hospital with Medial distal tibial Locking compression plate for distal tibial fractures.

Period of Study:

The period of study was from may2011 to December 2012 with a total duration of 20 months.

In this period patients admitted for distal tibial fractures with or without intra-articular extension were considered for this study. The mean duration from hospital admission to definitive surgery was around 10 days to 14days in cases of closed fractures.

Inclusion Criteria

- Patients willing to participate in this study.
- Skeletally mature patients
- Ruedi and Allgower type – I, II, III fractures
- Only closed fractures
- Minimum follow up of 6 months

Exclusion Criteria

- Age less than 16 years and above 60
- Compound fractures
- Associated calcaneum fractures and talus fractures
- Severely mangled extremity
- Associated spinal and abdominal injuries

The total number of patients in this study was**30**

OBSERVATION

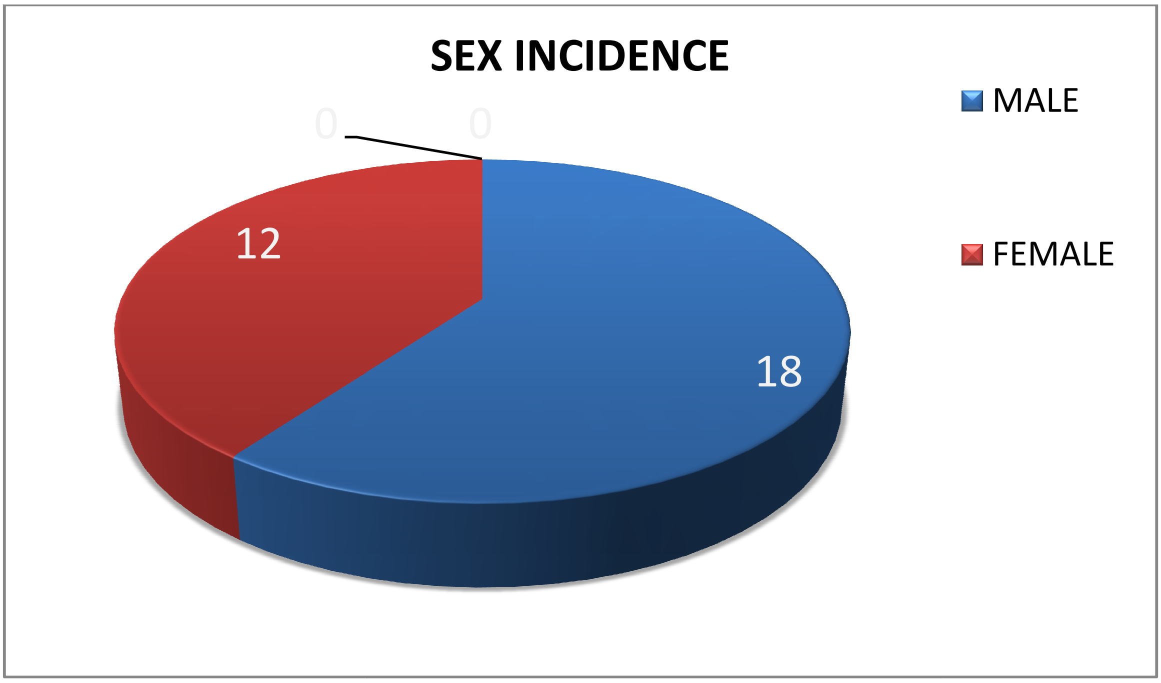
The following observations were made in this study.

AGE INCIDENCE

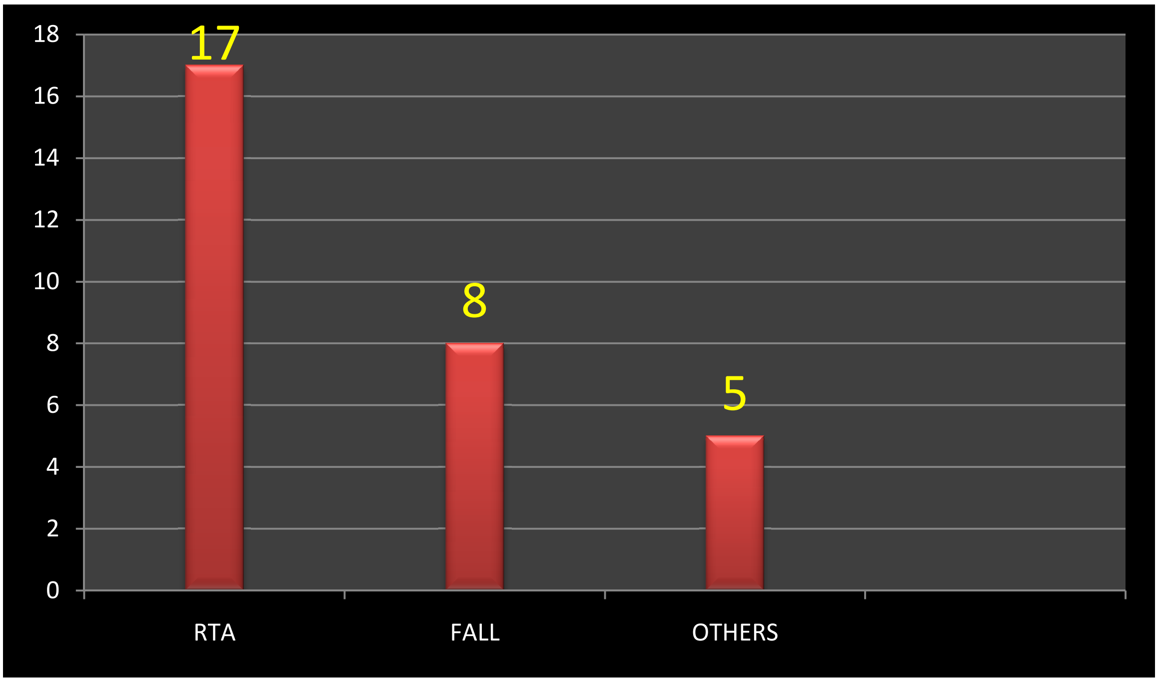
Patient's age ranged from 20 to 67 years. Average of 32.8 yrs.

AGE (yrs)	No. of Patients
21-30	6
31-40	5
41-50	10
51-60	7
Above 60	2
Total	**30**

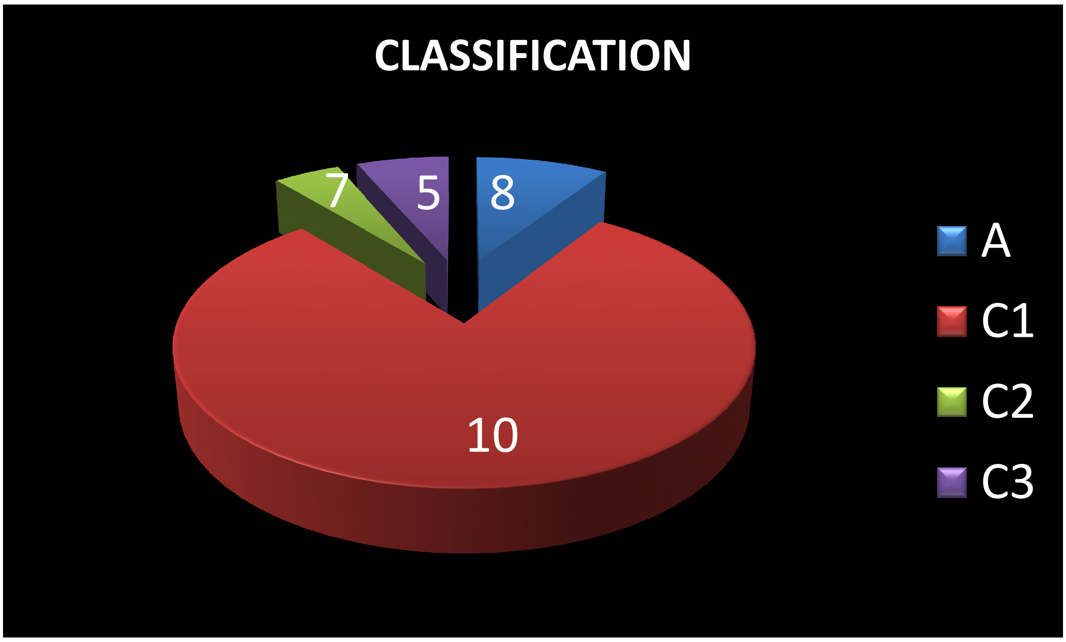
SEX INCIDENCE:



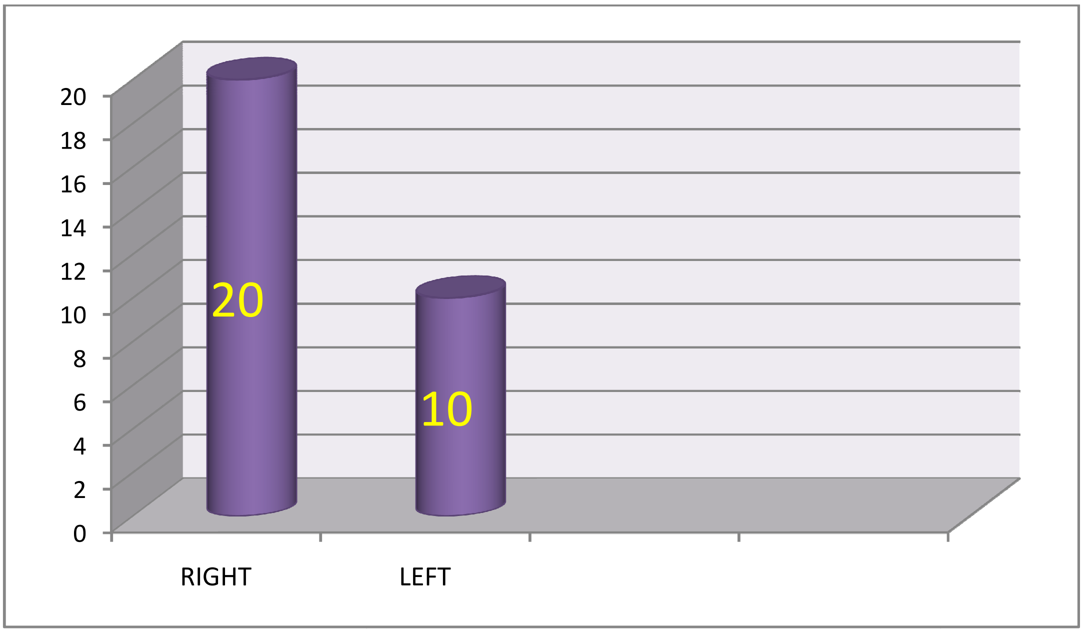
MODE OF INJURY:



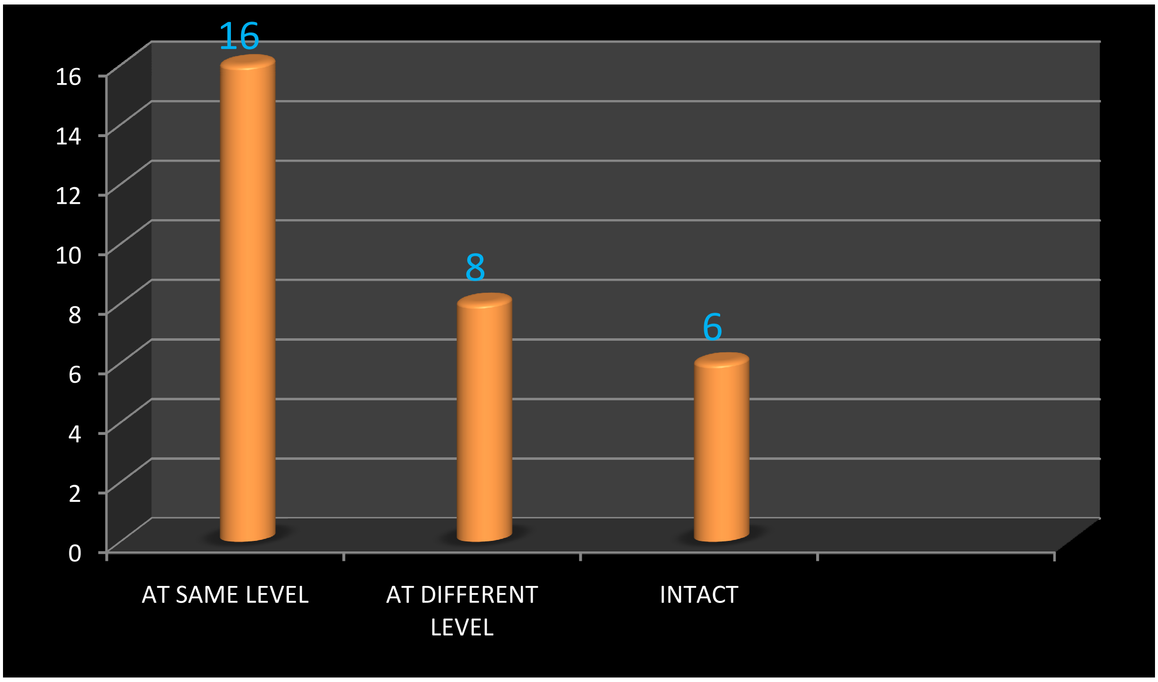
INCIDENCE BASED ON CLASSIFICATION: (AO)



INCIDENCE BASED ON SIDE INVOLVEMENT:



FIBULAR FRACTURE INCIDENCE:



FOLLOW UP:

In our study of 30 cases, there is a minimum follow up of 6 months and maximum of 20 months with an average of 9.4 months.

CASE ILLUSTRATIONS

Name: Devi

Ip No.: 39221

Age: 57/F

Occupation: House Wife

Mode of injury: History of Fall

Diagnosis: Distal tibial fracture

Classification: AO Type A

Procedure: MIPPO with LCP

Approach: Direct Medial

Complication: None

Time of Union: 10 weeks

Ankle Range of Motion: Full and Pain free

IOWAScore: 91

Outcome: Excellent.

Name: Ebenezer

Ip No.: 105060

Age: 53/M

Occupation: Clerk

Mode of injury: History of RTA

Diagnosis: Distal tibial fracture

Classification: AO Type C1

Procedure: MIPPO with LCP

Approach: Antero Medial

Complication: None

Time of Union: 12 weeks

Ankle Range of Motion: Full and Pain free

IOWA Score: 92

Outcome: Excellent.

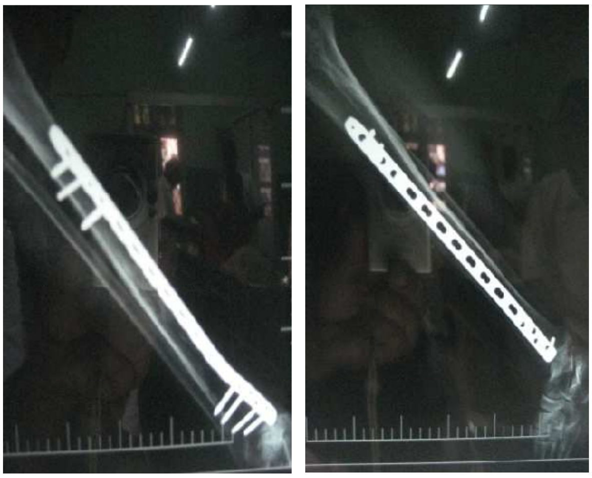
CASE 2:

PRE OP

IMMEDIATE POST OP

10 WEEKS FOLLOW UP

16 WEEKS FOLLOW UP



POST OP WOUND STATUS AND RANGE OF MOVEMENTS

Name: Rajie

Ip No.: 26673

Age: 51/F

Occupation: House Wife

Mode of injury: History of Fall

Diagnosis: Distal tibial fracture

Classification: AO Type A

Procedure: MIPPO with LCP

Approach: Direct Medial

Complication: None

Time of Union: 11 weeks

Ankle Range of Motion: Full and Pain free

IOWA Score: 94

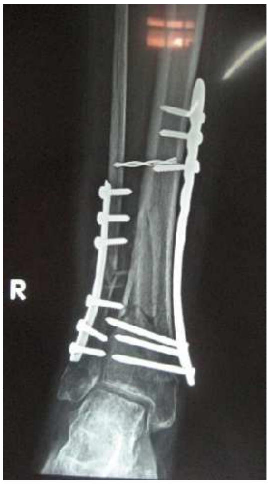
Outcome: Excellent.

CASE 3:

PRE OP

IMMEDIATE POST OP

9 WEEKS FOLLOW UP



15 WEEKS FOLLOW UP

POST OP WOUND STATUS AND RANGE OF MOVEMENTS

Name: Mohana

Ip No.: 22899

Age: 25/F

Occupation: House Wife

Mode of injury: History of RTA

Diagnosis: Distal tibial fracture

Classification: AO Type C3

Procedure: ORIF with LCP and plating for fibula

Approach: Antero Medial

Complication: Superficial Infection

Time of Union: 14 weeks

Ankle Range of Motion: Restriction of terminal range but pain free

IOWA Score: 88

Outcome: Good.

CASE 4:

PRE OP

8 WEEKS FOLLOW UP

16 WEEKS FOLLOW UP

POST OP WOUND STATUS AND RANGE OF MOVEMENTS

RESULTS

Distal tibial fractures though amenable to open reduction and internal fixation carries a high risk of complication and a potential for redo surgery. The outcome of an injury is best judged by how much it affects the patients, deformity, impairment or loss of function.

Ovoida and Beals[33] considered "***an excellent result to be pain free patient who has returned to all activities without limp***". A number of factors affect the outcome of distal tibial fractures. The single most important factor is the severity of the initial injury, which is indicated primarily by the amount of damage to the plafond and the impaction, comminution and the displacement of the fragments and the extent to which soft tissue damage have occured. Another is the extent to which reduction was achieved and also the post-operative complications.

FRACTURE UNION:

All the fractures were united. Radiological union obtained in all cases with a mean duration of 12 to 16 weeks. All patients were started full weight bearing after radiological union.

FUNCTIONAL SCORE:

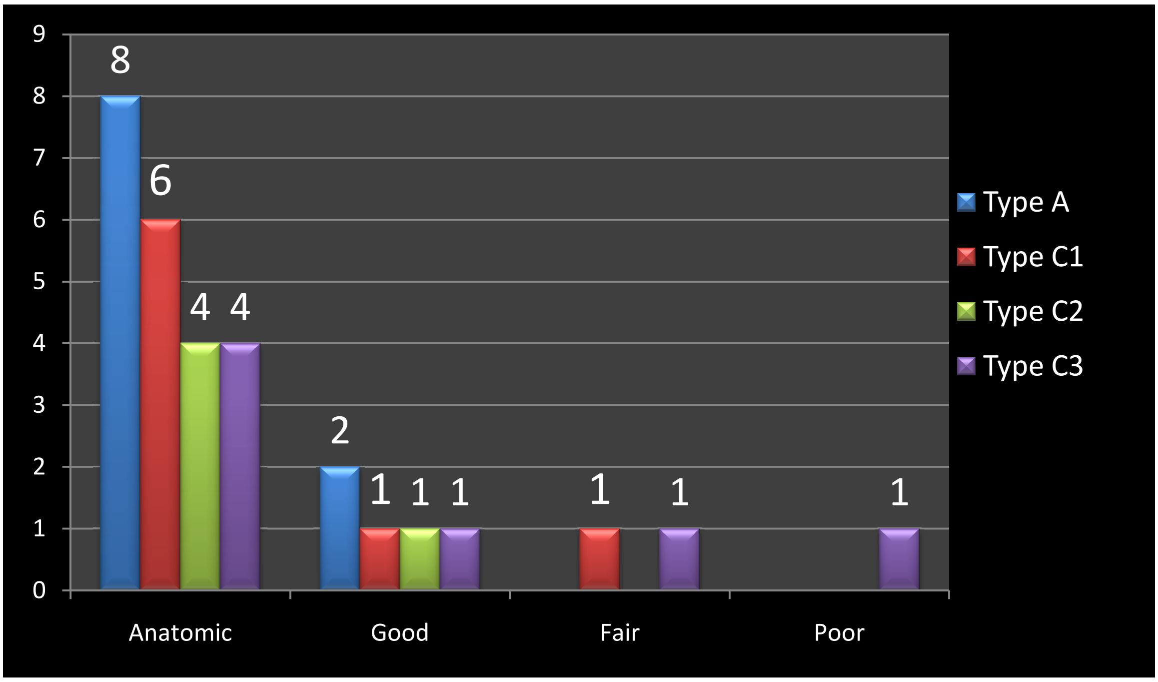
A variety of rating systems were proposed for subjective and objective components. We have used modified Teeny and Wiss Score for radiological evaluation of ankle and IOWA scoring for functional analysis. The mean functional ankle scores were 80.5with a maximum of 94 and minimum of 74. Anatomic reduction was achieved in about 22 cases with good alignment.

TEENY WISS RADIOLOGICAL SCORING:

In our study we were able to achieve good anatomic reduction in 72 %(22cases) of the patients. The rest of the cases had good rating[47].

Reduction	AO Type A	Type C 1	Type C 2	Type C 3
Anatomic	8	6	4	4
Good	2	1	1	1
Fair	0	1	0	1
Poor	0	0	0	1

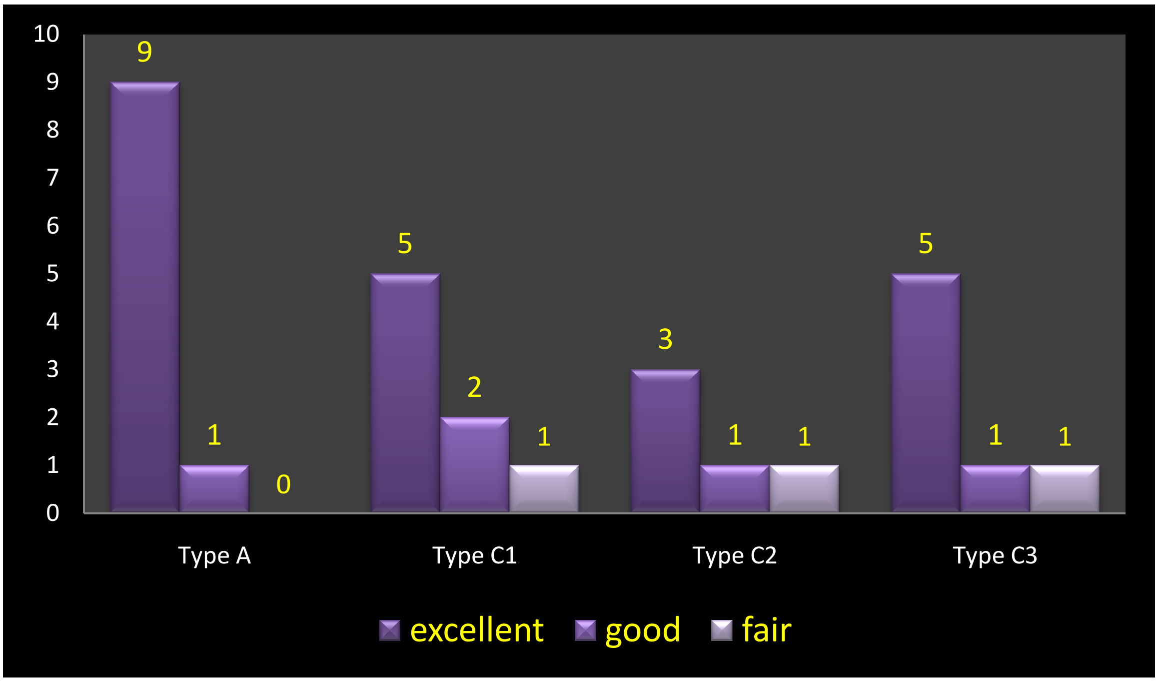
TEENY WISS RADIOLOGICAL SCORING



IOWA ANKLE EVALUATION SCORE

Scoring	Excellent	Good	Fair
Type A	9	1	0
Type C1	5	2	1
Type C2	3	1	1
Type C3	5	1	1

IOWA ANKLE EVALUATION SCORE



COMPLICATIONS:

In our study the complication we met were superficial infection of 3 cases and one case of deep infection. In our study we had one case of flap necrosis. The flap necrosis was due to less interval between the incision for tibia and fibula. That case required flap cover and healed without any further complication. All superficial infection settled with higher antibiotics and with wound wash. The case of deep infection required implant removal and was treated with hybrid ex-fix.

DISCUSSION

Distal tibial fractures result from a range of low to high energy axial-loading and are commonly associated with comminution of both the metaphysis and the distal fibula. This relative rare injury (<10% of lower extremity fractures) occur in adult owing to fall from height or from road traffic vehicle crash. The ideal or optimal treatment for these fractures remains controversial. Fractures of distal tibia most often associated with significant soft tissue injuries. The treatment of distal tibial fractures can be challenging because of its subcutaneous location, poor vascularity and limited soft tissue[3,4,12].

The key point is treatment of this injury is to recognize the importance of these soft tissue compromises. Definitive fixation is only advisable and done only when the soft tissue allows for surgery or when the wrinkle sign is evident. Minimally invasive plating techniques reduce the iatrogenic soft tissue injury and damage to bone vascularity, and also preserve the osteogenic fracture hematoma.

The key principles in the management of these fractures – Restoration of the length and axis of the tibia and fibula; the reconstruction of the distal end of tibia; the filling of the defect resulting from impaction and the support of the medial side of tibia, by plating to prevent the varus deformity[32].

In our study we used a single-stage fixation of all distal tibial fractures. We used medial distal tibial locking compression plate for all cases. This plate is a low profile plate of 3.5 mm system. The Medial distal tibial plate is a pre-contoured plate to that of the distal tibia and thus allows placement of the plate without disruption of fractures fragments. The thread holes in the plate locks to that of the screw head and minimize plate-bone interface and maintain the vascularity at the fracture site.

Among 30 patients, all AO type A (10 cases) fractures were managed with MIPPO technique. AO type C3 fractures were managed with open reduction of the articular surface and fixed with locking compression plate. AO type C1 and C 2 fractures were managed using MIPPO technique and the fractures was transfixed through the plate.

Our study included a total of 30 patients. The peak incidence in our study was among the age group between 40-50 years. In our study we had excellent union and functional outcome in about 27 cases (90%) and 3 cases (10%) of fair outcome based on **IOWA** scores. As per **TEENY WISS SCORE**[47] we had good anatomic rating in about 22 cases (72%), good rating in about 5 cases (18%), fair in 2 cases (8%) and one case (2%) of poor rating.

Mast et al recommended primary definitive internal fixation if the patient was presented early within 8 to 12 hours following injury. They advocated a delay in the definitive procedure for about 7 to 10 days for soft tissue to heal, if the patient presented late. In our study the average duration of delay in the definitive treatment was about 10 to 14 days[27].

Patterson and Cole et al reported an impressive 0% infection rate following fixation after an average of 24 days, however this study is limited by its relatively small sample size. In our study we had a delay of about 10 to 14 days before going for definitive stabilization[34].

Barei et al demonstrated that distal tibial fractures with intact fibula, on the whole was considered as less severe injury than those with fractured fibula. An intact fibula was identified as less severely injured than C type fractures[5,9]. The first principle of management by **Ruedi and Allgower** was restoration of fibular length which remains vital to obtaining good results. The goal of fibula fixation was restoration of limb length, to prevent varus tilt and rotation and gross mechanical alignment. Of the 30 cases, 14 cases of fracture fibula had gross displacement which required fixation with 1/3rd tubular plate. Plating was done in fracture fibula with comminution. The rest of the cases were not fixed as most of the fractures were undisplaced stable fractures or it was fractured at different levels. All fibula fractures healed within 3 months without any gross complications[41,42,43].

Helfet et al in their study had a superficial infection rate of 3% and deep infection of 6 % in their series of 32 fractures treated with locking compression plate. In our study we had 3 cases (10%) of superficial infection and 2 cases (8%) of deep infection, which was comparable to the above study[17,18].

Philip et. aland Mark Jackson et al in their study of complication of definitive open reduction and internal fixation of distal tibial fractures, they had good functional result in 73.7% cases and 5% of deep infection rate in a follow up of 30.4 months. In our study we had 72% of good functional outcome and 8 % of deep infection rate, which was acceptable when compared to the above study[36].

Pierre Joveniaux et al and Xavier Ohi et al in their study of distal tibia fracture: management and complication, they had a functional score of 76 % in their series. Their result had 20 cases of excellent, 15 cases of good, 9 cases of fair and 6 cases of poor in their series of 50 cases. In our study we had nearly 22 cases of excellent outcome, 5 cases of good, 2 cases of fair and one case of poor outcome among the 30 cases[35].

Mario Ronga MD et al and Nicola Maffulli MD et al in their study of minimally invasive locked plating of distal tibial fractures, they had the following outcomes – of the 21 cases they achieved union in 20 cases and one case went in for non-union. They had 3 cases of angular deformities all less than 7° and no patient had a leg-length discrepancy. Compared to their study, in our study we used MIPPO in about 14 cases, in which all cases went in for union in about 10 to 14 weeks with no case of malunion or nonunion[26].

Rakesh Gupta et al and Rajesh Kumar Rohllla et al in their study of locking plate fixation in distal tibial fractures – series of 79 patients, had reported about 88% of healing without malunion, 2.5% of malunion and 3.7% of non-union. They used both MIPPO and ORIF for fixing these fractures. They found good and early union rate in the MIPPO group. In our study also we had good and early union in the MIPPO group and also we had no case of malunion or non-union.

Pugh and colleague evaluated 60 patients, 25 of whom were treated with external fixators. They noted that they had more number of malunion in the external fixator group compared to that of internal fixation. They met most of their complication in the external fixator group. In our study also we had good functional outcome in internal fixation group[38].

The average follow up period our study was 9.4 months (range from 6 to 20 months). In type III fractures patients may develop late secondary arthrosis, but it requires a longer follow up. In our series, the results of the patients who had long follow up period of more than 22 months had good clinical scores despite some early mild arthritic changes in type C severe communited fractures.

Arthrodesis was indicated when there was extensive comminution and also in severe type III fractures. In our study, type III injuries accounted for 22% of the cases and arthrodesis was not done in any of our patients, compared to that of 23 % of cases in a study by **M.Blauthet et al. Marsh et al** reported an arthrodesis rate of 13 % in their series of 40 ankle fractures after a minimum follow up of 5 years. Chen noted a 4.7% arthrodesis rate in plating tibial plafond fractures when followed for a period of 10 years. Since our study was a short term study, arthrodesis could not be commented which might require a long term follow up.

The incidence of head injury or spinal cord injury was less in our series compared to other studies. 15% of our cases had associated other bony injuries like fractures of clavicle and distal radius.

Hence the outcome of surgically treated distal tibial fractures depends on the associated injury to and the management of, the soft tissues surrounding the injury and accuracy of the articular reduction. A correlation exists between the severity of the fracture, overall outcome and the development of secondary degenerative arthritis.

CONCLUSION

- A short series of result of our study were analyzed and the overall results have encouraged us in preferring the surgical management of distal tibial fractures over conservative methods.
- Distal tibial fractures are to be internally fixed either within 24 hrs of the injury before the edema sets in or a delay of 8 to 12 days for the edema to settle down and the wrinkle sign appears.
- Respect the soft tissues: do not operate too early or through compromised skin, instead wait till the soft tissues is amenable for surgery.
- Restoration of the articular surface and reestablishing its relationship to the tibial shaft is the primary goal of treatment.
- Good functional result depends on reasonable anatomic reduction of the articular surface either by direct or indirect methods.
- Understand the fracture completely before planning any surgery (obtain adequate radiographs, CT scan and radiographs of the uninjured limb).
- Open reduction and internal fixation with anatomical restoration of the articular surface is to done in all cases AO type C fractures otherwise it will lead to mal-alignment and secondary degenerative osteoarthosis.
- Anatomic realignment of fibula indirectly redues the talus beneath the anatomic axis of tibia. Restoration of fibular length, alignment and

rotation has the substantial impact on the indirect realignment of anterolateral and posterolateral tibial plafond from their attachment to the anterior and posterior tibiofibularsyndesmotic ligaments. Hence fibula fixation is advocated wherever possible.

- Conservative management can be reserved in cases where fibula is intact and type I fractures and also in those with associated medical complications contraindication to surgery.
- Surgical reconstruction must be tailored to the personality of each fractures and operative approaches dictated by the quality of the soft tissues.
- From our study Medial Distal Locking Compression Plating for distal fractures was found to be safe and effective. For AO type A fractures, can be fixed either using MIPPO or ORIF technique. For AO type C fractures Open reduction of the articular fragment is mandatory and then stabilize with locking compression plate for added up stability. Also the incision between the tibial and fibula exposure must be atleast 7 cm.
- For highly comminuted injuries with unreconstructable articular surface, primary ankle fusion is an alternative to ORIF.

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PROFORMA

Case No: Unit:

Name: Age/Sex:

I.P No: Occupation:

Address: Phone:

Date of Injury:

Date of Admission:

Date of Surgery:

Date of Discharge:

Mechanism of Injury:

- Road Traffic Accident
- Accidental Fall
- Industrial Accident
- Others

Severity of Injury

- High Velocity
- Moderate Velocity
- Trivial

General Condition:

Hemodynamic Status:

Side Involved: (Right/Left)

X-Ray findings:

Type of Fracture:

- Type A: Extra-articular
- Type B: Partial-articular
- Type C: Intra-articular

Associated other long bone injuries: (Yes/No)

Associated Head injury: (Yes/No)

Treatment elsewhere if any:

Treatment in our Institution:

- Time interval between injury and definitive management
- Procedure done
- Additional Procedures
- Bone grafting:(Yes/No)

Blood transfusion:(Yes/No)

Post Operative Events:

Complication:

Follow Up:

- No. of Weeks since Surgery
- Radiological Picture
- Scar Status
- Complications
- Ankle Range of motion
- Ankle Score

Assistant Professor Signature:

MASTER CHART

Sl.No	Name	Age	Sex	IP no	lode of inju	Side	AO Type	Associated Injuries	Time interval between admission and surgery	Type of management	complication	IOWA ankle score	Additional procedure	follow up	Result
1	Mahendran	40	M	102594	Fall	R	C2	Nil	9 days	ORIF with LCP	Nil	90	Nil	18 months	Excellent
2	Ebenezar	53	M	106056	RTA	R	C1	Nil	11 days	MIPPO with LCP	Nil	92	Nil	20 months	Excellent
3	Rajie	51	F	26673	fall	R	A	Nil	4 days	MIPPO with LCP and fibula plating	Nil	94	Nil	18 months	Excellent
4	velayutham	55	M	39777	RTA	R	A	Nil	12 days	MIPPO with LCP and fibula plating	superficial infection	93	Wound wash a	16 months	Excellent
5	loordhusamy	68	M	43639	RTA	R	C2	Nil	12 days	MIPPO with LCP and fibula plating	superficial infection	72	Wound wash a	20 months	Fair
6	lalitha	50	F	47309	RTA	L	A	Nil	11 days	MIPPO with LCP	Nil	92	Nil	19 months	Excellent
7	Irfan	35	M	59606	Fall	R	C2	Nil	10 days	MIPPO with LCP and fibula plating	Nil	90	Nil	17 months	Excellent
8	Sajuth kumar	40	M	32583	Fall	L	A	Nil	12 days	MIPPO with LCP and fibula plating	Nil	92	Nil	18 months	Excellent
9	Kannan	65	M	100769	RTA	L	A	Nil	11 days	MIPPO with LCP	Nil	84	Nil	20 months	Good
10	Munusamy	56	M	37814	RTA	R	C2	Nil	12 days	ORIF with LCP and fibula plating	Nil	90	Nil	18 months	Excellent
11	Devi	57	F	39221	Fall	R	A	Nil	11 daays	MIPPO with LCP and fibula plating	Nil	91	Nil	16 months	Excellent
12	Sekar	44	M	31096	RTA	R	C3	Nil	14 days	ORIF with LCP and fibula plating	deep infection	74	Implant remov	16 months	Fair
13	kothandapani	54	M	38910	RTA	L	C2	Nil	13 days	ORIF with LCP and fibula plating	Nil	82	Nil	20 months	Good
14	Valarmathi	35	F	8623	Fall	L	C3	Nil	10 days	ORIF with LCP and fibula plating	Nil	90	Nil	19 months	Excellent
15	Shanthi	37	F	110510	Fall	L	C3	Nil	12 days	ORIF with LCP and fibula plating	Flap necrosis	80	Flap cover	22 months	Good
16	Sivaraman	59	M	50047	RTA	L	C1	Nil	11 days	ORIF with LCP	Nil	94	Nil	18 months	Excellent
17	Govindasamy	57	M	44381	RTA	R	A	Nil	13 days	MIPPO with LCP and fibula plating	Nil	93	Nil	16 months	Excellent
18	Thirupathi	44	M	48848	Fall	L	C1	Nil	10 days	ORIF with LCP	Nil	92	Nil	18 months	Excellent
19	Giri	36	M	2267	RTA	R	C3	Nil	13 days	ORIF with LCP	Nil	90	Nil	24 months	Excellent
20	saiful	35	M	62885	others	R	A	Nil	10 days	MIPPO with LCP and fibula plating	Nil	94	Nil	20 months	Excellent
21	Mohana	25	F	22899	RTA	L	C3	Nil	9 days	ORIF with LCP and fibula plating	superficial infection	90	Wound wash a	24 months	Excellent
22	adhikari	55	M	104023	RTA	R	A	Nil	13 days	MIPPO with LCP	Nil	92	Nil	19 months	Excellent
23	Venkatesan	45	M	117744	others	L	A	Nil	12 days	MIPPO with LCP and fibula plating	Nil	92	Nil	20 months	Excellent
24	Rajmohan	44	M	86141	RTA	R	C3	calcaneal fract	13 days	ORIF with LCP and fibula plating	Nil	90	Nil	18 months	Excellent
25	Nithya	24	F	67443	others	R	C1	Nil	11 days	ORIF with LCP	Nil	80	Nil	19 months	Good
26	Valliammal	57	F	73201	others	R	C1	Distal radius #	12 days	ORIF with LCP	Nil	70	Nil	17 months	Fair
27	jaya	45	F	65624	others	R	C1	Nil	10 days	MIPPO with LCP	Nil	92	Nil	18 months	Excellent
28	Muthammal	58	F	26414	RTA	R	C3	Distal radius #	14 days	ORIF with LCP	Nil	90	Nil	20 months	Excellent
29	Kalaiselvi	43	F	40769	RTA	R	C1	Nil	8 days	ORIF with LCP	Nil	90	Nil	16 months	Excellent
30	vijayalakshmi	40	F	72616	RTA	R	C1	Nil	11 days	ORIF with LCP	Nil	82	Nil	18 months	Good