A PROSPECTIVE STUDY ON OUTCOME OF MINIMALLY INVASIVE PERCUTANEOUS PLATE OSTEOSYNTHESIS(MIPPO) USING MEDIAL DISTAL TIBIA ANATOMICAL LOCKING COMPRESSION PLATES FOR DISTAL TIBIA FRACTURES.

Dissertation Submitted for

MS Degree (Branch - II) Orthopaedics

April 2013

The Tamilnadu Dr.M.G.R.Medical University

Chennai – 600 032.

MADURAI MEDICAL COLLEGE, MADURAI.

CERTIFICATE

This is to certify that this dissertation titled " **A PROSPECTIVE STUDY ON OUTCOME OF MINIMALLY INVASIVE PERCUTANEOUS PLATE OSTEOSYNTHESIS (MIPPO) USING MEDIAL DISTAL TIBIA ANATOMICAL LOCKING COMPRESSION PLATES FOR DISTAL TIBIA FRACTURES**. submitted by **DR.A.SENTHILRAJAN** to the faculty of Orthopaedics, The Tamilnadu Dr. M.G.R. Medical University, Chennai in partial fulfillment of the requirement for the award of MS degree(branch – II) Orthopaedics, is a bonafide research work carried out by him under our direct supervision and guidance.

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DECLARATION

I**, DR. A.SENTHILRAJAN,** solemnly declare that the dissertation titled "**A PROSPECTIVE STUDY ON OUTCOME OF MINIMALLY INVASIVE PERCUTANEOUS PLATEOSTEOSYNTHESIS (MIPPO) USING MEDIAL DISTAL TIBIA ANATOMICAL LOCKING COMPRESSION PLATES FOR DISTAL TIBIA FRACTURES.**" has been prepared by me. This is submitted to **The Tamilnadu Dr. M.G.R. Medical University, Chennai,** in partial fulfillment of the regulations for the award of MS Degree (Branch II) Orthopaedics

Place: Madurai **DR.A.SENTHILRAJAN.**

Date:

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INTRODUCTION

Distal tibia fracture is a therapeutic challenge in modern orthopaedics. Due to fracture pattern, periarticular location, minimal soft tissue coverage, the surgical treatment is complex one. Various modality of surgical treatment such as closed intramedullary nailing, Open Reduction Internal Fixation with conventional plate osteosynthesis and external fixation has been tried so far. But none of them have good functional outcome but high complication rate (20-50%)

Closed intramedullary nailing of distal tibia fracture can be a good option in AO type A fractures but the hourglass shape of the distal tibia does not allow anatomical reduction resulting in rotational and angular malalignment. Closed nailing is not an option, if the fracture line is less than 5cm from the articular margin(TypeB,C fracture).

External fixation is indicated in severe soft tissue injury or as a temporary stabilizing device. Pin tract infection,malreduction and joint stiffness are the drawbacks of external fixation.

Though ORIF with conventional plating provides anatomical reduction and addressing the rotational,angular malreduction.

It is associated with extensive soft tissue dissection and periosteal stripping which devitalize the fracture fragment resulting in nonunion,infections and wound dehiscence.

The newer technique of fixation of distal tibia fractures - minimally invasive percutaneous plate osteosynthesis involves less soft tissue handling and the minimal periosteal stripping resulting in low infection rate and faster healing. The precontoured anatomical locking plate used on the medial aspect prevents the varus collapse,implant failure and also secure the fracture reduction without further displacement.

AIM

To Study The Functional Outcome Of Minimally Invasive Percutaneous Plate Osteosynthesis(MIPPO) Using Medial Distal Tibia Anatomical Locking Compression Plates For Distal Tibial Fractures."

REVIEW OF LITERATURE

Hansmann developed the first bone plate in Germany in 1880's.

The first attempt at which is called as "biological plating "date back to some 20 years (Boitzy and Weber).

The development of indirect reduction techniques (Mast et al 1989) and the bridging plate (Heitemeyer et al 1985) brought about a basic change to fracture treatment using plates.

Principles of Biological fixation:

1. Indirect reduction techniques -Manipulation and reduction at a distance from the fracture site, aimed to preserve the soft tissues attached to the fracture fragment.
2. Leaving comminuted fragments out of fixation and preserving their blood supply.
3. Biocompatible , low elastic modulus implants should be used.
4. Minimal soft tissue and operative exposure.

Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) is one such method in which percutaneously inserted plate is fixed at a distance proximal and distal to the fracture site through minimal exposure.

Borelli et al concluded that conventional plating is associated with increased incidence of extensive soft tissue dissection and devitalization leading to vascular compromise of the fragment in metaphyseal region as

compared with MIPPO technique. MIPPO technique is more of biological fixation than conventional plating.

Wang Cheng et al compared the MIPPO technique with conventional ORIF with non-locking plate osteosynthesis. They concluded that it is advantageous over the conventional non locking plate osteosynthesis in terms of low infection rate and faster healing, even though with few complication such as skin irritation and malreduction

Oh CW et al(2003), Redfern et al(2004) concluded that percutaneous plating of distal tibia fractures healed without need of second surgical procedure. The mean union rate was 15.2 weeks and 23 weeks respectively with few complications such as malalignment.

Maffulli N et al.(2004) have studied the functional outcome of percutaneous plating in distal tibia fractures. They concluded that union rate of 95% , angular deformity and joint stiffness of 35% were reported. They recommended that percutaneous plating is superior than conventional open plating.

Hasenboehler et al(2007), compared the closed nailing and the MIPPO technique for distal diaphyseal fractures of tibia. They concluded that though both procedures are biological one, the knee irritation and malalignment complications are avoided in MIPPO. They had mean

union of 75% at 6 months,84% at 9 months, 90% at the end of 15 months which is superior than closed nailing.

Lau et al(2008), Abid Mushtaq et al(2009) concluded that percutaneous plating of distal tibia fractures have average union of 18.7 weeks and 5.5 months respectively. Lau et al reported 15% of late infection in his study. He reported that implant removal was done in 25 among 48 patients(52%), most common reason for implant removal was skin impingement.

Leung FK et al (2009) concluded that less incidence of serious complication in distal tibia fractures in MIPPO with LCP. He reported 90% of anatomical reduction and 9% of acceptable fracture reduction in his studies.

Mario Ronga et al(2010) studied the outcome of MIPPO with LCP among 21 patients for 2 years. He reported that union rate was 95%, angular deformity was 19%, ankle motion was less than 20degree as compared with normal side in 23%. He reported that 76% of sportsmen did not recover to preinjury status and delayed union of 14%.

EPIDEMIOLOGY

More number of distal tibia fractures with severe intra-articular comminution are reported with increased use of high-speed motor vehicles. Low energy rotational violence due to accidental fall and the high energy axial compression violence due to road traffic accidents and fall from height are the two common modes of violence. Low energy injury associated with less soft tissue injuries where as the high velocity injuries associated with severe soft tissue injuries and high incidence of open fractures. Incidence of distal tibia fractures varies with age and sex. It constitutes 3-10% of fractures around the distal tibia and 1% of all lower extremity fractures with incidence of 3 per 10,000 per year among 30 to 34-year-old women and 28 per 10,000 per year among 15 to 19-year-old boys. High velocity trauma (RTA, fall from height) is the primary mechanism of fracture in young patients.

ANATOMY AND BIOMECHANICS OF DISTAL TIBIA AND FIBULA

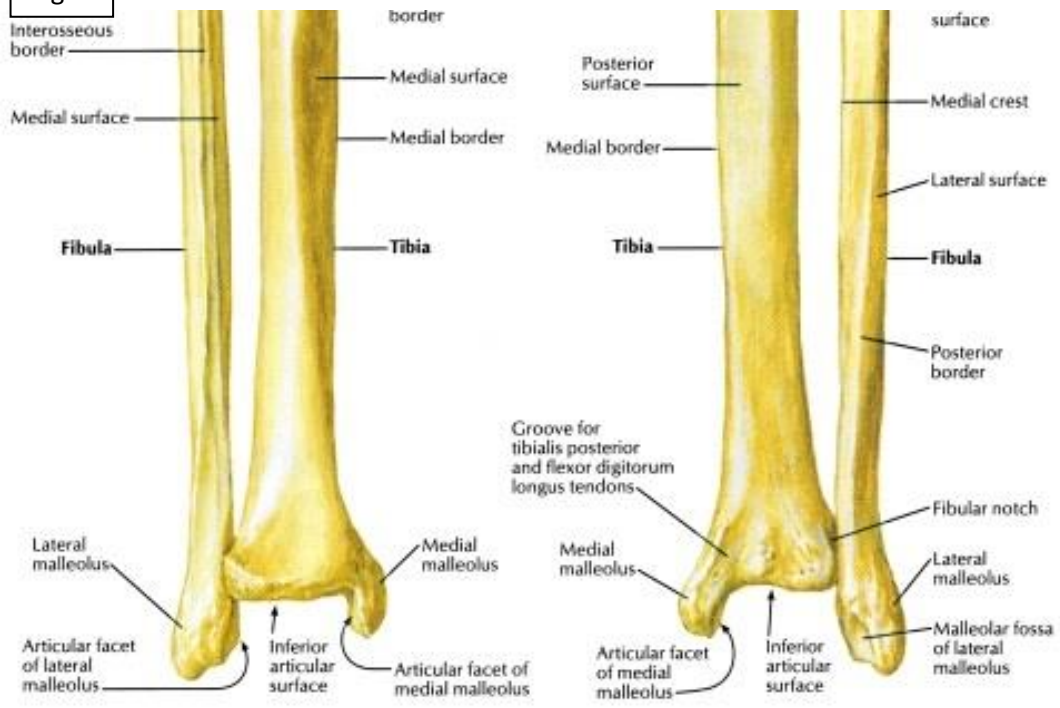
The distal end of the tibia has anterior, medial, posterior, lateral and distal surfaces, and projects inferomedially as the medial malleolus. It is laterally rotated relative to the proximal tibia (tibial torsion). The smooth anterior surface bulges slightly and ends distal to the distal surface. The medial surface is smooth and subcutaneous.

It is continuous with the shaft proximally and the medial malleolus distally. The posterior surface is smooth and is separated from the medial surface by a prominent ridge that passes inferomedially to the posterior aspect of the medial malleolus. The lateral surface is the triangular fibular notch, which is roughened proximally but smooth distally, where it is sometimes covered by articular cartilage.

The distal surface articulates with the talus and is wider anteriorly than posteriorly. It is concave sagittally and slightly convex transversely and continues medially into the malleolar articular surface. The medial malleolus is short and thick and has a smooth lateral surface with a crescentic facet that articulates with the medial surface of the talar body. The distal end of the fibula or lateral malleolus projects distally and posteriorly relative to the medial malleolus.

Its lateral aspect is subcutaneous, the posterior surface has a broad groove with a prominent lateral border, and the anterior surface is rough and round and articulates with the anteroinferior aspect of the tibia. The medial surface has a triangular articular facet, vertically convex and its apex distal, which articulates with the lateral talar surface. Behind the facet is a rough malleolar fossa.

Fig 1



MUSCLE ANATOMY

The interosseous membrane, the deltoid, and the anterior and posterior tibiofibular ligaments are attached to the distal tibia. No muscles are attached to the bone in this region. There are no muscles attached to the distal fibula below the level of the interosseous ligament.

The ligamentous attachments are those of the lateral ligament complex, i.e. the anterior talofibular, the calcaneofibular and the posterior talofibular ligaments. The interosseous ligament is attached on its medial surface. The medial surface of the fibula gives rise to the extensor hallucis longus, extensor digitorum longus and the peroneus tertius muscles.

The lateral surface has the origin of the peroneus longus and brevis muscles. The posterior surface gives origin to the flexor hallucis longus and soleus muscles lateral to the medial crest of the fibula; medial to it arises the tibialis posterior muscle.

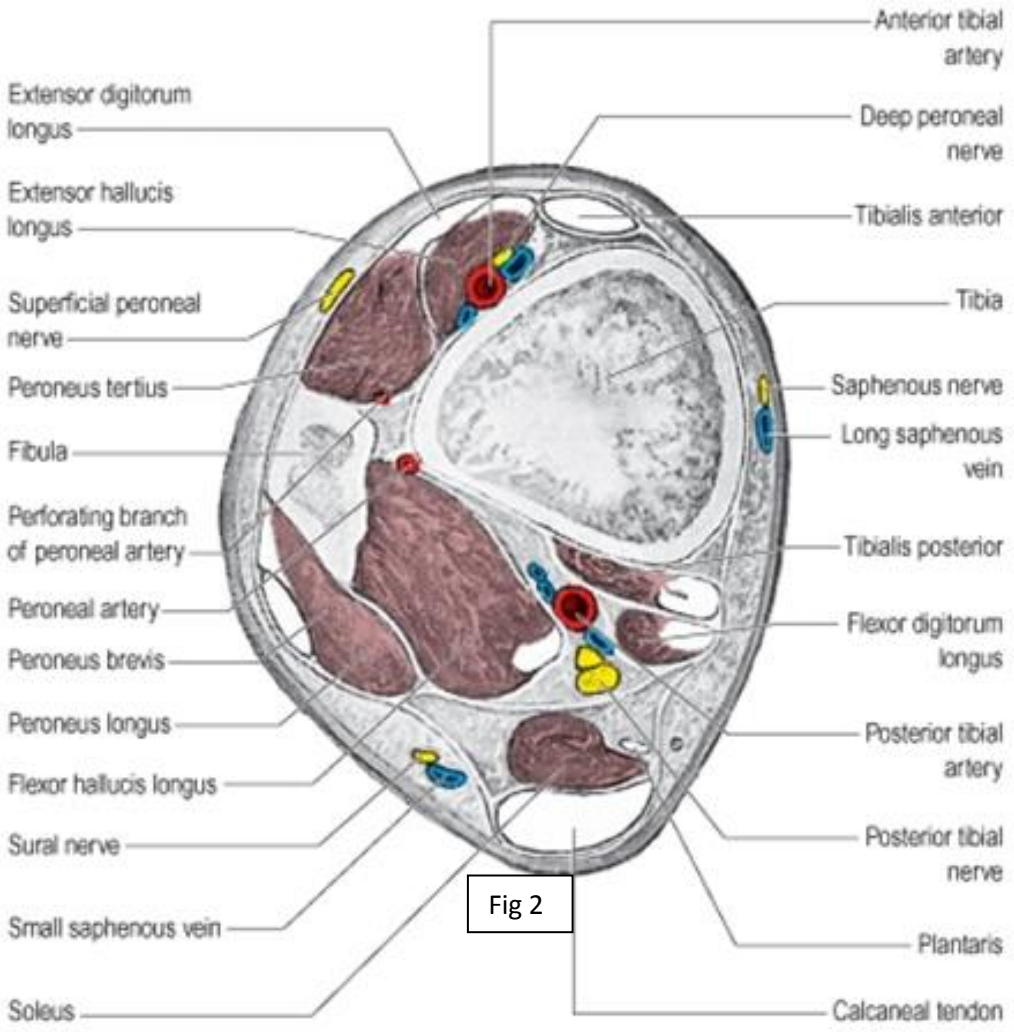


Fig 2

VASCULAR ANATOMY

The distal tibia is supplied by an arterial network formed by branches of the dorsalis pedis, posterior tibial and peroneal arteries. The distal fibula is supplied by an arterial network made up of branches of the dorsalis pedis, posterior tibial and peroneal arteries.

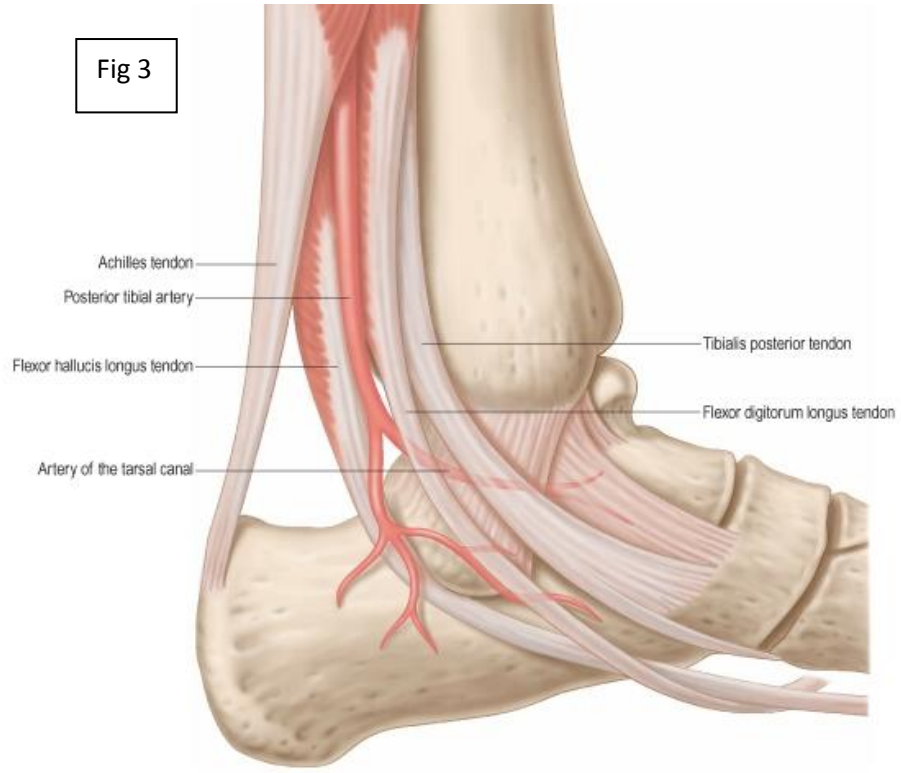
NEURO-ANATOMY

The distal tibia is innervated by branches from the deep peroneal, posterior tibial, saphenous and sural nerves. The distal fibula is innervated by the deep peroneal, tibial, saphenous and sural nerves.

SURGICAL ANATOMY

Ankle mortise is formed by distal tibia and fibula. Superior surface of talus articulates with ankle mortise. Ankle mortise is wide anteriorly than posterior and concave in antero-posterior aspect. Distal tibia and fibula articulate together in postero-lateral aspect by distal tibio-fibular syndesmosis. Maximum compression strength occurs within 3 cm proximally from the articular margin, more than 3 cm it is least resistant to compression force and yield easily in case of axial compression force which produce more comminution in that area. Strongest bone stock present in distal sub-chondral bone of tibia is providing good screw purchase in plate fixation.

Fig 3

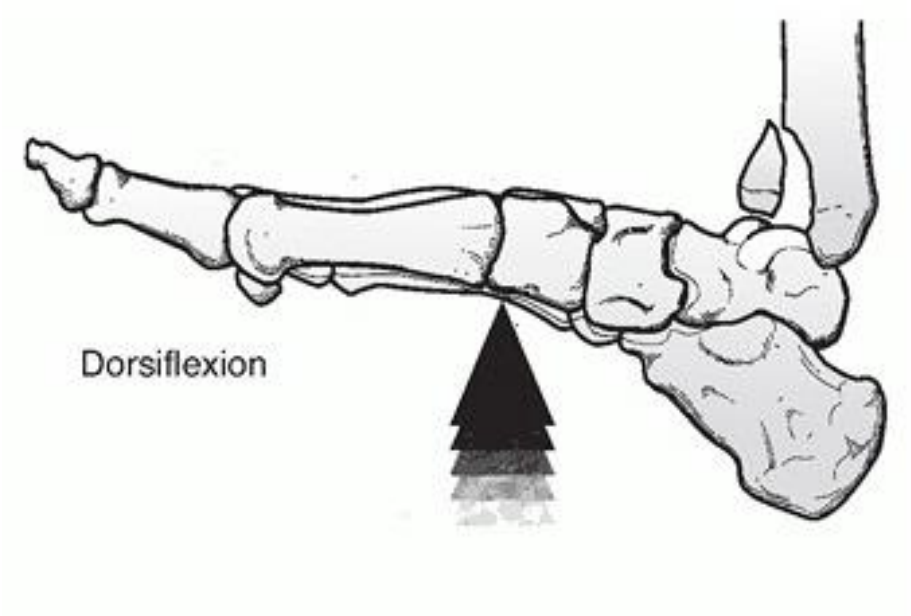


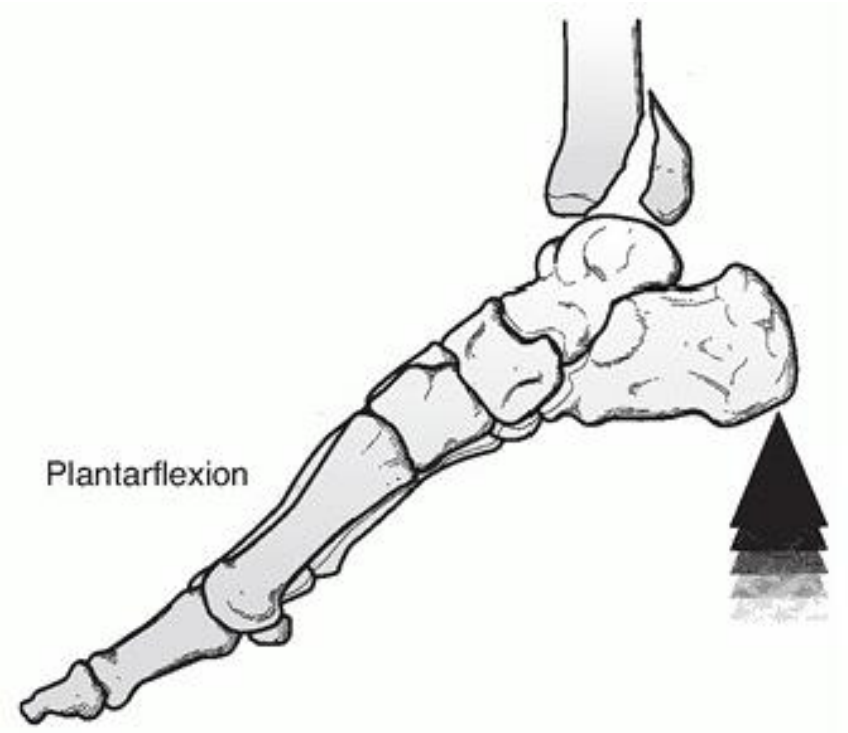
MECHANISMS OF INJURY:

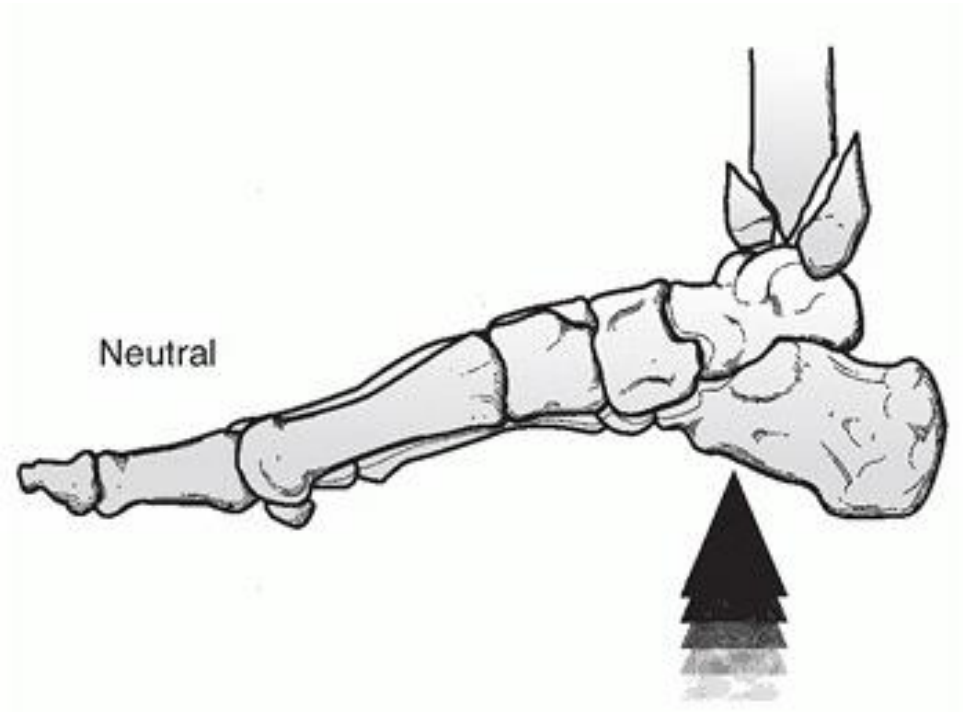
Extraarticular fractures are result of RTA. Fall from height. Intraarticular fractures are result of two main mechanism of injury, one is low energy rotational violence another one is high velocity axial compression violence. Most of the intraarticular complex comminuted fractures are result from axial compression violence,it is otherwise called "Explosion" fracture. Due to the viscoelastic nature of the bone, it absorb huge amount of energy before thr fracture. When the absorbing capacity of bone exceed to its limit, produce explosive fracture. Depending upon the foot position at the time of impact the characteristic fracture patterns

are produced. when the foot in dorsiflexion, Axial compression impact resulting anterior plafond comminution,

When the foot in plantar flexion, axial compression impact resulting in posterior plafond comminution, when the foot is in neutral position, it result in central comminution.




Plantarflexion


Neutral

FRACTURE ANATOMY:

Extra-articular fractures commonly present with transverse,oblique,spiral or communited fracture pattern. Due to the intact ligamentous structures intra-articular fractures produce characteristic fracture fragments,

1. Intact deltoid ligament produce medial malleolar fragment,
2. Intact posterior tibio-fibular ligament produce posterior malleolar (volkman)fragment,
3. Intact anterior tibio-fibular ligament produce antero-lateral (chaput)fragment.

CLINICAL EVALUATION:

Significant pain and swelling which worsen over several days can be seen in several patients. Usually it is associated with ecchymosis and the swelling gradually subside over a period of 2-4weeks. Presence of fracture blisters and the type of fracture blister should be assessed. Clear fluid filled blisters are associated with less severe injury where as hemorrhagic blisters are associated with more severe injury. Hemorrhagic blisters warrant close observation and postpone the surgical intervention till it resolve because it is associated with post operative wound infection ,delayed wound healing and wound gaping.

RADIOLOGICAL EVALUATION:

Plain x-ray tibia and fibula anteroposterior,lateral and ankle mortise views should be taken. CT-scan will be helpful in assessing the intra-articular extension ,major fracture line,number of fracture fragments,amount of comminution and impaction.

CLASSIFICATIONS:

AO CLASSIFICATION:

Type-A – Extraarticular fractures.

A1 – Metaphyseal simple.

A2 – Metaphyseal wedge.

A3 – Metaphyseal complex.

Type-B – Partial articular with a portion of articular fragment in continuity with shaft.

B1 – Pure split.

B2 – Split depression.

B3 – Multifragmentary depression.

Type-C – Complete metaphyseal fracture with articular involvement.

C1 – Articular simple,metaphyseal simple.

C2 – Articular simple,metaphseal multifragmentary.

C3 – Articular multifragmentary.

AO/OTA CLASSIFICATION

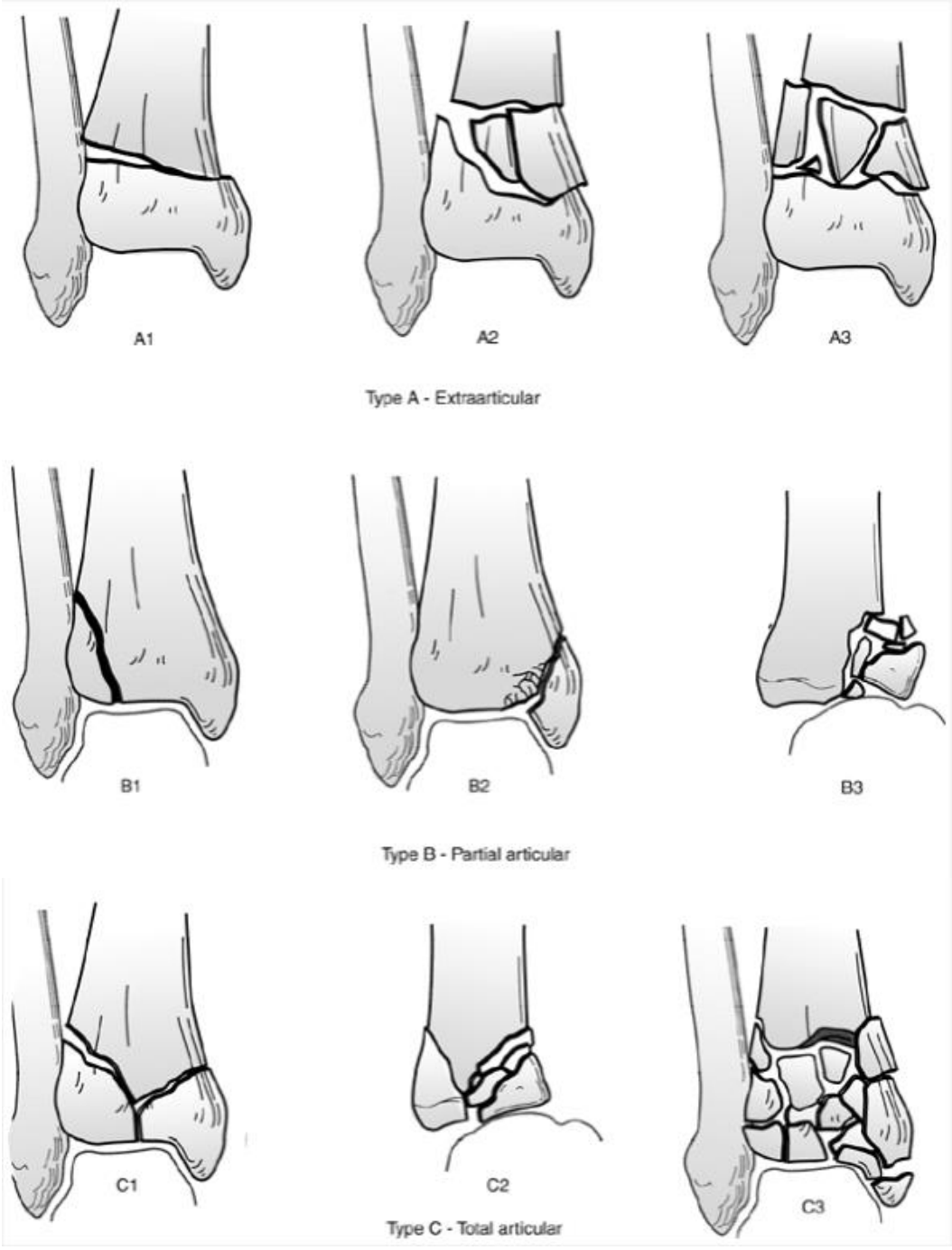


Fig 4

RUEDI AND ALLGOWER CLASSIFICATION:

Type-I – Articular cleavage fracture without significant displacement of the articular surface.

Type-II – Displaced intraarticular fracture without comminution and impaction.

Type-III – Intraarticular fracture with comminution and impaction.

Ruedi And Allgower Classification

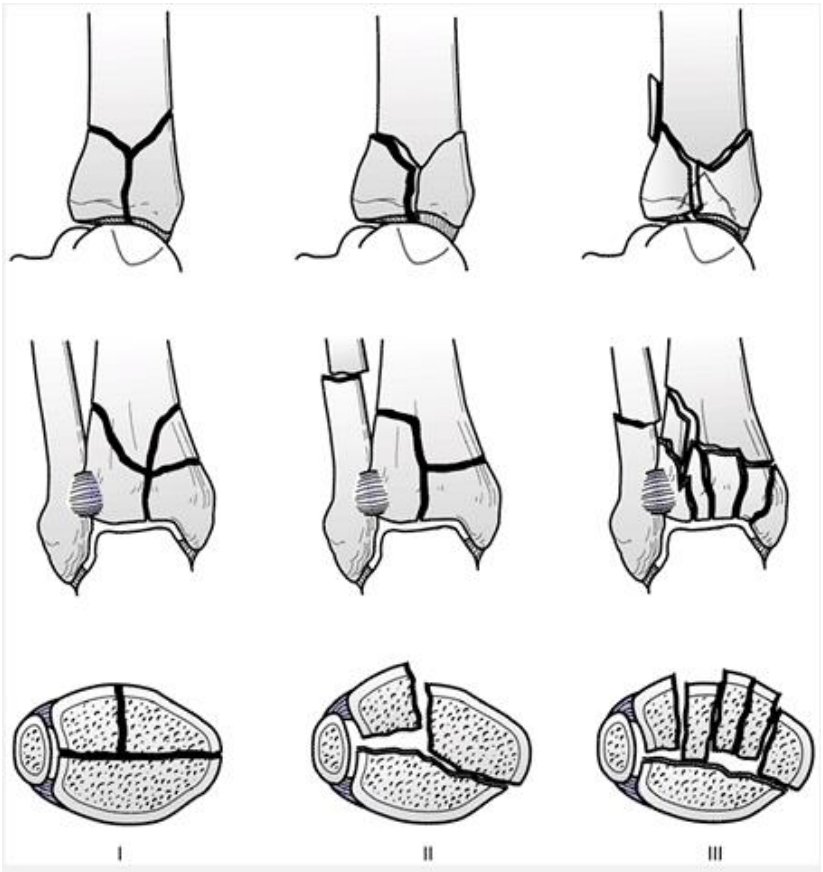


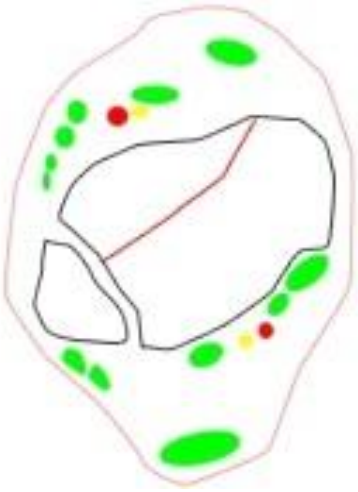
Fig 5

TOPLISS et al(2005) CLASSIFICATION:

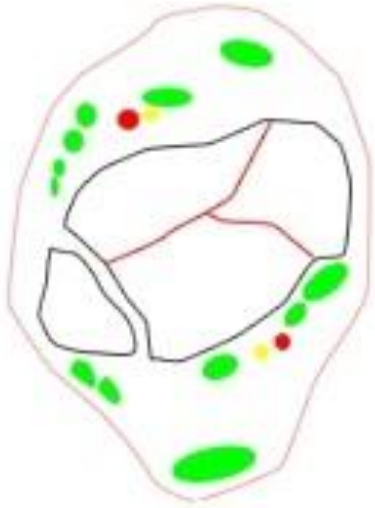
TOPLISS et al classified the pilon fracture based on the plain x-ray and CT .

He divided into three main groups based on main fracture line

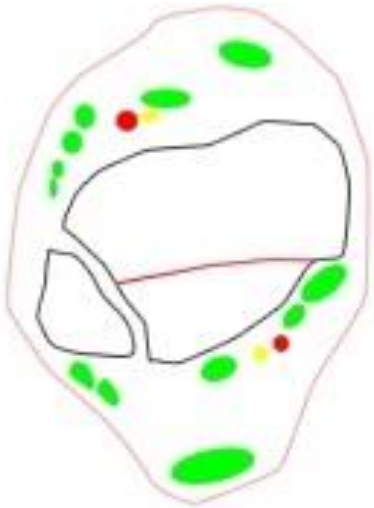
1. Coronal group – Distal metaphyseal-diaphyseal dissociation and valgus alignment(56%)
2. Sgittal group – Proximal metaphyseal-diaphyseal dissociation and varus alignment (33%)
3. Comminuted fractures – Not able to classify either coronal or sagittal group (6%)



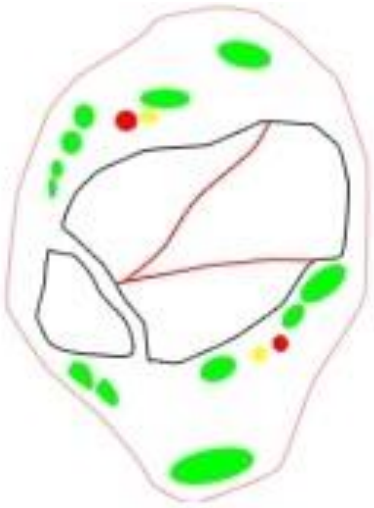
a. Anterior coronal fractures in low energy injury



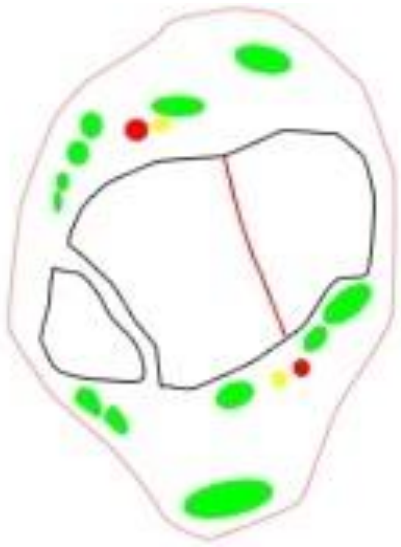
b. Anterior coronal fractures in high energy fractures



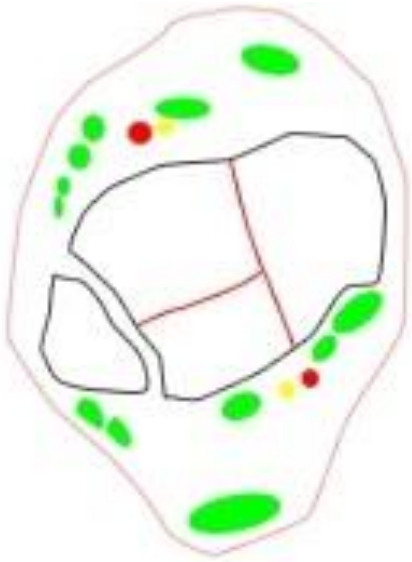
c. Posterior coronal fractures in low energy injury



d. Posterior coronal fractures in high energy injury



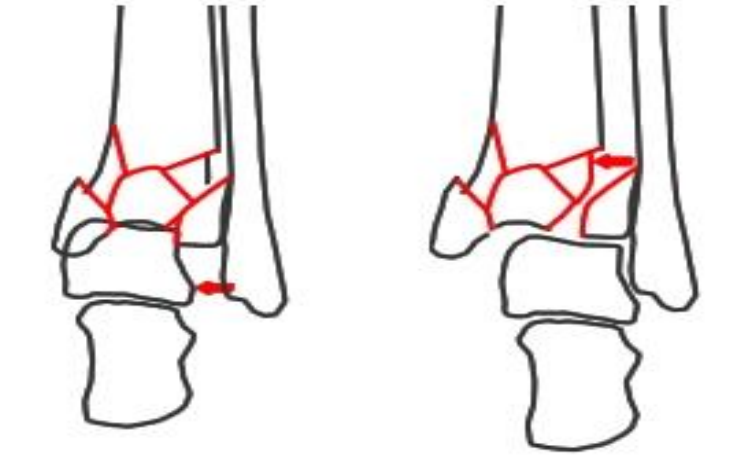
e. Sagittal fractures in low energy injury



f. Sagittal fractures in high energy injury

Lateral disruption fractures – fractures with incongruity of joint between the lateral malleolus and the lateral talar facets.

Functional diastasis – main fracture fragment of tibia along with intact inferior tibio-fibular syndesmosis.



RELIABILITY OF CLASSIFICATION:

For effective use a classification system must have intra and inter observer reliability and precisely predict the prognosis along various treatment algorithms. Two studies (Swiontowsk et al and Martin et al) had compared the reliability of AO and Ruedi Allgower classication. Swiontowski et al(1997) found moderate interobserver reliability of AO classification when it was divided into major groups (A,B,C) than into subgroups(A1,A2,A3 etc).

Martin et al found improved interobserver reliability when the distal tibia fractures were classified into major AO groups(A,B,C) than into Ruedi Allgower classification.

TREATMENT OF DISTAL TIBIA FRACTURES:

1. NON-OPERATIVE
2. OPERATIVE

NON-OPERATIVE:

Non-operative treatment is indicated in undisplaced (Ruedi Allgower type-I) fractures and displaced intraarticular fractures incase of bedridden, non-ambulatory, surgically unfit patients.

Non-operative treatment consists of closed reduction and cast immobilization followed by gradual weight bearing according to the radiological union. Displaced fractures and fractures with soft tissue injury are initially treated with calcaneal pin traction followed by cast immobilization.

Ruff et al has analyzed the outcome of non-operative treatment ankle motion in distal tibia fractures. He found that achieving normal tibio-talar anatomy by closed reduction shows better results.

Ayeni et al found that undisplaced fractures have good outcome than displaced fractures

Kellam et al has compared the outcome of non-operative and operative treatment in which he found undisplaced rotational violence fractures have good outcome with non-operative treatment.

OPERATIVE TREATMENT:

PRINCIPLES:

a. Anatomical, congruent reduction.

b. Stable fixation.

c. Early mobilization and rehabilitation.

EXTERNAL FIXATION:

External fixation can be used as definitive fixation or temporary fixation in a part of staged treatment protocol where the extensive soft tissue injury does not allow early internal fixtion.But it is associated with malreduction and malunion(5-25%), nonunion(2-17%), and pintract infection(10-100%). Current concept of external fixation in distal tibia fractures is open reduction and internal fixation of fibula in order to maintain the limb length followed by temporary external fixation of tibia, after 2 to 3 weeks once the soft tissue injury healed convert it into internal fixation.

CLOSED REDUCTION AND INRAMEDULLARY NAILING:

Closed nailing of distal tibia fractures is biological one. But the hourglass shape of distal tibia does not allow anatomical reduction which results in rotational and angular malalignment. Various studies reported that the healing potential of closed nailing is inferior to percutaneous technique, non anatomical reduction and distraction at fracture site may be the reason. closed nailing is not an ideal option in fractures with fracture line less than 5cm from the articular margin, as in Type B,C fractures.

ORIF WITH PLATE OSTEOSYNTHESIS:

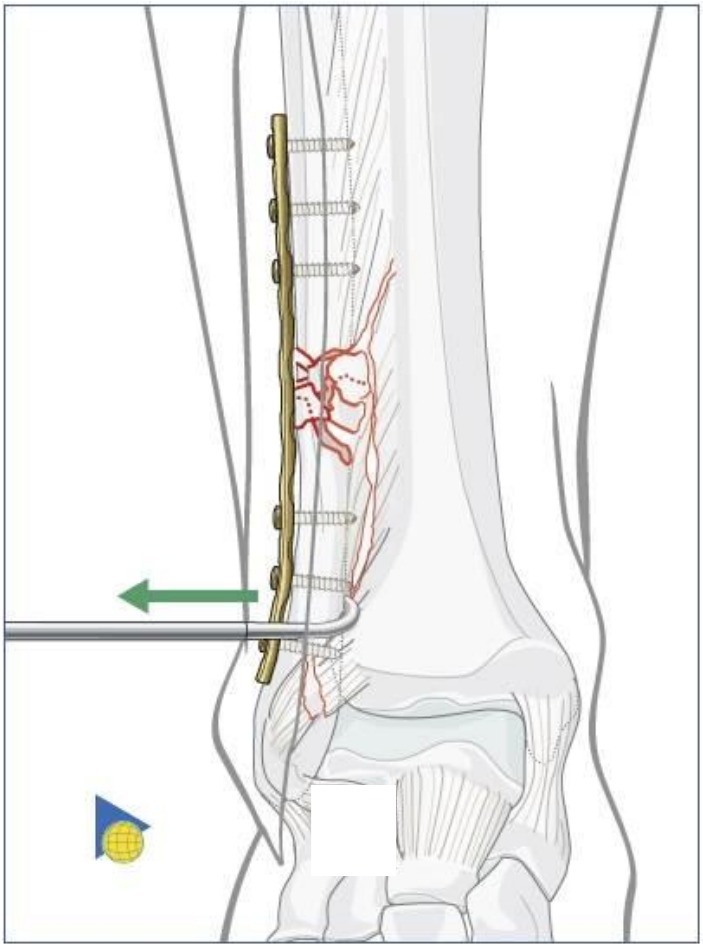
Conventional open plating technique require extensive soft tissue dissection and periosteal stripping which compromise the vascularity of the fracture fragments resulting in high rates of delayed and nonunion(8-35%) and infections(24%) .

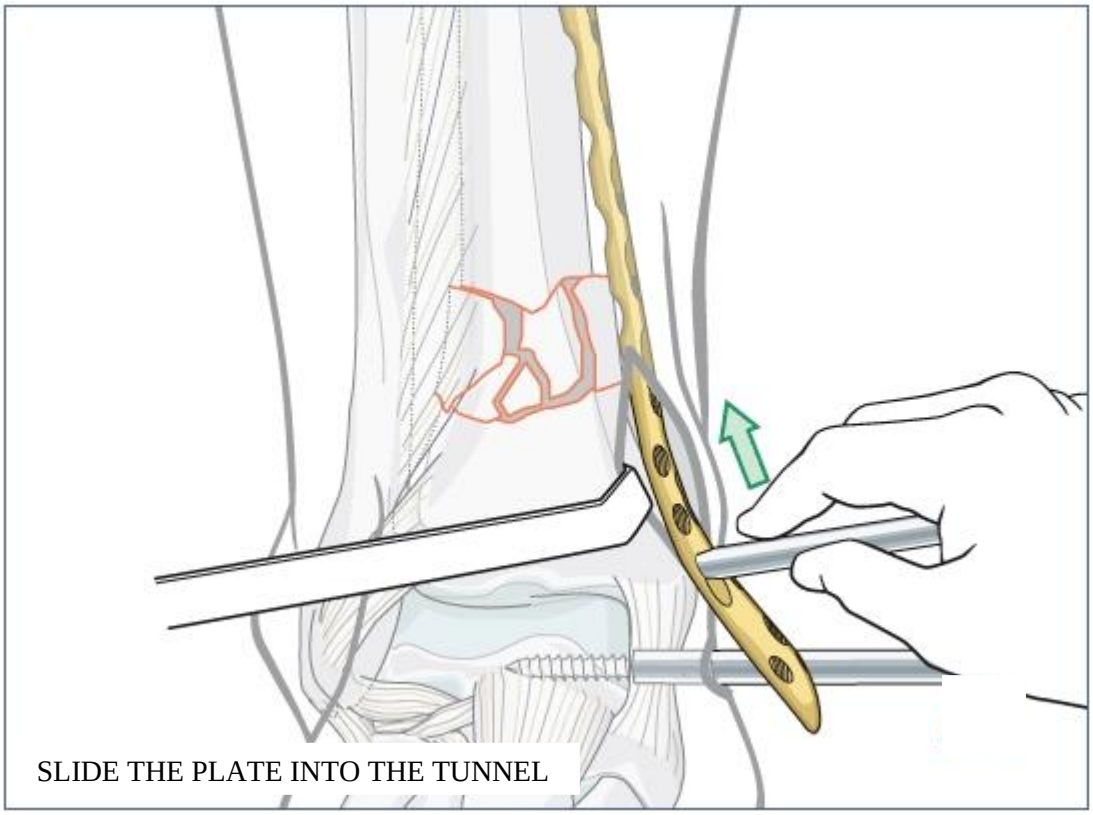
MIPPO TECHNIQUE:

To overcome the above complications associated with conventional open technique the newer MIPPO technique having less soft tissue handling and periosteal stripping which resulting in faster fracture healing and less complications.

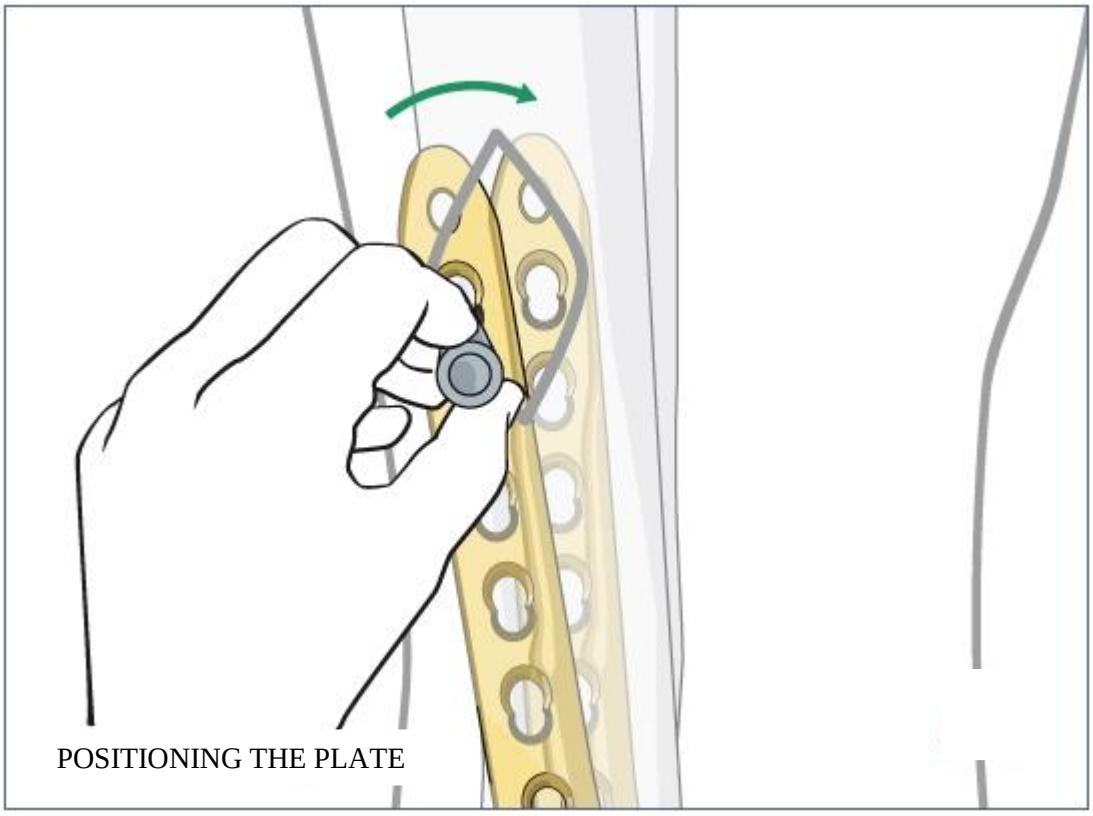
ROLE OF CONCURRENT FIBULA FRACTURE:

The concurrent fibula fracture in distal tibia fracture plays a major role in fracture fixation. In comminuted distal tibia fractures the fibula fracture must be fixed to restore the axial alignment of tibia and indirect fracture reduction. If the distal tibia fracture is not comminuted, the fibula fixation is optional.

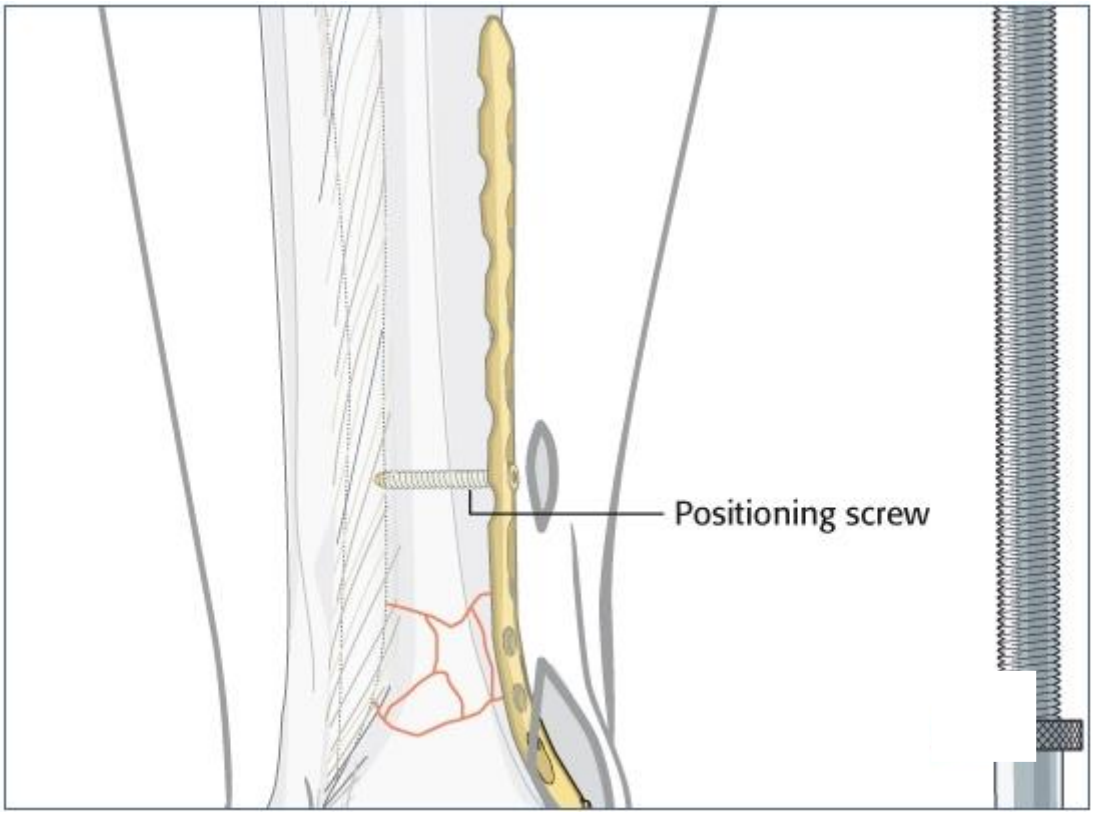


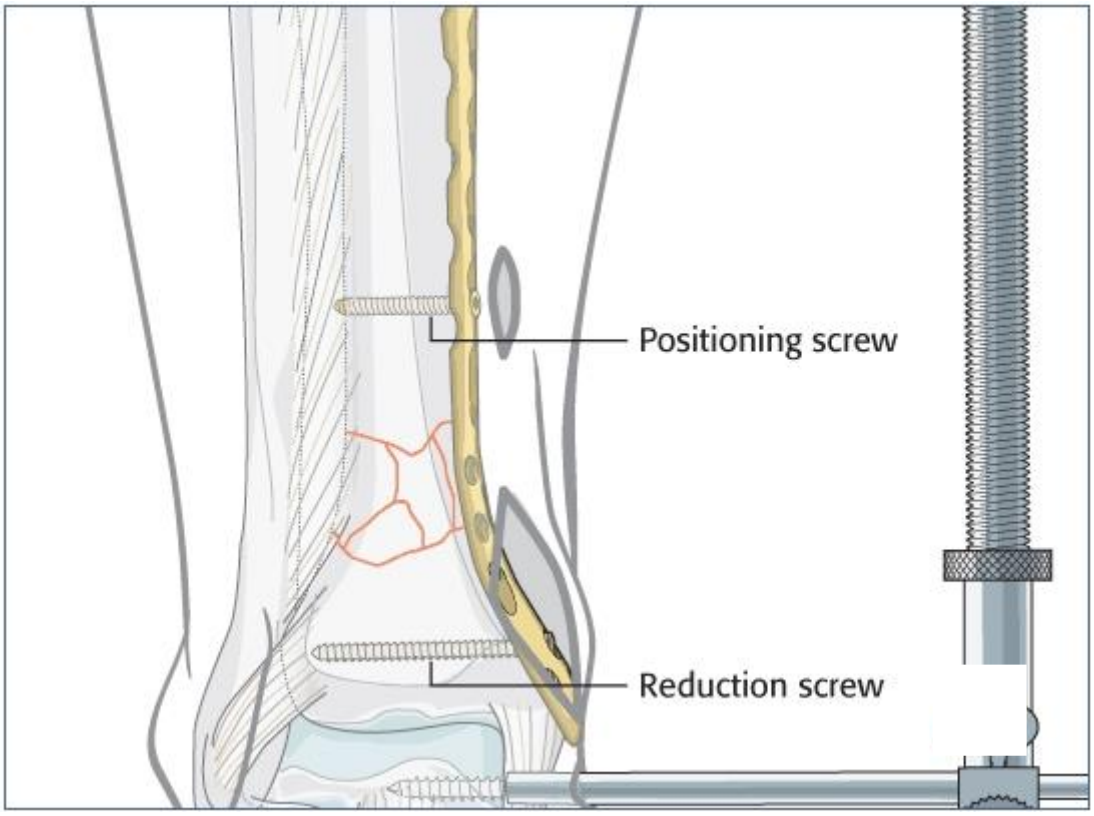


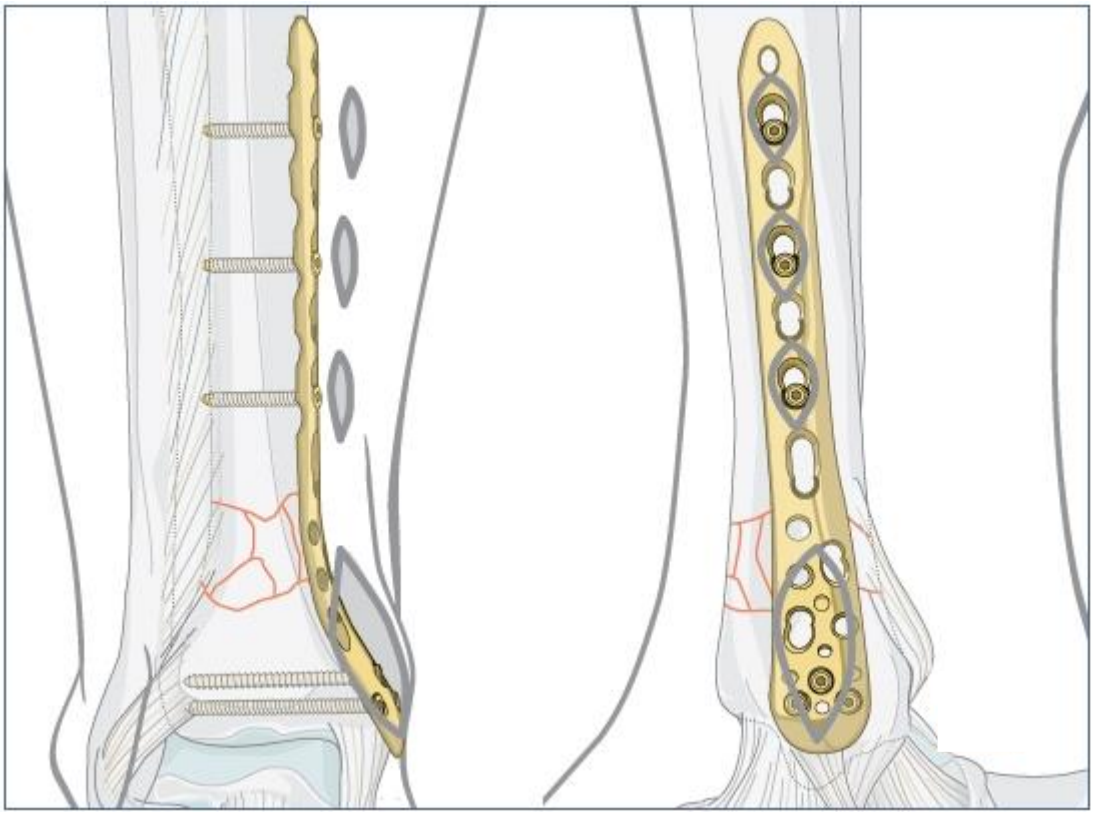
SLIDE THE PLATE INTO THE TUNNEL



POSITIONING THE PLATE


Positioning screw


Positioning screw
Reduction screw



MEDIAL PLATING:

Plating can be done on medial,lateral and antero-lateral aspects. Medial plating is indicated in fractures with medial comminution and minimal lateral joint involvement. Where as lateral and antero-lateral plating are indicated in fractures with comminution on both medial lateral and anterior aspect.

TYPE OF PLATE:

Conventional and locking plates are commonly used. Among conventional plates semitubular plates, L buttress plates, cloverleaf plates are commonly used for distal tibia fractures. In distal tibia fractures, conventional plating have high rate of complications.

The pull out strength of conventional plates are very minimal. They are associated with increased incidence of screw loosening, and varus collapse while mobilizing the patients which may lead to varus deformity.

Several new locked plate- screw devices have been developed over the past few years. Research suggests that plate with locked screws may provide improved fracture stability and healing. When a screw is locked to the plate, a fixed point of contact is created, which may be advantageous in the cancellous bone of the distal tibia. Anatomically precontoured locking plates specifically designed for the distal tibia fractures have favourable shapes of screw configuration, which may enhance the maintenance of the reduction and reduce hardware complications. The screw configuration of the locking screws in the distal tibial head is multidirectional.

The biomechanical properties of the LCP were thoroughly studied before the system was introduced into clinical use. Anatomical reduction of fracture should be done prior to locking the screw to the plate. As it is anatomically precontoured plates, plate should be positioned in appropriate angle,plating and locking screw is placed as recommended for securing the reduction without further displacement.

RATIONALE FOR SURGICAL TREATMENT:

A number of studies on distal tibia fracture fixation have been performed in an effort to validate the use of rigid fixation with external fixation,plate and screw fixation by open technique and minimally invasive technique, and Intra Medullary devices. In general, plates and screws have had the greatest resistance to bending stress and torsional loading. The stability of the screw plate construct is increased by locking screws, which are fixed at a given angle within the plate; if used in sufficient numbers.

They can maintain the position of a reduced fragment until bony healing occurs the soft tissue trauma is the major concern in treating the distal tibia fractures, So any surgical intervention which have less soft tissue handling gives better results. As minimally invasive technique associated with less soft tissue dissection, it is emerging as the better method of fixation for distal tibia fractures now-a-days.

COMPLICATIONS:

WOUND COMPLICATION:

Wound infection is the most common complication in distal tibia fractures. It could be either superficial or deep infection(fig.5 a,b). skin necrosis,surrounding inflammation and cellulitis indicates superficial wound infection.

If the superficial infection is not treated properly,it may lead on to deep infection where there is complete skin necrosis and exposure of the implant,bone and tendons. Superficial infection can be successfully treated with rest,immobilization,proper antibiotic coverage. In deep infection the radiological union, implant loosening and implant failure should be assessed. If the fracture unites, the implant can be removed and thorough wound debridment and removal of necrotic tissue should be done followed by proper wound cover with flap.

Fig 5 (a,b)

OSTEOMYELITIS:

Osteomyelitis is a sequalae of improperly treated deep infection. If the radiological union achieved. implant removal should be done followed by thorough wound debridement.

Necrotic bone fragments should be removed and if needed antibiotic impregnated beads can be tried. Ankle arthrodesis is necessary in patients with articular destruction and poor ankle motion.

NONUNION:

Nonunion occurs in 0-16% of the distal tibia fractures. It is commonly due to the malreduction,infection,poor vascularity and instability. Nonunion of extraarticular fractures with adequate distal fragment for distal locking can be managed with intramedullary nailing and bone grafting. Nonunion of intraarticular fractures are very rare. Infective nonunion can be treated with control of infection and stabilization with external fixation.Gap nonunion can be treated with bone transport procedure such as Illizarov technique. Simple nonunion can be treated with bone grafting and eliminating the cause of nonunion.

DELAYED UNION:

Delayed union occour in severly comminuted fractures with co-morbid conditions such as smoking, diabetes mellitus, malnourishment and peripheral vascular disease.

Fig 6 (a,b,c)

A Case Of Delayed Union

MALUNION:

Malunion are commonly associated with indirect reduction and MIPPO techniques. The common malunion is varus and extended position. It can be treated by corrective osteotomy and stabilized with plate or Ilizarov.

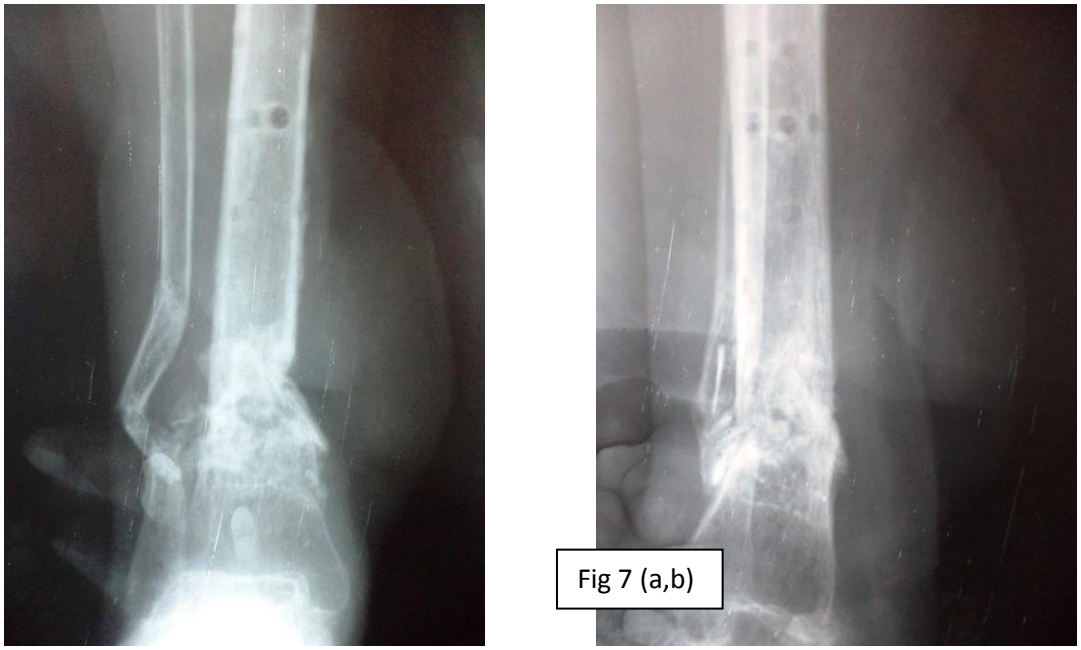


Fig 7 (a,b)

POST TRAUMATIC ARTHRITIS:

Severe intraarticular fractures, fractures with cartilage damage and associated talar fracture produce severe post traumatic arthritis. Exact incidence of post traumatic arthritis is not known. Post traumatic arthritis clinically present with mild to severe joint pain and narrowing of joint space radiologically. Mild symptoms respond to analgesics. Severe arthritis warrents ankle arthrodesis. Total ankle replacement can be tried in selected cases.

SKIN IRRITATION

Due to the subcutaneous placement of the locking plate in MIPPO technique, the skin irritation is significantly reported in most of the studies.

MATERIAL & METHOD

OBJECTIVE:

Prospective analyze of the outcome of minimally invasive percutaneous plate osteosynthesis(MIPPO) using medial distal tibia anatomical locking plate for distal tibia fractures & the functional outcome in these patients

INCLUSION CRITERIA:

1. Distal tibia fractures involving the lower one third of tibial Metaphysis and metaphyseo-diaphyseal junction AO/OTA classification type A,B,C distal tibia fratures
2. Ruedi allgower type II&III pilon fractures.
3. simple fractures.
4. Age: 20-80 years

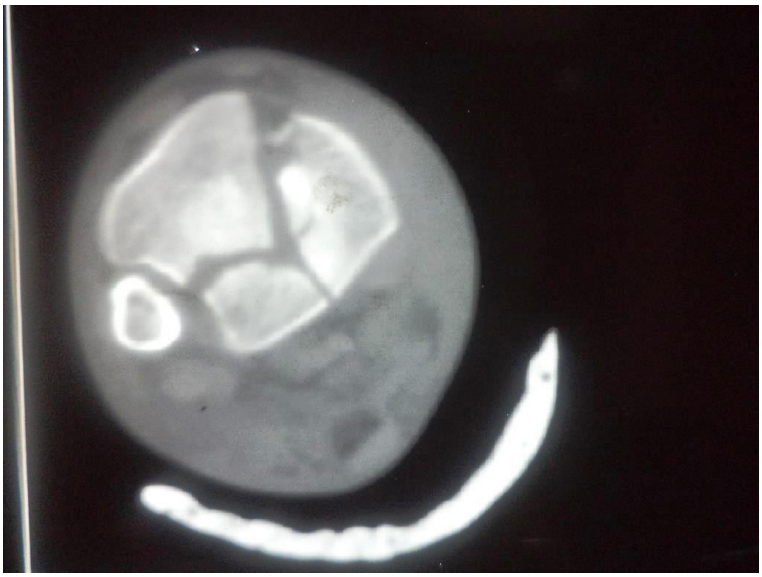
EXCLUSION CRITERIA :

1. Type I ruedi-allgower pilon fracture.
2. Compound fractures.
3. Delayed presentation of more than three weeks.
4. Non-union distal tibia fractures

IMAGING :

X-Ray Ankle with leg Antero-Posterior,Lateral and Ankle Morticeviews.

CT Ankle with leg.



CHOICE OF IMPLANT :

1. Medial Distal Tibia Anatomical Locking Plate For Tibial Fracture(fig.8)

2. One Third Tubular Plate System For Fibula Fracture(fig.9).

Fig 8

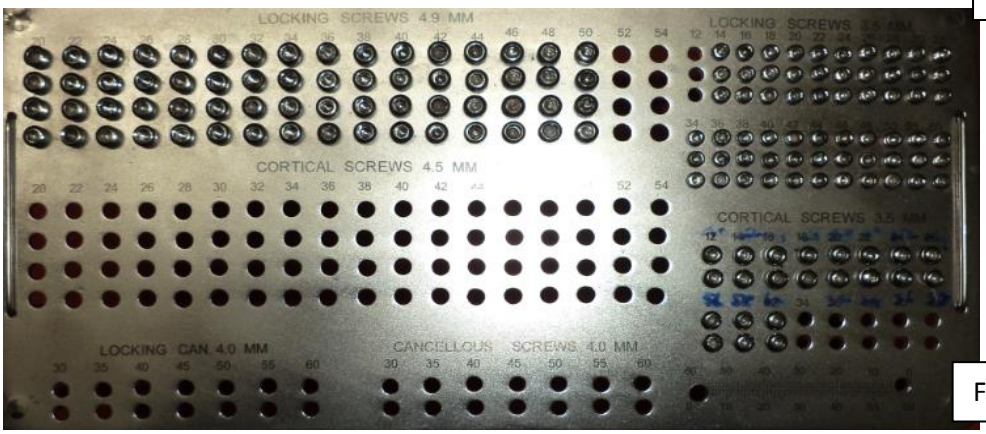


Fig 9

TIMING OF SURGERY:

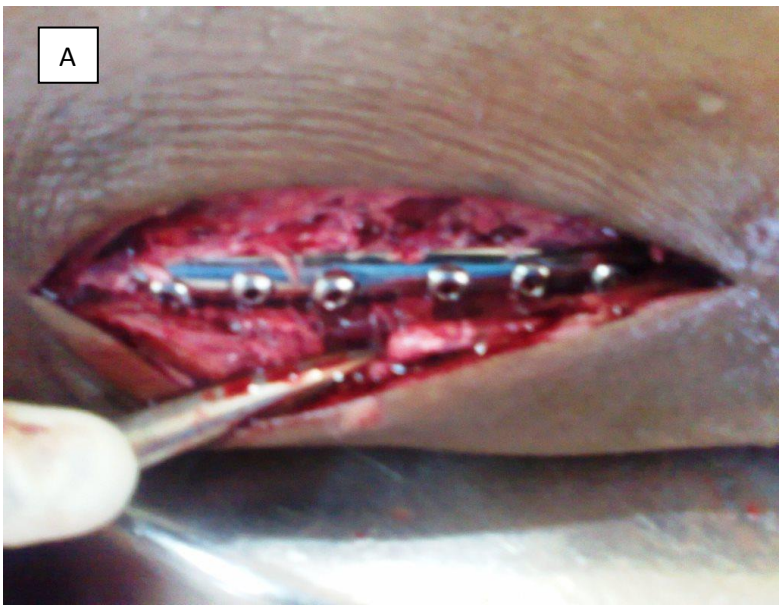
Ideal time to operate distal tibia fracture by MIPPO technique is with in seven days of injury before the fracture site become sticky and the evidence of wrinkle sign.

ANESTHESIA AND POSITION:

Under spinal anesthesia, supine position and sand bag under the gluteal region

SURGERY :

Fibula is fixed first with one third tubular plate by open technique to achieve stable lateral fixation which helps indirectly to restore the length of tibia and avoid over distraction(fig.11-a). After fixing the fibula fracture, reduction of tibia is checked under C-ARM(fig.11-b), then it is fixed with minimally invasive percutaneous plate osteosynthesis. A transverse incision of about 1cm is made over the medial malleolus to access the medial malleolus, a subcutaneous tunnel is created using a periosteal elevator(fig.11 c,d). After fracture reduction, a medial distal tibia anatomical locking plate is slided under the soft tissue into the tunnel to bridge the fracture site, temporarly fix the plate with pins, check the position under C-ARM and finally fixed with locking screws(fig.11-e).



A)Open Reduction Internal Fixation of fibula with 1/3 tubular plate to restore the limb length and indirect reduction of tibia in comminuted distal tibia fractures

B) After fibula fixation, the fracture reduction checked under C-ARM

C) 1cm stab incision made just above the medial malleolus and proximal end of the plate,to slide the plate through the tunnel.

d) Plate was positioned and fixed with temporary pins

e) Final C-ARM should be done to assess the fixation

f) Final fixation with locking screws

G,h) Mediculous skin closure in necessary to avoid wound gaping.

POST-OP PROTOCOL:

1. The patient's lower limb is immobilized in a above knee slab
2. EOT done on the 2nd POD.
3. The sutures are removed in 12 thday.
4. At the end of 3 weeks the above knee slab is removed and ankle brace is applied. Initially to start with gentle ankle motion exercise.The patient is then allowed for non- weight bearing mobilization with the help of walking aid.
5. After 6 weeks,based on radiological union allow the patient to partial weight bearing. Full weight bearing advised once the fracture is united clinico-radiologically.

POST-OP FOLLOW UP :

The functional outcome is evaluated by clinical and radiological (AP/LATERAL) aspects at 6th ,12th weeks, 3rd ,6th months and one year interval using 'Olerud-Molander Ankle Questionnaire/ Score (OMAS).

ANTICIPATED OUTCOME :

1. Expected normal healing is 6 months
2. A period of 6 to 9 months indicates delayed union.
3. Failure of union even after 9 months should be taken as non-union

Any tibial fracture not healed within 9 months of duration with no evidence of progressive healing for the last three months,is considered as nonunion.(1988 FDA).

OBSERVATIONS AND ANALYSIS

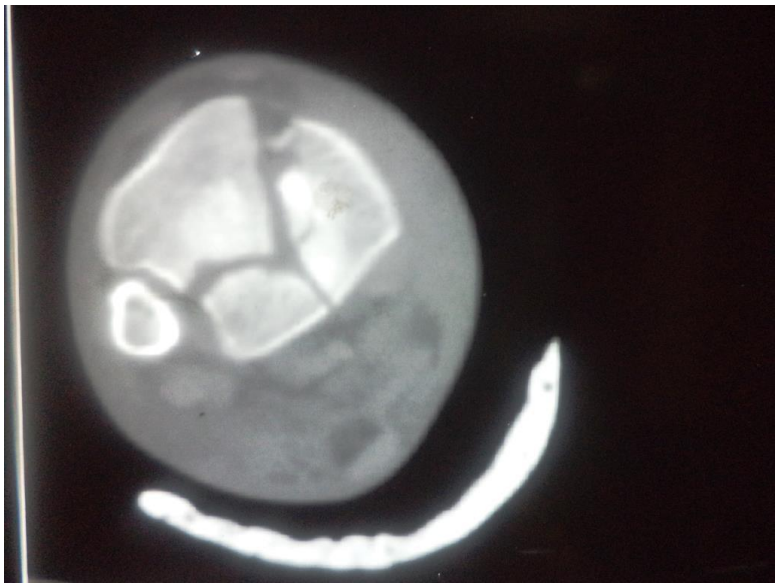
CASE 1 Mrs.FATHIMA 30/F








CASE:2 Mr.RAMESH 26/M



PRE-OPERATIVE

12 WEEK FOLLOW UP

24 WEEK FOLLOW UP

1 YEAR FOLLOW UP

FRACTURE UNITED.

FUNCTIONAL OUTCOME AT 2 YEAR

SQUATTING AT 1 YEAR

CASE 3: Mrs.PANCHU 34/F

PRE-OPERATIVE

IMMEDIATE POST OPERATIVE

24 WEEK FOLLOW UP

CASE 4: Mr.PANDI 32/M

PRE-OPERATIVE

POST-OPERATIVE

CASE 5. Mr.MURUGESAN 43/M

CASE 6. Mr.RAVINDRAN 35/M

CASE 7. Mr.KARUPPIAH 36/M

CASE 8. Mr.SUNDARASU 28/M

CASE.9 Mrs.MEENA

CASE 10. Mr.KANI

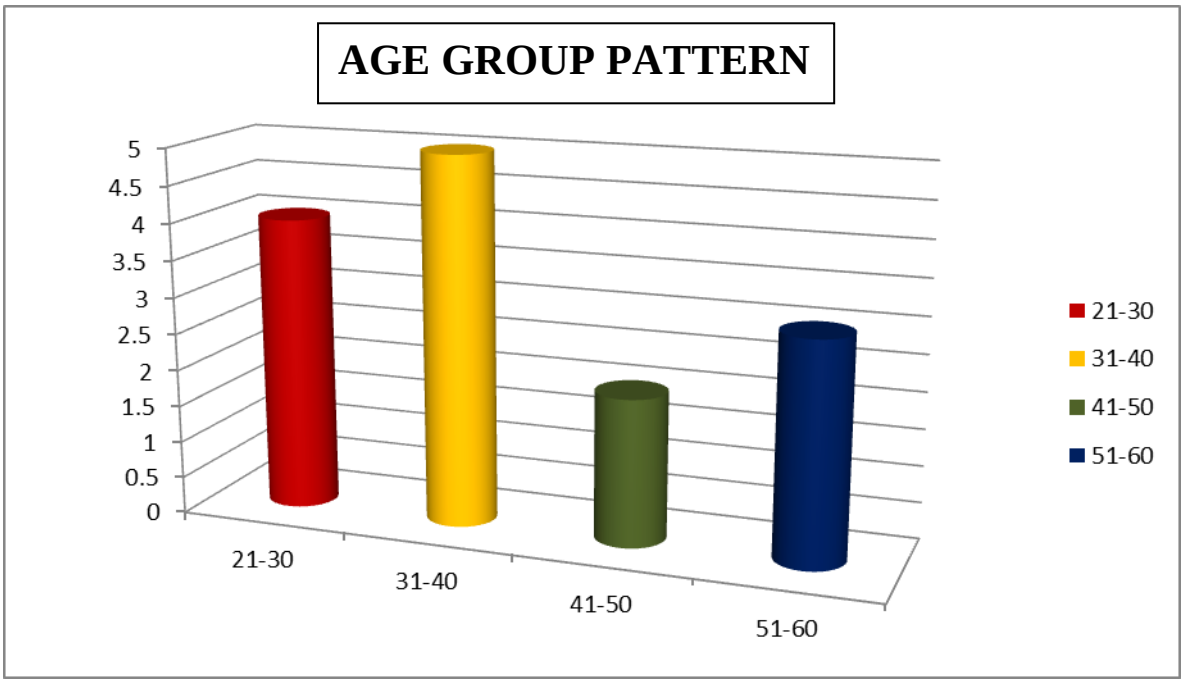
COMPLICATIONS

1. PREMATURE WAIT BEARING – IMPLANT FAILURE

2.WOUND INFECTION

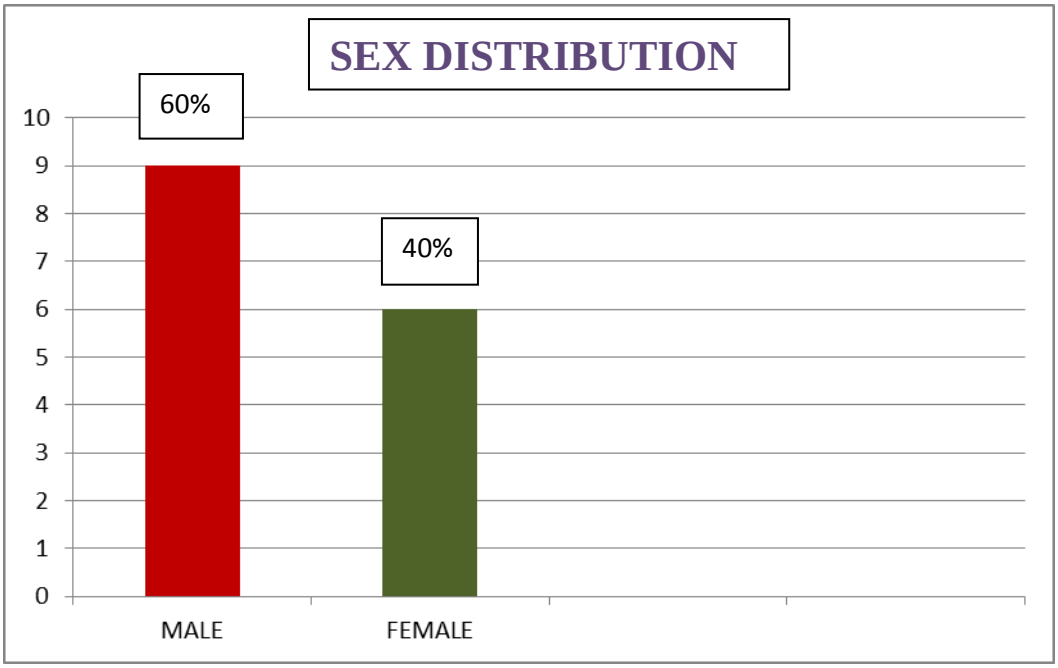
AGE GROUP PATTERN

Age group	No	Percentage
21-30	4	26 %
31-40	5	33%
41-50	2	13%
51-60	4	26%
Total	15	100%
Mean age	39.5	



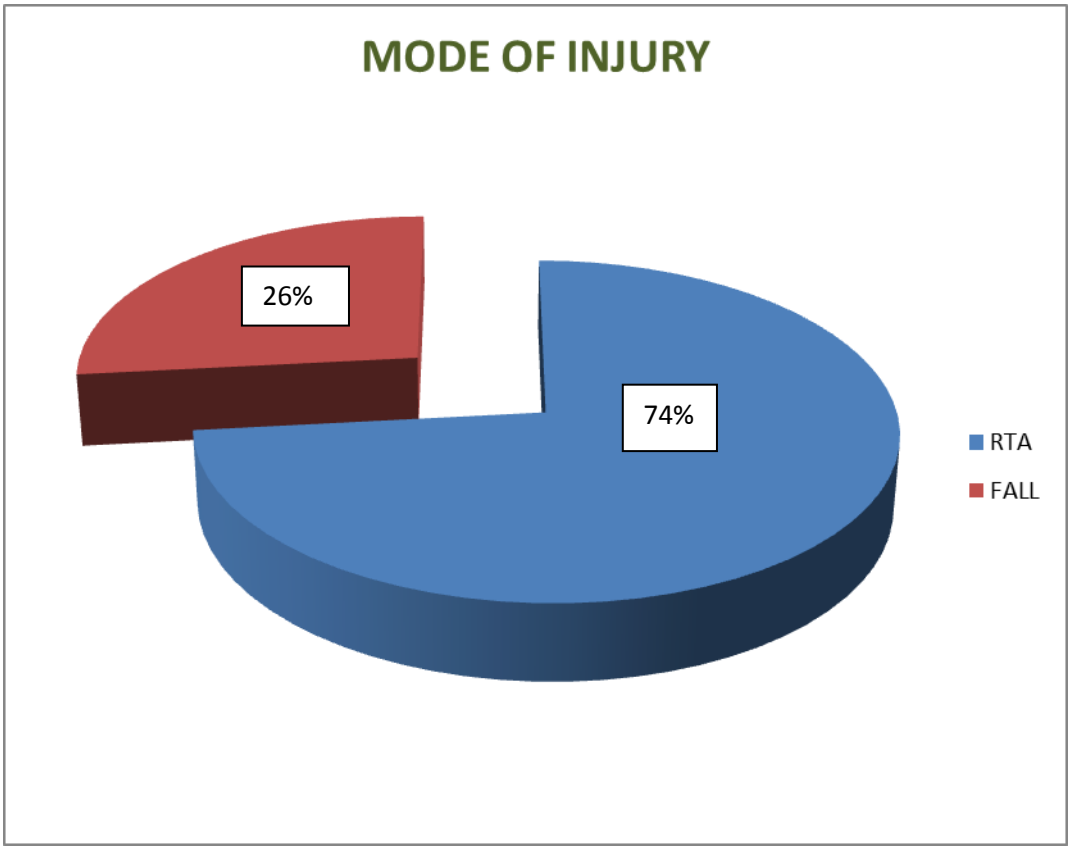
SEX DISTRIBUTION

SEX DISTRIBUTION	No	Percentage
Male	9	60%
Female	6	40%



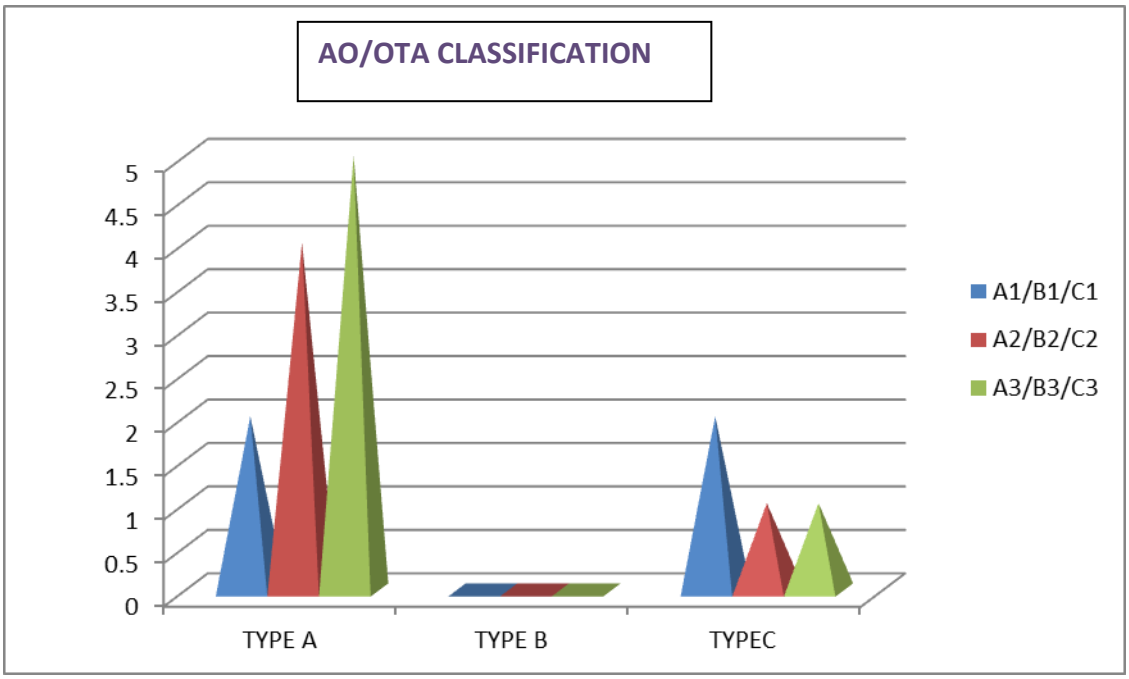
MODE OF INJURY

Mode		
	No	Percentage
RTA	11	74 %
Accidental fall	4	26 %



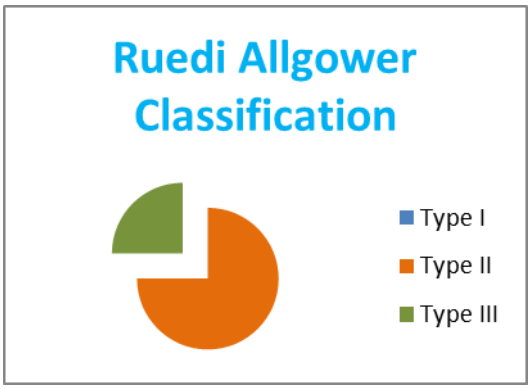
CLASSIFICATIONS

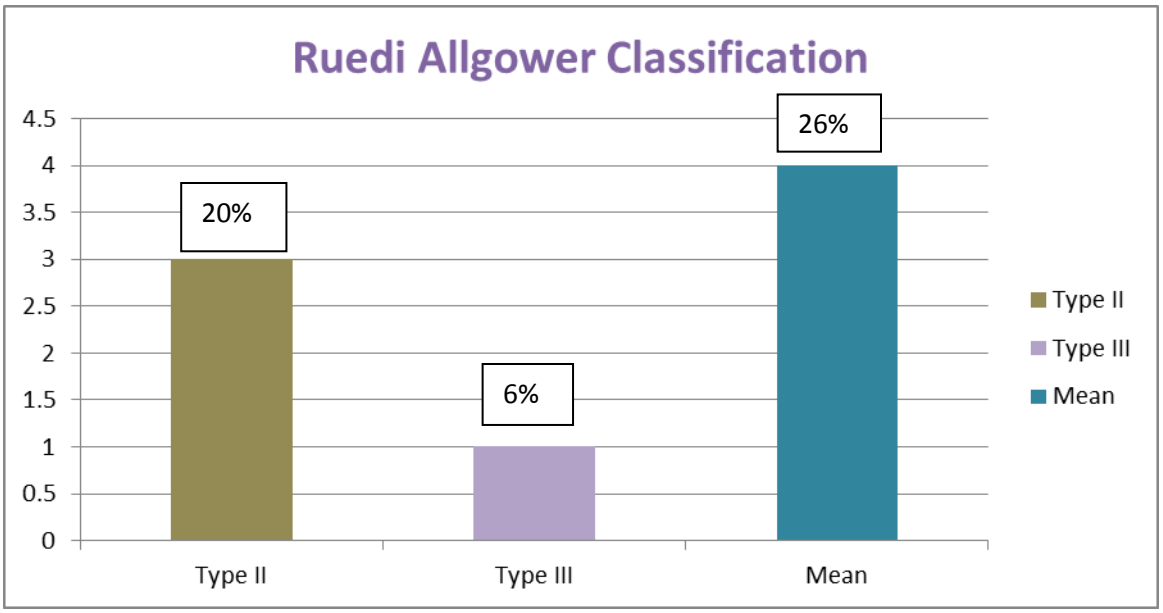
AO/OTAClassification		
	No	Percentage
A1	2	13 %
A2	4	26%
A3	5	33 %
C1	2	13 %
C2	1	6%
C3	1	6%



Ruedi Allgower Classification

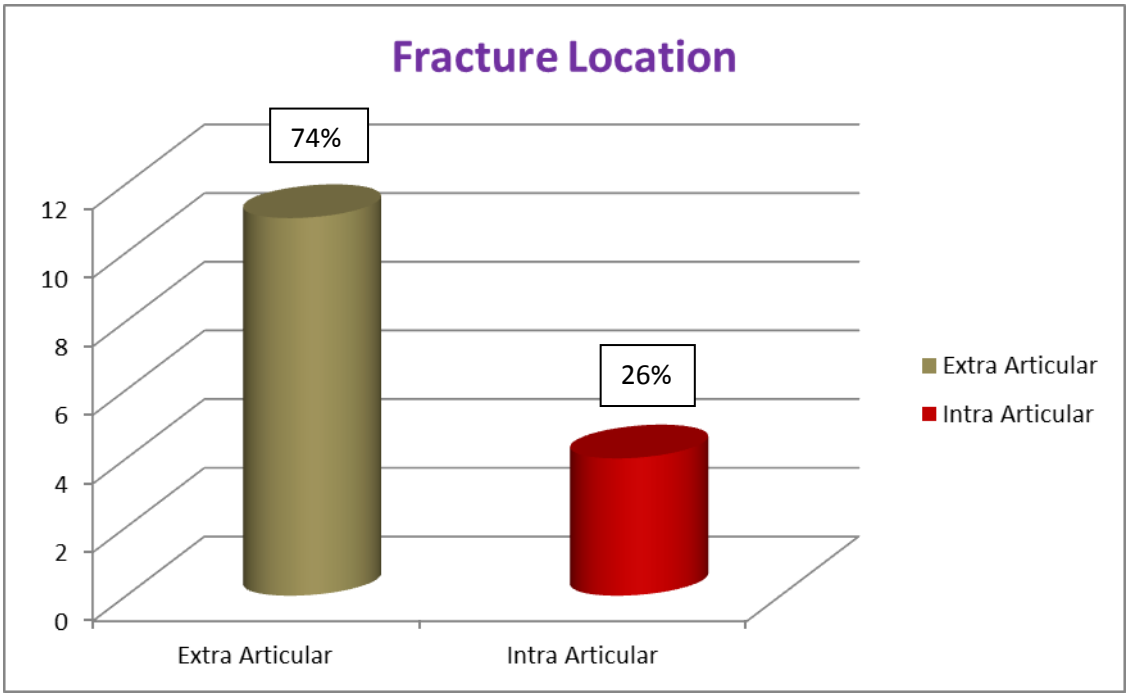
TYPE	NO	PERCENTAGE
Type II	3	20%
Type III	1	6%
MEAN	4	26%





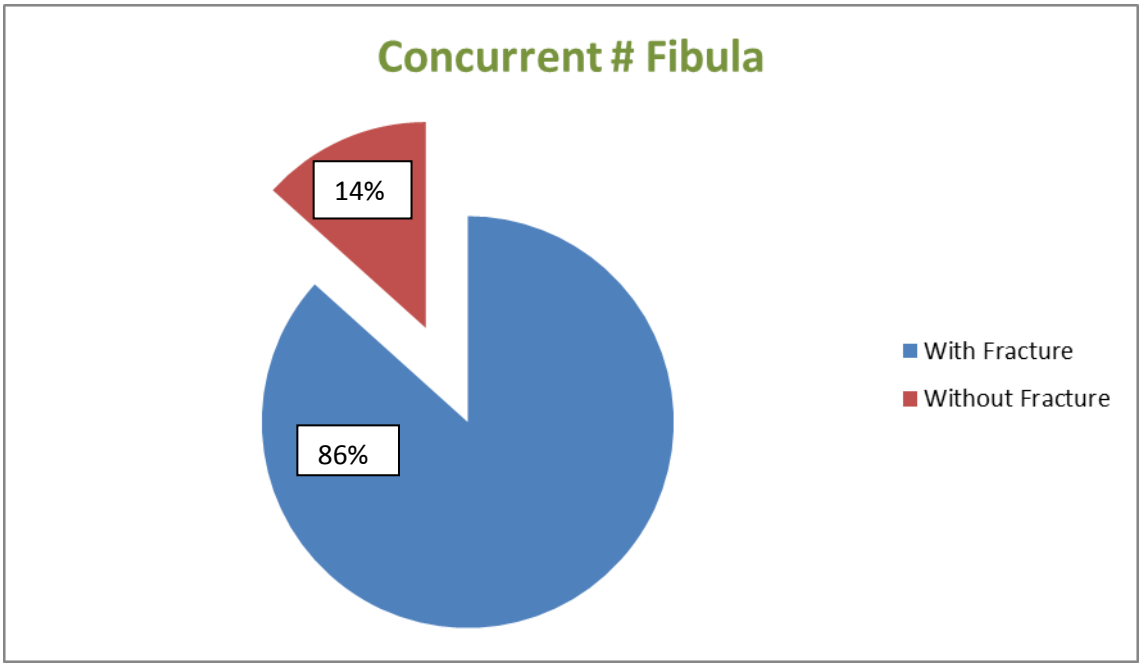
FRACTURE LOCATION

TYPE	NO	PERCENTAGE
Extra Articular	4	26%
Intra Articular	11	74%
MEAN	15	100%



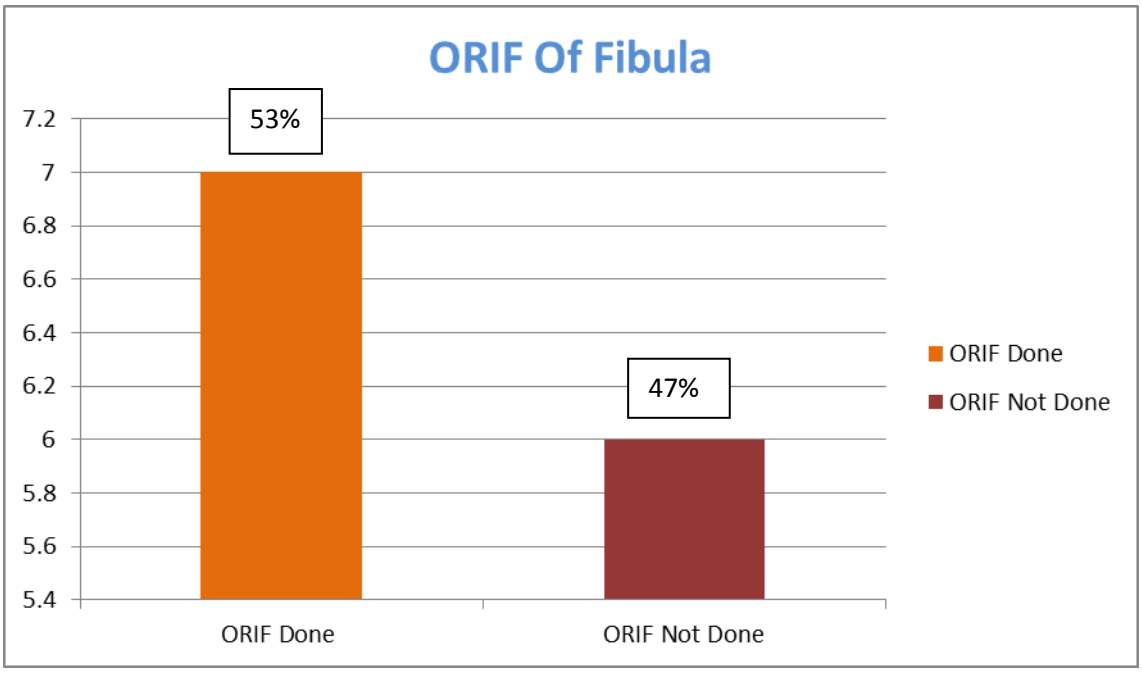
CONCURRENT FIBULA FRACTURE

Fibula fracture	NO	PERCENTAGE
With fracture	13	86%
Without fracture	2	14%
Mean	15	100%



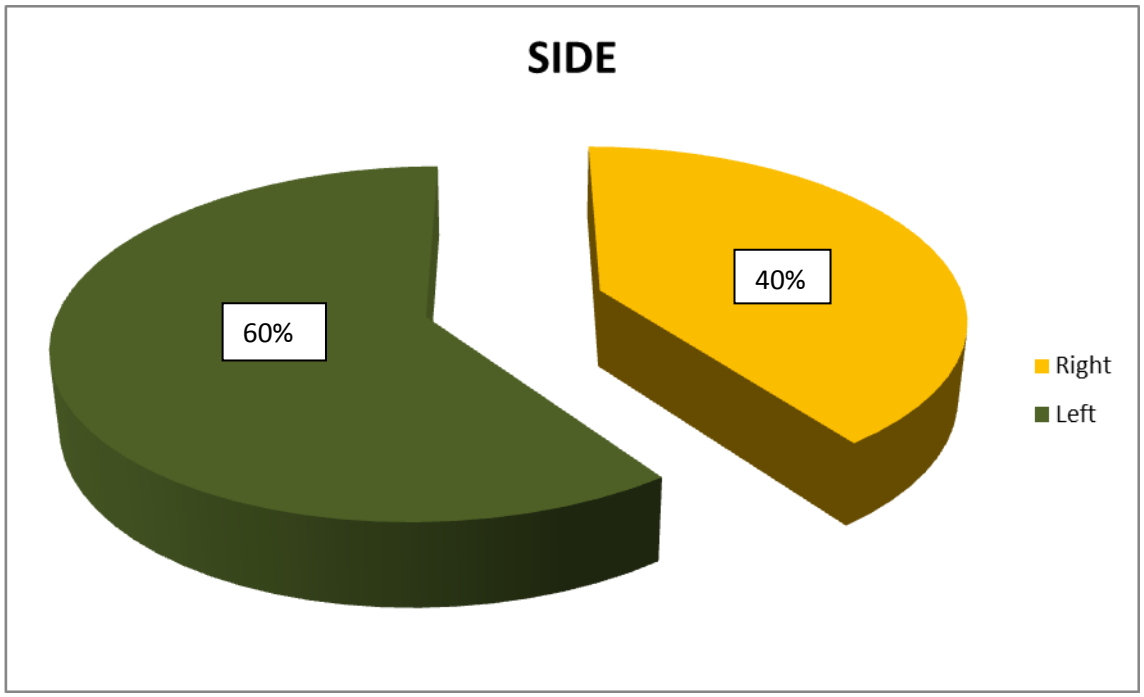
FIBULA FIXATION

ORIF Fibula	No	Percentage
Done	7	53 %
Not Done	6	47 %



SIDE DISTRIBUTION

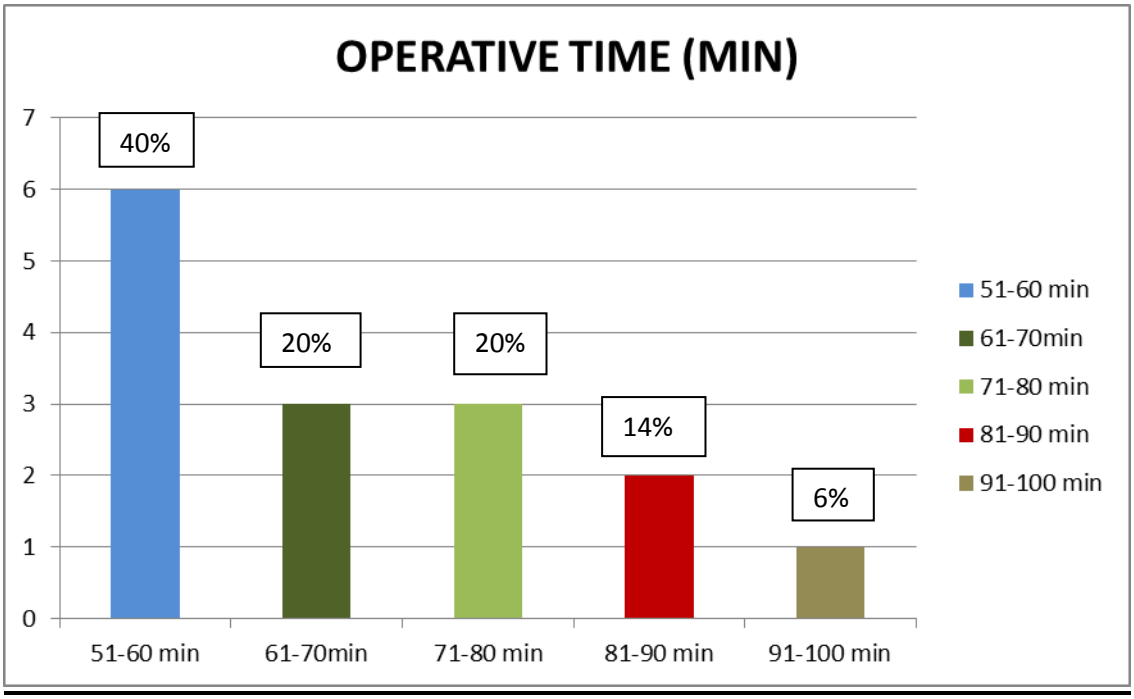
SIDE DISTRIBUTION	No	Percentage
Right	6	40%
Left	9	60 %

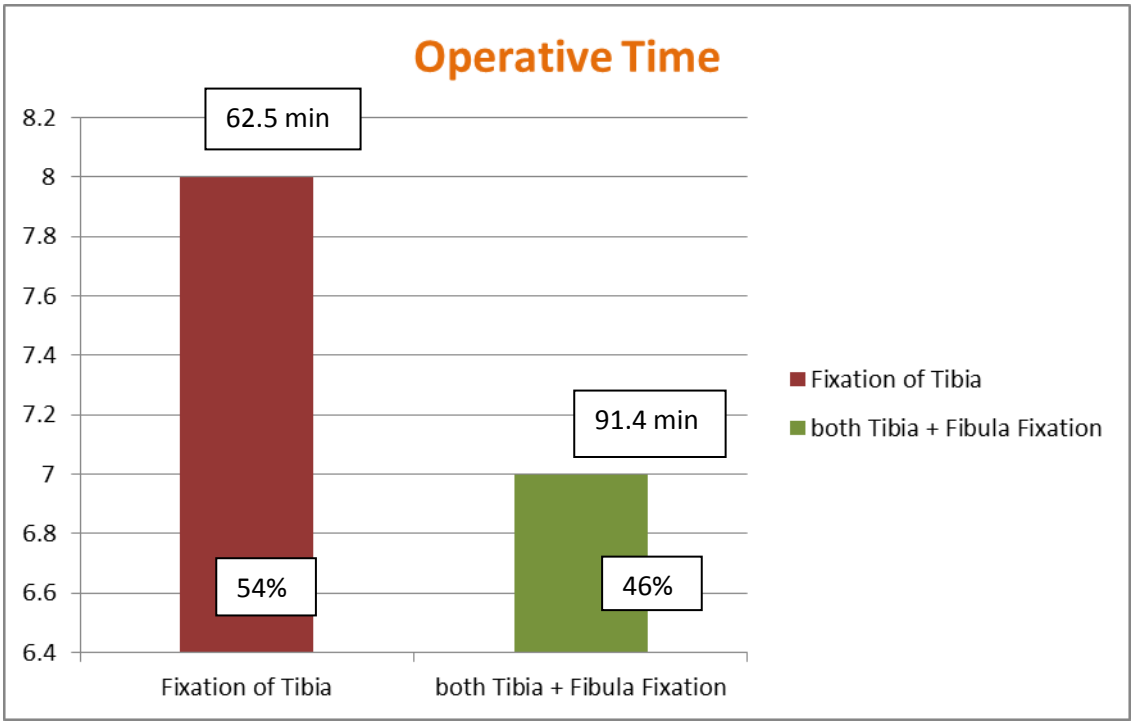


OPERATIVE TIME

Operative Time (mints)		
	No	Percentage
50-60	6	40%
60-70	2	14%
70-80	3	20%
80-90	3	20%
90-100	1	6%
MEAN TIME	71	

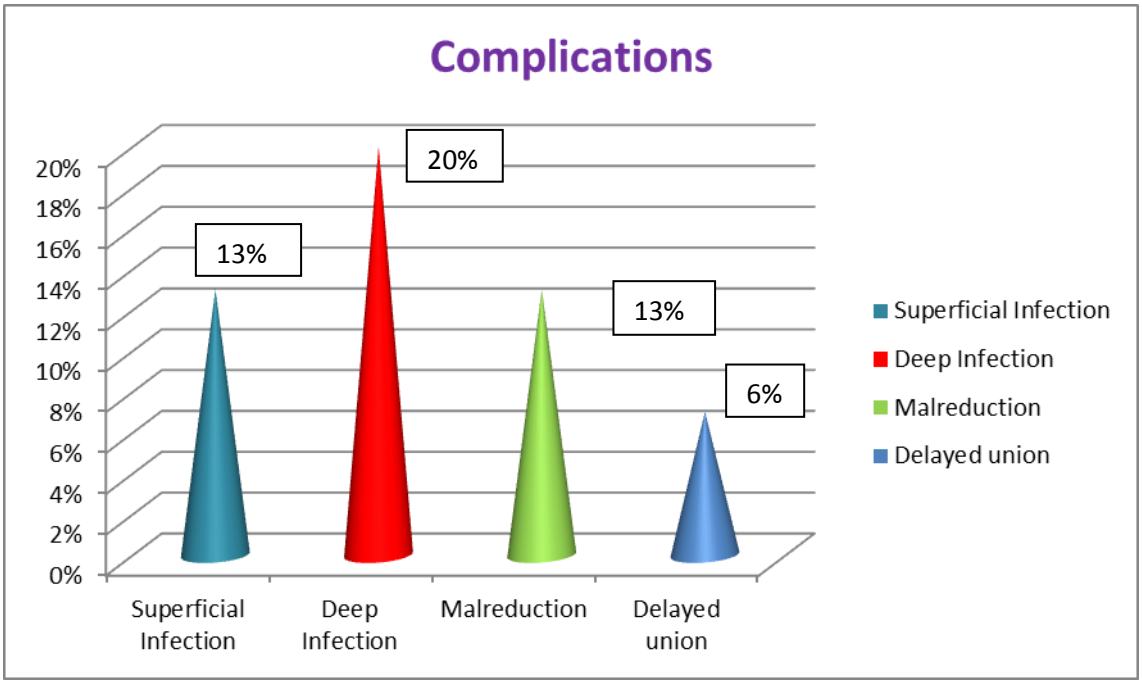
Fracture Fixation		
	No	Percentage
Fixation Tibia	8	54%
Both Tibia + Fibula fixation	7	46 %


OPERATIVE TIME (MIN)
7
6
5
4
3
2
1
0
40%
20%
20%
14%
6%
51-60 min
61-70min
71-80 min
81-90 min
91-100 min
51-60 min
61-70min
71-80 min
81-90 min
91-100 min


Operative Time
8.2
8
7.8
7.6
7.4
7.2
7
6.8
6.6
6.4
62.5 min
91.4 min
54%
46%
Fixation of Tibia
both Tibia + Fibula Fixation
Fixation of Tibia
both Tibia + Fibula Fixation

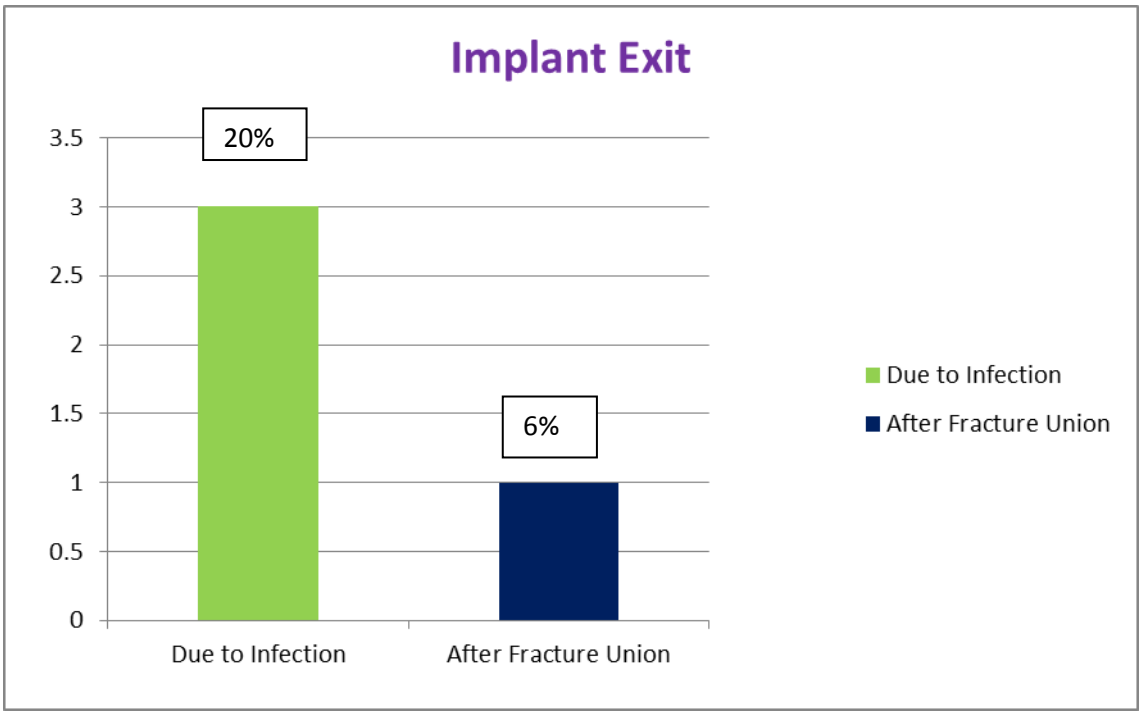
COMPLICATIONS

COMPLICATIONS	No	Percentage
Superficial Infection	2	13%
Deep Infection	3	20 %
Malreduction	2	13%
Delayed union	1	6%



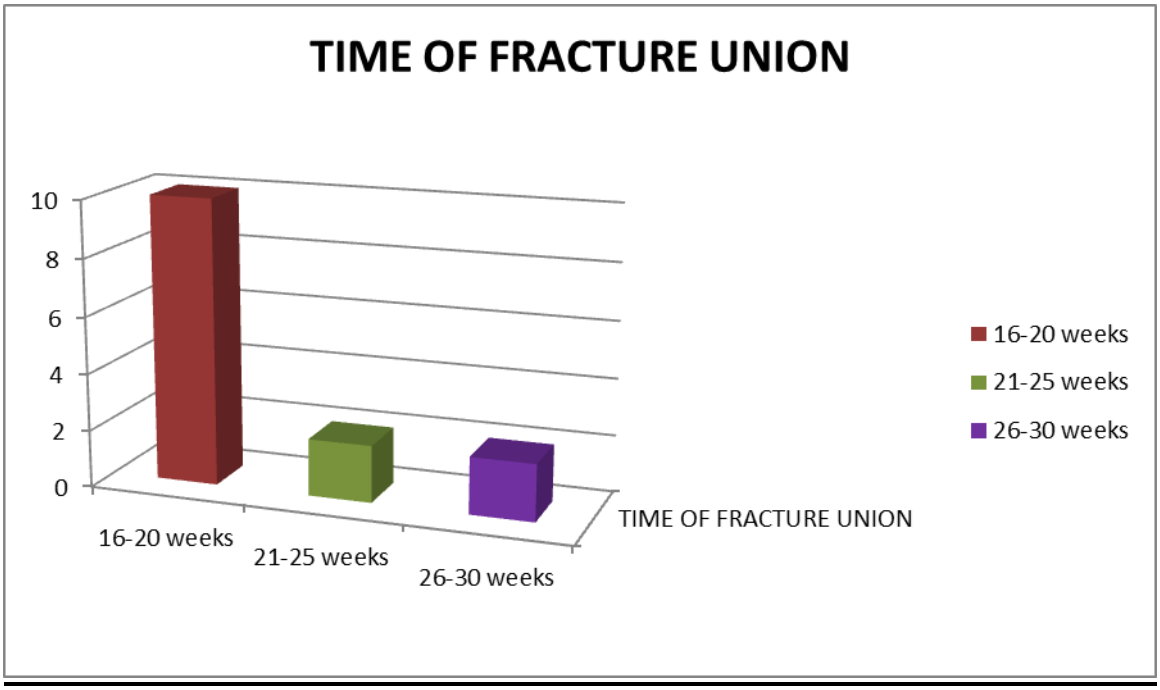
IMPLANT REMOVAL

IMPLANT REMOVAL	No	Percentage
Deep Infection	3	20%
Fracture united	1	6 %
Total	4	26%



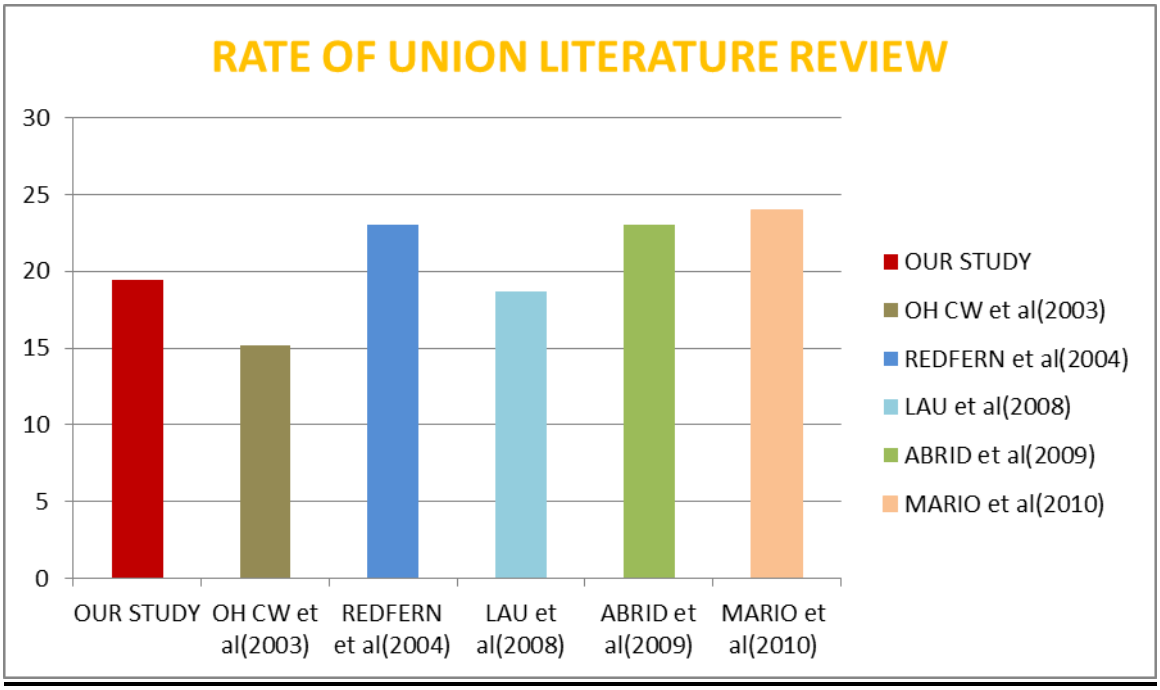
TIME FOR FRACTURE UNION

Time (Weeks)	No	Percentage
16-20	10	72%
21-25	2	14%
26-30	2	14%
MEAN	19.4	



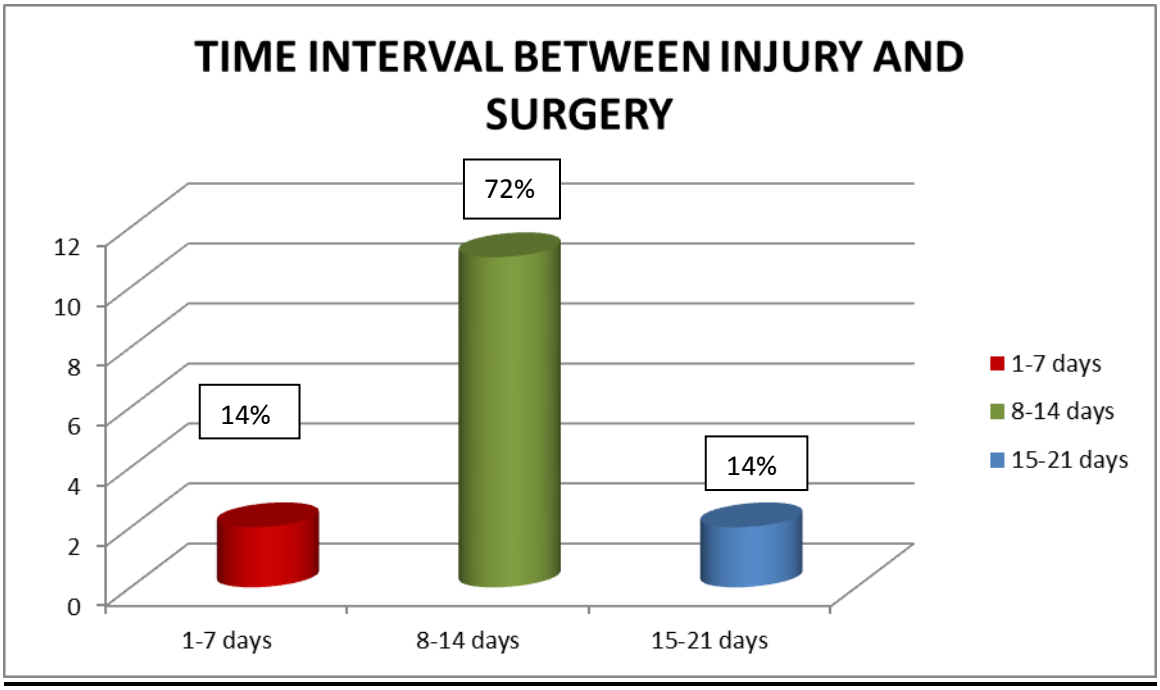
LITERATURE REVIEW OF MEAN UNION RATE(weeks)

	STUDY	MEAN RATE OF UNION(weeks)
1.	OUR STUDY	19.4
2.	OH CW et al(2003)	15.2
3.	REDFERN et al(2004)	23
4.	LAU et al(2008)	18.7
5.	ABRID et al(2009)	23
6.	MARIO et al(2010)	24



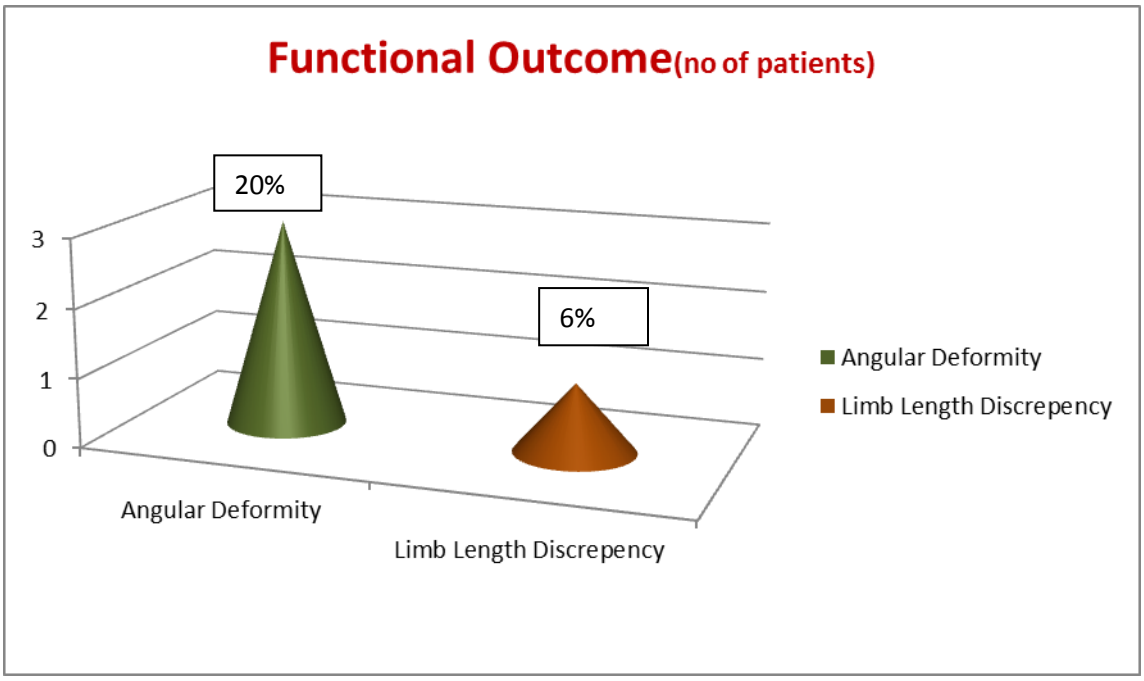
TIME INTERVAL BETWEEN INJURY AND SURGERY

Time Interval In days	No	Percentage
1-7	2	14%
8-14	11	72%
15-21	2	14%
Mean	11.33	



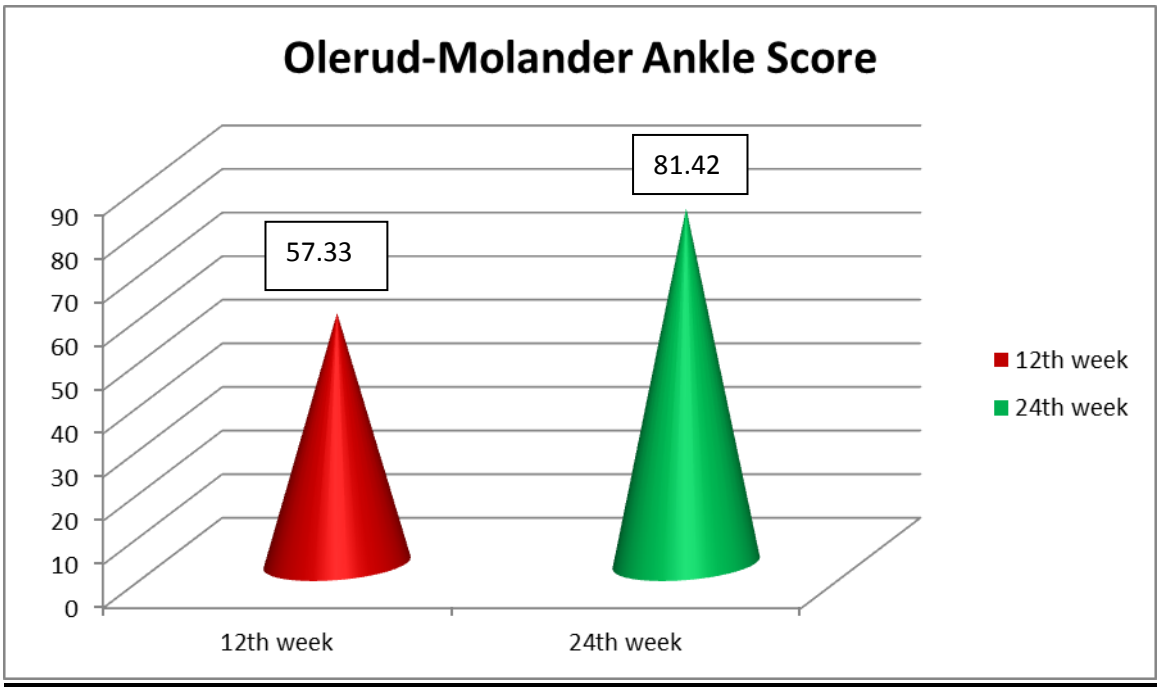
FUNCTIONAL OUTCOME

Functional Outcome	No	Percentage
Angular Deformity	3	20%
Limb Length Discrepancy	1	6 %



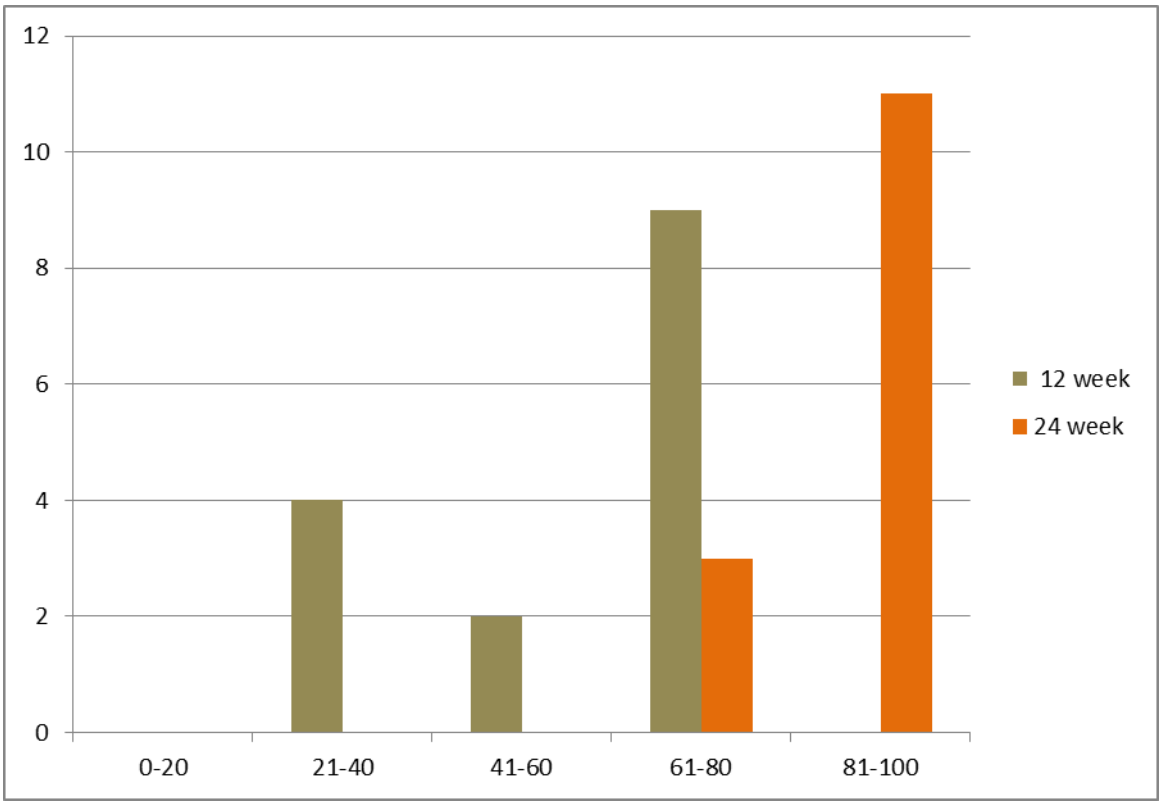
Olerud-Molander Ankle Score

Olerud-Molander Ankle Score	Mean score
12th week	57.33
24th week	81.42



Olerud-Molander Ankle Score

Olerud-Molander Ankle Score	12th week	Percentage	24th week	Percentage
0-20	0	0	0	0
21-40	4	26%	0	0
41-60	2	14%	0	0
61-80	9	60%	3	21%
81-100	0	0	11	79%



RESULTS

Fifteen patients with distal tibia fractures were included in the study and were managed with Minimally Invasive Percutaneous Plate Osteosynthesis with medial distal tibia anatomical locking plates and . Among the the fifteen patients thirteen patients have had concurrent fibula fractures. ORIF of fibula was done in seven patients to maintain the limb alignment and it would help in indirect reduction of tibia fracture fragments. The mean age of the patients was 39.50 years. The study included 9 men (60%) and six women (40%); The distal tibia fracture was caused by a low-energy injury(fall) in 4 patients (26%) and by a high-energy injury in 11 patients (73%). The concurrent fibula fractures were in 13 patients (86%). Left side(60%) is more common than right(40%).

The mean time interval between injury and surgery was 10.73 days. The mean operative time was 89.3 min. According to the fracture pattern, three(20%), five(13%), seven(53%) and nine (13%) holed plates were used. In seven patients, fibula fractures were stabilized with one third tubular plate with separate incision(53%).The mean rate of union was 19.4 weeks which is comparable to other studies. 72% of fractures united between 16 to 20 weeks. one patient had delayed union.(7%).The

mean Olerud-Molander Ankle injury score improved significantly from 57.3 at the end of 3 months to 81.4 at the end of 6 months.

COMPLICATIONS:

1. Superficial wound infection(13%) occurred in 2 patients. It resolved after regular wound care and antibiotics.
2. Deep wound infection occurred in 3 patients(20%), among them, implant removal and thorough wound debridment was done in two patients after fracture union, fracture was not united in one patient, he was put on temporary external fixation, two patients required local flap cover(13%).
3. Implant removal was done in five patients(4 due to infection, one after fracture healing)(33%).
4. One patient (6%) had plate bending due to premature weight bearing.
5. One patient lost the follow up due to unknown reason. Two patients had malunion(13%).
6. Three patients had angular deformity. One patient had limb length discrepancy.
7. No patient had a postoperative neuro vascular complication.

DISCUSSION

Distal tibia fractures is challenging for the modern orthopeadic due to the increasing incidence of fracture in young population. It will affect the productivity of the community. Due to the increased use of high velocity motor vehicles, the number of fractures may increase in future. It is more common in second and third decade,and most of the distal tibia fractures are associated with severe soft tissue injury which seems to be challenging for the orthopaedic surgeons to treat these fractures.

For distal tibia fractures, the combined external and delayed internal fixation, immediate ORIF with plate osteosynthesis, intramedullary nails are the common modality of treatment. It is found that there is successful outcome after plate osteosynthesis,where as open reduction and internal fixation with nonlocking plates have high rate of complication- related to unstable fixation,wound complications which later lead on to non-union. The new technique of Minimally Invasive Percutaneous Plate Osteosynthesis are giving good results with less complication, due to minimal soft tissue dissection and periosteal stripping,less vascular compromise of the fracture fragments.

The non locking plates were having minimal pull out strength and associated with screw loosening and varus collapse.

The new anatomically precontoured Locking Plate system have the advantage to over come the complications occuring in conventional plating.

Wang Cheng et al they compared the MIPPO technique with conventional ORIF with non-locking plate osteosynthesis. They concluded that it is advantageous over the conventional non locking plate osteosynthesis in terms of low infection rate and faster healing, though with minimal disadvantageous such as skin irritation and malreduction

Pierre Joveniau et al they compared the MIPPO with Intramedullary nailing and Conventional ORIF plate osteosynthesis. They concluded that MIPPO have minimal surgical trauma, less soft tissue infection rate and better functional recovery of tibia with faster healing rate with minimal disadvantage such as malreduction.

Mehmet Erol et al, Mario Ronga et al, Neeraj Mahajan et al, they concluded that MIPPO is safe and effective procedure for distal tibia fractures. They found MIPPO has the excellent fracture healing,low infection rate with few complications of delayed healing.MIPPO technique have no need of specialized instrumentations, it is less time consuming and cost effective.

Eric J. Strauss et al studied the concurrent fibula fractures in distal tibia fracture fixation with locking plate systems.

They concluded that locking plate provides better fixation for fracture pattern in which the fibula can not be effectively stabilized.

Minimally Invasive Percutaneous Plate Osteosynthesis with anatomically precontoured medial distal tibia locking plate fixation of distal tibia fractures is safe and effective method. On reviewing the literature only few studies has been conducted on this. Most authors have concluded that the MIPPO technique with locking plate provides secure fixation and a better outcome.

In our two year follow up, we observed 4 complications in 15 patients. 33% of the complications were due to the superficial and deep infections. While some complications such as non-union, post traumatic arthritis, neuro vascular injury were not seen in our study as compared with other studies. The main challenge in the operative treatment of distal tibia fractures is to achieve effective stabilization of an adequately reduced fracture with minimal surgical soft tissue trauma and preserving the vascularity of the fracture fragments in order to maximize the functional outcome. Inadequate medial buttressing, varus malreduction results in secondary loss of reduction and implant failure.The locking of the screw head onto the threaded hole prevents the screw from backing

out. The limitations of our study were less number of patients and not randomized.

CONCLUSION

In conclusion, the correct surgical technique (such as positioning the plate at correct offset after appropriate fracture reduction, which is confirmed by a final C-ARM check), and correct timing of surgery (which is evidenced by wrinkle sign), the anatomically precontoured medial distal tibia locking plate is suitable option for internal fixation of distal tibia fractures which may favour a better functional outcome and faster fracture healing. The complications like infections, malreduction, angular deformity are less frequent when the distal tibia fracture are treated with locking compression plates, compared to other techniques like conventional plates, intra medullary nails, external fixation, and conservative methods.

ANNEXURE-I

PROFORMA

Name : Age Sex

Address:

Ip No Unit DOA DOS

Ward

Mode Of Injury Side; Right/Left

Associated Injuries

Ao/ Ruedi Allgower Classification

Past Medical History

INVESTIGATION

1. X-Ray Leg With Ankle Ap/Lateral View
2. X-Ray Ankle Mortice View/ CT

BLOOD

Hb/BT/CT/Urea/Sugar/Creatinine/Grouping And RhTyping

Urine Albumin/Sugar/Deposits

Chest X-RAY,ECG

INITIAL MANAGEMENT

1. Closed Reduction And Above Knee Slab Application
2. Limb Elevation
3. Details Of Other Treatment Particulars

SURGERY

1. Interval Between Injury And Surgery
2. Operating Time
3. Type Of Plate

COMPLICATIONS

1. Primary Malreduction
2. Shortening
3. Angulation Deformity
4. Early Infection
5. Late Infection
6. Wound Gapping
7. Plate Exposure
8. Non Union
9. Delayed Union

POST OP FOLLOW UP

1. Angulation

2. Leg-Length Discrepancy
3. “Omas” Functional Score
4. Infection

FRACTURE UNION

3rd month

6th month

12th month

ANNEXURE-II

Olerud-Molander Ankle Score

Parameter	**Degree**	**Score**
1)Pain	None	25
	Walking on an uneven surface	20
	Walking on an even surface	10
	Walking indoor	5
	Constant pain	0
2)Stiffness	None	10
	Stiffness	0
3)Swelling	None	10
	Only evening	5
	Constant	0
4)Stairs	No problem	10
	Impaired	5
	Impossible	0
5)Running	Possible	5

	Impossible	0
6)Jumping	Possible	5
	Impossible	0
7)Squatting	No problem	5
	Impossible	0
8)Supports	None	10
	Taping/wrapping	5
	Stick/crutch	0
9)Daily life	Same as before	20
	Loss of tempo	15
	Change of occupation due to injury	10
	Severly impaired work capacity	0

No	Name	Age/Sex	Mode of injury	AO classification	RuediAllgower	Extra/Intra Articular	Concomitant Fibula #	Fibula # Fixed	Side	Associated injury	Interval between admission	Operating time (min)	Complication	Implant Exit

1.	Ramesh	26/m	RTA	C1	II	IA	Yes	Yes	R	2nd MT#	8	75	-	De
2.	Sundarasu	28/m	RTA	A3	-	EA	Yes	Yes	R	-	12	70		De
3.	Varalakshmi	56/f	RTA	A2	-	EA	Yes	No	L	-	10	60	DI	De
4.	Panchu	34/f	RTA	A3	-	EA	No	-	L	-	8	55	-	-
5.	Meena	32/f	Fall	A1	-	EA	Yes	No	R	-	11	55		-
6.	Kani	52/m	RTA	A2	-	EA	Yes	Yes	R	-	15	90	MR	-
7.	Krishnan	58/m	RTA	C3	III	IA	Yes	Yes	R	-	14	100	DI	De
8.	Dhanalakshmi	56/f	Fall	A2	-	EA	Yes	No	L	-	14	90	DI	De
9.	Murugan	25/m	RTA	A3	-	EA	Yes	Yes	L	-	8	70	MR	-
10.	Murugesan	43/m	Fall	C2	II	IA	No	-	L	-	7	80	SI	-

ANNEXURE III

11.	Pandi	32/m	Fall	C1	II	IA	Yes	Yes	R	-	9	80	-	-
12.	Karuppiah	36/m	RTA	A1	-	EA	Yes	No	L	-	7	55	-	-
13.	Fathima	30/f	RTA	A3	-	EA	Yes	Yes	L	-	13	70	-	-
14.	Ravindran	35/m	RTA	A3	-	EA	Yes	No	L	-	10	60	-	-
15.	Sebastiyammal	50/f	RTA	A2	-	EA	Yes	No	L	-	16	60	SI	-

Abbreviations : RTA – Road Traffic Accident, EA – Extra Articular, IA – Intra Articular, R – Right, L – Left, MT – Metatarsal, SI – Superficial Infection,

DI – Deep Infection

ANNEXURE- IV

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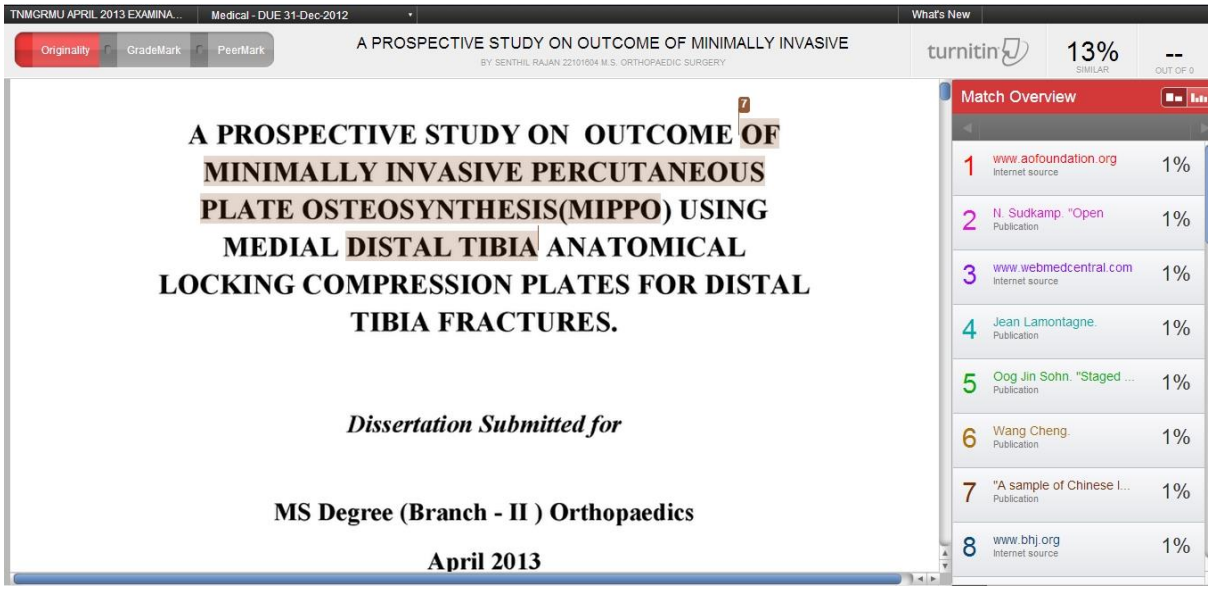
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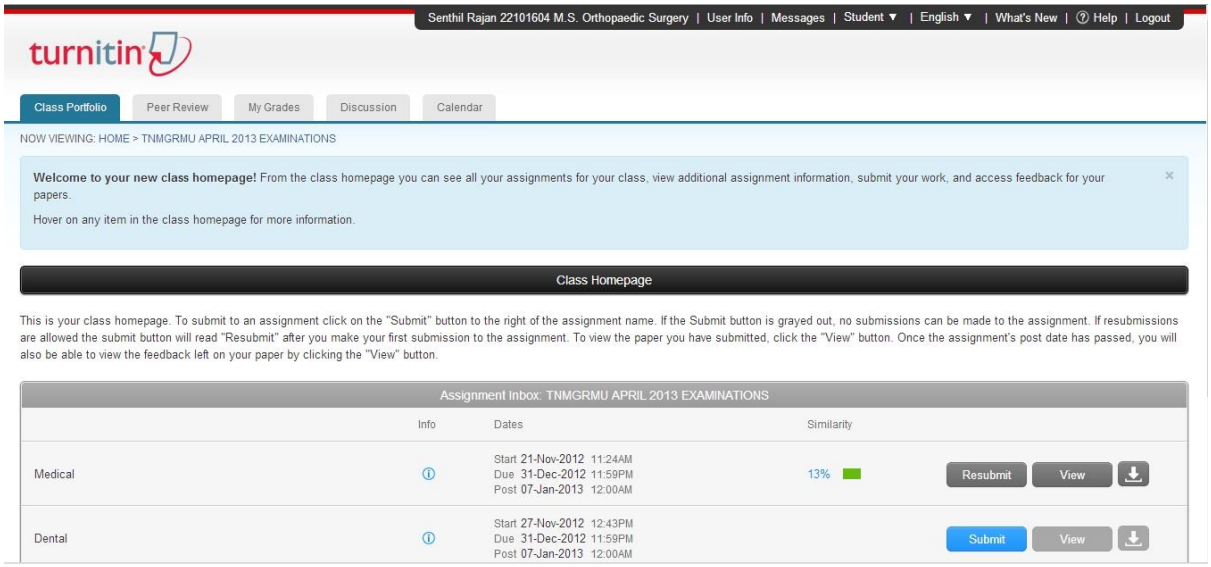
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