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Prospective Study of Management of Distal Tibia Fracture with Locking Compression Plate Using Minimally Invasive Percutaneous Plate Osteosynthesis Technique.

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***Abstract**: Distal diametaphyseal tibia fracture though requires operative treatment is difficult to manage. Conventional osteosynthesis is not suitable because distal tibia is subcutaneous bone with poor vascularity. Closed reduction and minimally invasive plate osteosynthesis (MIPO) with locking compression plate (LCP) has emerged as an alternative treatment option because it respects biology of distal tibia and fracture hematoma and also provides biomechanicaly stable construct especially in patient with Co-morbid factors and addictions. Our study aimed to manage fractures of the distal third tibia by the minimally invasive plate osteosynthesis technique and follow them prospectively.*

List Of Abbreviation

MIPPO	-	Minimally invasive percutaneous plate osteosynthesis.
LCP	-	Locking compression plate
IMIL	-	Intra Medullary Interlocking Nailing
ORIF	-	Open Reduction And Internal Fixation
DCP	-	Dynamic Compression Plate
LCDCP	-	Limited Contact Dynamic Compression Plate
RTA	-	Road Traffic Accident
POP	-	Plaster Of Paris
AAOS	-	American Association Of Orthopaedic Surgery
AO	-	Arbeitsgemeinschaft Fur Osteosynthesefragen
ASIF	-	Association For Study Of Internal Fixation
OTA	-	Orthopaedic Trauma Association

Abstract

Back Ground And Objective

1. *To evaluate the results of Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) in treatment of distal tibial fractures*
2. *To study the surgical difficulties encountered during the procedure.*
3. *To study the efficacy of minimally invasive percutaneous plate osteosynthesis in treating distal tibial fractures in terms of:*

- *Time required for the union of fracture.*
- *Rate of malunion and non-union and rate of infection.*

***Methods:** The present study was undertaken at the department Orthopaedics, Yenepoya Medical College. This study involved both male and female patients with distal tibia fractures, who presented to Yenepoya Medical College. 30 patients who had distal tibia fractures who met the selection criteria were treated with minimally invasive percutaneous plating during the period from May 2013 to November 2014 were included in the study*

***Results:** The age of the patients ranged from 20 to 50years with mean age of 35years. Most of the patients were in the age group of 20-50years.The mode of injury in the majority of the patients was road traffic accidents. The majority of the fractures operated in our study were extra-articular fractures, i.e. AO/OTA 43-A (100%).5 patients (25%) had a both bone leg fracture, with majority of the fibular fractures occurring at the level of the tibial fracture, suggesting a bending mechanism. Out of the 5 patients with an associated fibular fracture, only 1 patients needed fixation of the fibula (5%), and is fixed with one third tubular plate. We attained 90% of the excellent result using MIPPO technique.*

Conclusion:

- *The MIPPO technique is a reliable fixation approach to fractures of the distal tibia, preserving most of the osseous vascularity and fracture haematoma and thus providing for a more biological repair.*

- *This technique can be used in fractures where locked nailing could not be done like distal tibial fractures with small distal metaphyseal fragments, vertical split and markedly comminuted fractures.*
- *Due to preserved vascularity, there is low incidence of delayed union and non-union.*
- *There was reduced incidence of infection due to limited exposure. Infection was also prevented by careful handling of soft tissues and by minimising the operating time.*

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I. Introduction

Fractures of the distal tibia are unique in that the bone is subcutaneous with decreased muscular cover; the consequent decreased vascularity leads to complications like delayed bone union, wound complications such as dehiscence and infection. These fractures can be managed with various techniques like IMIL nailing, external fixators,[1–3] and Open reduction and plating,[4,5] with varying results.

In current orthopaedic practice, minimally invasive percutaneous plating osteosynthesis (MIPPO) and interlocking nailing are the preferred techniques for fractures of the distal tibia. The intramedullary nail spares the extraosseous blood supply, allows load sharing, and avoids extensive soft tissue dissection.[6,7] However, proximal and distal shaft fractures can be difficult to control with an intramedullary device, increasing the frequency of malalignment.[8] Concerns regarding difficulties with reduction/loss of reduction, inappropriate fixation in fractures with articular extension, anterior knee pain[9] and hardware failure have slowed the acceptance of intramedullary nailing as a treatment of fractures of the distal tibia. The recent innovation of nails with tip locking is a testimony that earlier nails were insufficient fixation tools for distal tibia, however tip locking is technically difficult and fractures that require it are essentially difficult to fix with nails.[6,8,10]

Minimally invasive percutaneous plate Osteosynthesis (MIPPO) technique can address several of the issues associated with intramedullary nailing, while amalgamating all biological benefits of closed reduction and fixation.[11,12] We reviewed the clinical indications and efficacy of MIPPO in distal tibia.

MINIMALLY INVASIVE PERCUTANEOUS PLATE OSTEOSYNTHESIS is a surgical technique in which Percutaneously inserted plate is fixed at a distance proximal and distal to the fracture site through minimal exposure and also blood supply to the fractured fragments is maximally preserved.

- Aims at flexible elastic fixation to initiate spontaneous healing--including induction of callus formation
- Girdlestone in 1932 stated that
  - "There is danger inherent in the mechanical efficiency of our modern methods, danger lest the craftsman forgets that union cannot be imposed but may have to be encouraged, where bone is a plant, with its root in the soft tissue, and when its vascular connections are damaged, it often requires not the technique of a cabinet maker, but the patient care and understanding of a gardener."
  - This means that vascular supply of the bone is the basis of all fracture healing
- 1958, when AO/ASIF was founded
  - Anatomical reconstruction of the fracture fragments
  - Rigid fixation of fragments
  - Preservation of vascularisation of the bone fragments
- Subsequently:
  - Anatomical reduction
  - Stable internal fixation
  - Preservation of blood supply
  - Early pain free mobilization of muscles and joints adjacent to the fracture

➢ Rigid fixation of fractures did not always produce the desired end result.The conflicts often associated with fixation were:

- Sepsis
- Sequestrum formation
- Delayed union
- Non union
- Refractures
- Temporary porosis in the area of the footprint of the plate on the bone. cause considerable damage to the periosteal circulation at the interface between implant and bone.

History-Minimally invasive fracture fixation.

- 1980s MAST and GANZ created the term biological plating -- describe indirect reduction techniques
- 1996, KRETTEK et al proposed a MIPPO for the distal femur using the dynamic condylar screw
- 2001 the first MIPO approach using a helical bridge plate at the proximal humeral shaft was proposed by FERNANDEZ DELL'OCA
- 2004, LIVANI AND BELANGERO showed the anatomical basis for and clinical application of an anterior bridging plate for the humeral shaft
- INTERNAL FIXATOR DEVICES
  - PC FIX (point contact fixator)
  - LISS (less invasive stabilization system)
  - LCP (locking compression plates)
  - Locking head screws (LHSs) preserves periosteal blood supply and it is self drilling and self tapping.

- PC FIX (POINT CONTACT FIXATOR)
- Narrow plate with the under surface having only small points that come in contact with bone.
- LISS (less invasive stabilization system)
- PCFIX has limited applications in the metaphyseal and epiphyseal areas.
- LISS -- for these areas for distal femur and proximal tibia.
- It is an extramedullary, internal fixation devise
- A plate that can be inserted through minimally invasive approach.
- Screws that can be locked within the plate which ensures angular as well as axial stability.
- A radiolucent insertion handle, which helps in the submuscular insertion of the plate and easy percutaneous screw fixation
- LCP (LOCKING COMPRESSION PLATES)
- Facilitated the widespread use of MIPPO
- Can be used as external fixators (LHSs)
- Can be used as standard dynamic compression plates using cortical screws.
- It has a combination hole.
- Definition of MIO includes:
  - Small soft tissue windows
  - Minimal additional trauma to the soft tissue and fractured fragments results from performing mainly indirect reduction. Direct reduction only when it is necessary to achieve fracture alignment.
  - Special instruments
- The preconditions for internal fixation by MIPPO
  - Indirect closed reduction without exposure of the fracture.
  - Small incision for inserting the implants
  - Elastic bridging of fracture zone with a locked internal fixator (LISS/LCP)
  - Implants with minimal bone contact, slightly elevated plate from the bone surface to eliminate any mismatch of the precontoured plate to the anatomy of the bone.
  - Self drilling and self tapping locking head screws for mono or bicortical insertion.
  - Elastic fixation causing relative stability
- Indication for internal fixation by MIPPO
  - Multifragmentary fractures in the metaphysis
  - Simple fractures in the diaphysis and metaphyseal regions
  - Peri prosthetic fractures
  - Secondary fractures after IM nailing.
  - Tumour surgery

MIPPO ADVANTAGES

- Simpler technique
- No need of extensive surgical exposure
- Improved rates of fracture union
- Decreased infection rate
- Decreased need for bone grafting
- Early mobilization of extremity possible
- Ideal technique for dealing with multiple injuries
- Decreased incidence of refracture after plate removal

MIPPO DISADVANTAGES

1) INTRA OPERATIVE:

- Rotational and axial malalignment
- limb length discrepancy
- neurovascular injuries

2) EARLY POST OPERATIVE

- Acute infections
- wound complications

3) LATE POSTOPERATIVE

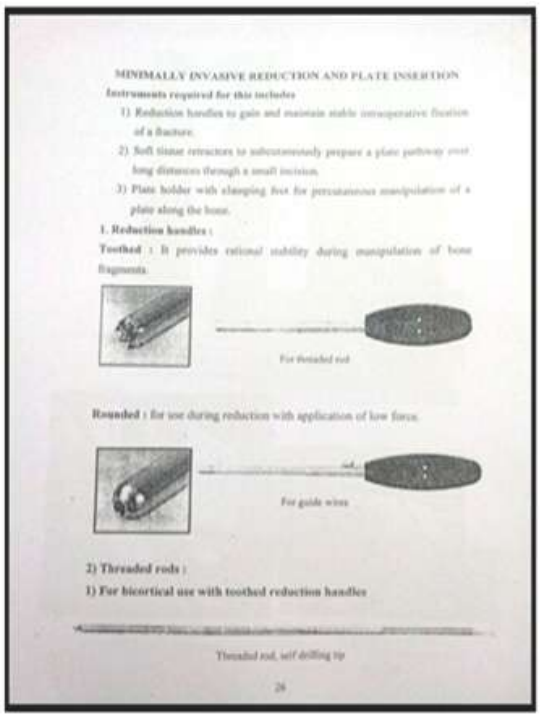
- implant failure
- delayed union
- non union

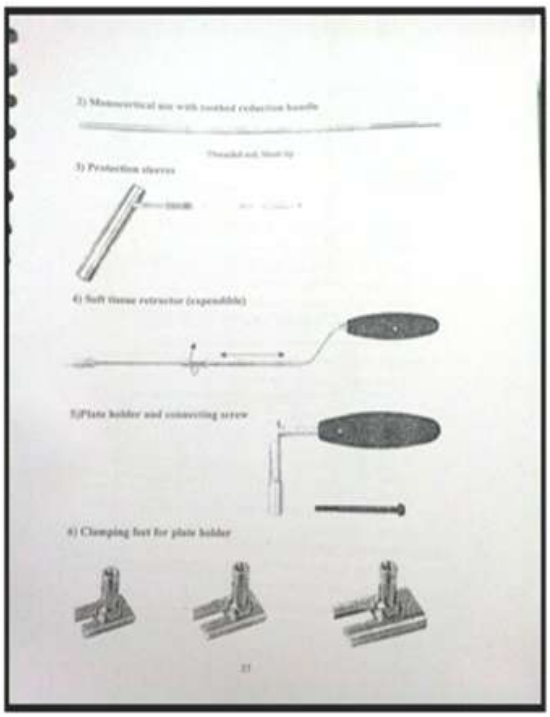
Complex periarticular fractures of the long bones are difficult to treat. Classic intramedullary osteosynthesis do not provide a stable fixation (Wiss et al., 1986), while open reduction and rigid fixation by classic plates (recommended in the 60s-70s) is requiring large incisions with important deperiostation. Potential

complications as infections, consolidation delays and construct damage due to nonunions undergofrequently (Bucholz et al., 1996). At that time, standard operative procedures considered that in epiphyseal-metaphyseal fractures, each fragment either from the articular or metaphyseal area should be subject for anatomical reduction and stabilization. There were obtained superior biomechanical results (absolute stability) but poor long-termbiological effects (Baumgaertel et al., 1998). The main disadvantages of rigid fixation by plates led to the development of the "Biological plate osteosynthesis" concept. By the development of new plates like bridging plates, Limited Contact-Dynamic Compression Plate / LC-DCP, Point-Contact fixator / PC-Fix, plates with angular stability and new surgical techniques of indirect reduction by Minimally Invasive Percutaneous Plate Osteosynthesis(MIPPO).

Biological plate osteosynthesis is important in bone vascularization, to improve consolidation, to decrease infection rate. While indirect reduction techniques (using distractor) are limiting the medial dissection and avoid bone grafting, MIPO techniques are limiting both the medial and lateral dissection in complex extraarticular fractures of the proximal and distal femur (Krettek et al, 1997a). MIPO techniques avoid direct exposure of the fracture site and transforms the implants in an internal extramedullary splint. Furthermore, MIPPO was successfully extended to complex tibial fractures, being actually indicated in all long bones complex fractures that are not suitable for intramedullary osteosynthesis.

1. The treatment purpose in minimally invasive plate osteosynthesis consists in anatomic reconstruction of the articular area, axis, rotation and length reestablishment for the metaphyseal-diaphyseal area, long plates osteosynthesis with screws fixed only distally and proximally from the fracture, bridging the comminution and with early functional rehabilitation.
2. Good results obtained by minimally invasive plate osteosynthesis are due to a fast healing by vascularization protection and also to an increased resilience to mechanical stress.
3. Fixation with long plates only distally and proximally from the fracture site maintains a certain instability degree that is useful for an accurate and fast healing (relative instability).
4. Minimally invasive Percutaneous plate osteosynthesis is a demanding technique, requiring a cautious intraoperative clinical and fluoroscopic control in order to reestablish limb axis, rotation and length.





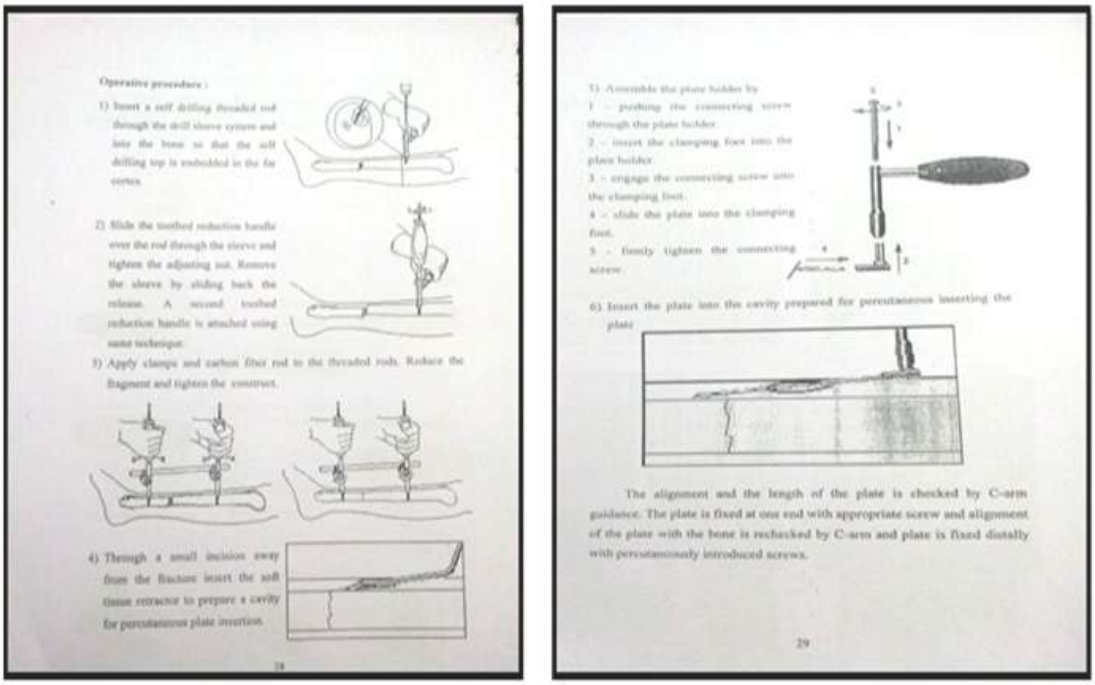


Figure 1 : Instruments and operative technique

Aims And Objectives

1. To evaluate the results of Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) in treatment of distal tibial fractures
2. To study the surgical difficulties encountered during the procedure.
3. To study the efficacy of minimally invasive percutaneous plate osteosynthesis in treating distal tibial fractures in terms of:

- Time required for the union of fracture.
- Rate of malunion and non-union.
- Rate of infection.

II. Review Of Literature

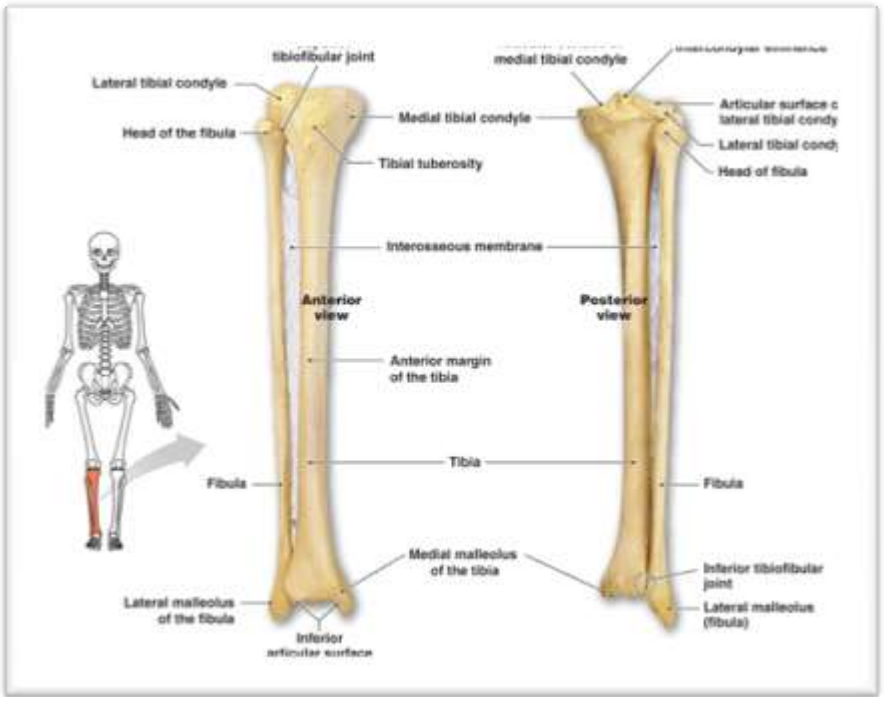
- Hansmann developed the first bone plate in Germany in 1880's.
- In 1968 Reudi published a paper on this topic, describing the fracture, principles of treatment and a classification system. His experience with immediate fixation of tibial fractures demonstrated durable results and few complications.
- Mehmet et al studied Thirty-five patients (23 males, 12 females) who were Operated on MIPPO principles for tibial diaphysis and distal tibial fractures.Twenty-eight were closed and seven were open fractures The mean duration Of the union was 20.7 (range: 16 to 28) weeks and 17.96 (range: 10 to 36) Weeks in open and closed fractures, respectively. All cases showed union Except one who had an implant failure. Necrosis at the wound developed in One case and infection in another.
- J. J. Guo,et al,in their study A total of 85 patients were randomised to Operative stabilisation either by a closed intramedullary nail (44) or by Minimally invasive osteosynthesis with a compression plate and concluded that both closed intramedullary nailing and a percutaneous locked compression Plate can be used safely to treat Orthopaedic Trauma Association type-43A distal metaphyseal fractures of the tibia.
- Ghulam shabir et al in a study on 73 patients concluded MIPPO is an effective method of treating distal tibia fractures decreasing the surgical trauma to soft tissues.
- Syah bahari et al in a study on 43 patient reported satisfactory outcomes with the use of the AO distal tibia locking plate in treatment of unstable distal tibial fractures. All fractures united with acceptable alignment and angulation. Two cases of superficial infection were noted, with one case of deep infection.
- Francois et al in his retrospective study of ten patients treated with percutaneous plating for fractures of the distal tibia and plafond with a minimum follow-up periodof one year. No significant soft tissue problems occurred.. All fractures healed within one year ; there was no fracture malunion.
- Borens et al conducted study on 17 patient for tibial plafond Fracture with newly designed low profile plate and concluded that it is good for fracture healing and soft tissue trauma.

- Ovadia and 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. Blauth et al studied the functional outcome of tibial pilon fractures treated by three different modalities. Primary internal fixation with a plate following the AO-ASIF principles (n=15), one-stage minimally invasive osteosynthesis for reconstruction of the articular surface with long-term transarticular external fixation of the ankle for at least four weeks (n=28); and a two-stage procedure entailing primary reduction and reconstruction of the articular surface with minimally invasive osteosynthesis and short term transarticular external fixation of the ankle joint followed by secondary medial stabilization with a plate using the MIPO technique.(n=8). They found that none of the patients who required secondary arthrodesis (23 percent of all cases) were in the group who had undergone two-step surgery ($p < 0.05$). The range of ankle movement was much greater in the two-step group than in the others; these patients also had less pain, more frequently continued working in their previous profession, and had fewer limitations in their leisure activities. They concluded that the two stage management protocol is satisfactory in achieving union with less complications and good functional outcome.
- Borrelli et al studied the effects of various methods of plating in tibia in human cadavers. They found that Open plating of the medial aspect of the distal tibia caused a statistically significant greater disruption of the extra osseous blood supply of the metaphyseal region than did percutaneously applied plates. They concluded that disruption of these extra osseous vessels following. Fracture and subsequent operative stabilization may slow healing and increase the risk of delayed union and non-union. These findings support current efforts to develop less invasive methods and implants for operative stabilization of distal tibia fractures.
- Rhinelander F in his study of vascular supply to tibia and its response to fracture made the following observations; the vascular supply of the tibia is supplied by intramedullary vessels, which provide nourishment to all of the intramedullary contents and to 2/3rd of the cortical bone. The outer 1/3 of the cortex receives its blood supply from the overlying soft tissues. In patients with displaced long bone fractures, the intramedullary vascularity frequently is disrupted and the traumatized bone and soft tissues must rely solely on the remaining periosteum and other soft tissues for nutrition. Therefore, any extensive surgical dissections of the bone fragments may devitalize the remaining vascular pedicles, resulting in delayed union or non-union of the fracture.
- Zelle et al in their review of 1125 patients with distal tibia fractures, treated by different methods found that, non-operative treatment (n=521) was associated with a non-union rate of 1.3%, a malunion rate of 15%, and 4.3% required secondary surgical procedures. Primary intramedullary nailing (n=489) was associated with a non-union rate of 5.5%, an infection rate of 4.3%, a malunion rate of 16.2%, and 16.4% of the patients required secondary surgical procedures. Plate fixation (n=115) was associated with a non-union rate of 5.2%, an infection rate of 2.6%, a malunion rate of 13.1% .
- Mario Ronga et al in April 2010 studied the effectiveness of minimally invasive locked plates among 21 patients for a minimum period of 2 years (average: 2.8 years). According to the AO classification, there were 12 Type A, 5 Type B, and 4 Type C fractures. Two patients were lost to follow-up. Union was achieved in all but one patient by the 24th postoperative week. Four patients had angular deformity of less than 7°. No patient had a leg-length discrepancy of more than 1.1 cm. Five patients had ankle range of motion less than 20° compared with the contralateral side. Sixteen patients had not returned to their pre-injury sporting or leisure activities. Three patients developed delayed infection

Anatomy

Tibia (Shin Bone)

The **tibia** is situated at the medial side of the leg, and excepting the femur, is the longest bone of the skeleton.In males, its direction is vertical, and parallel with the bone of the opposite side,but in females it has a slightly oblique direction downward and lateralward, to compensate for the greater obliquity of the femur. It has a **shaft** and **two extremities.**



The tibia is categorized as a long bone and has a diaphysis and two epiphyses.

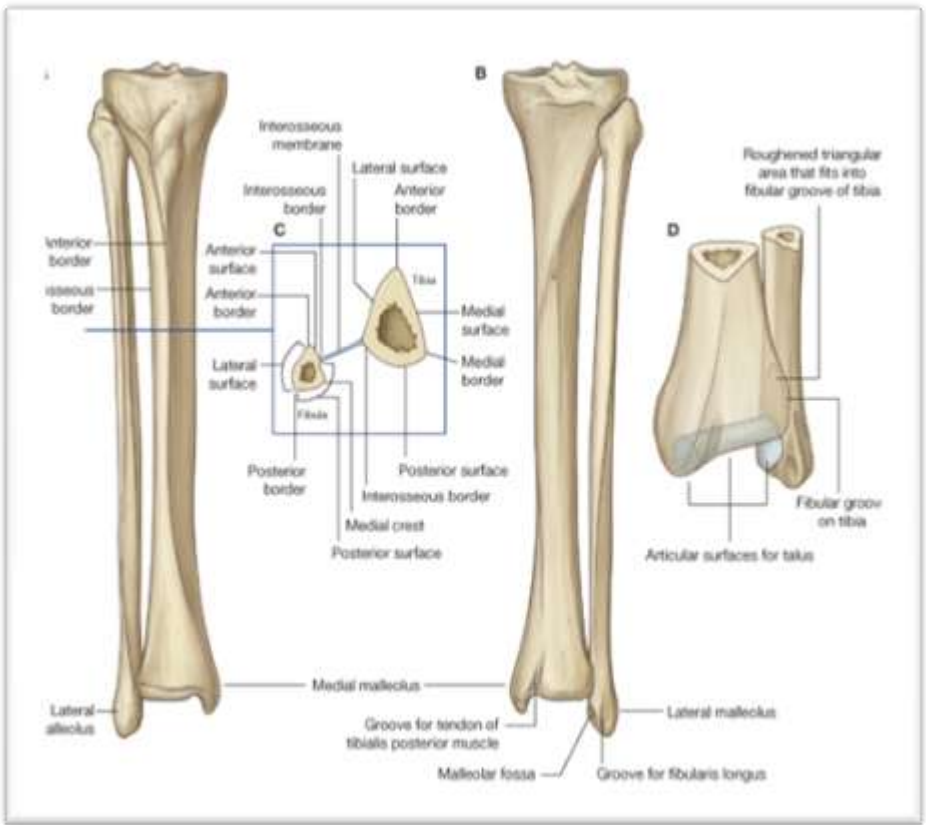


Figure 2 :Anatomy Tibia and fibula

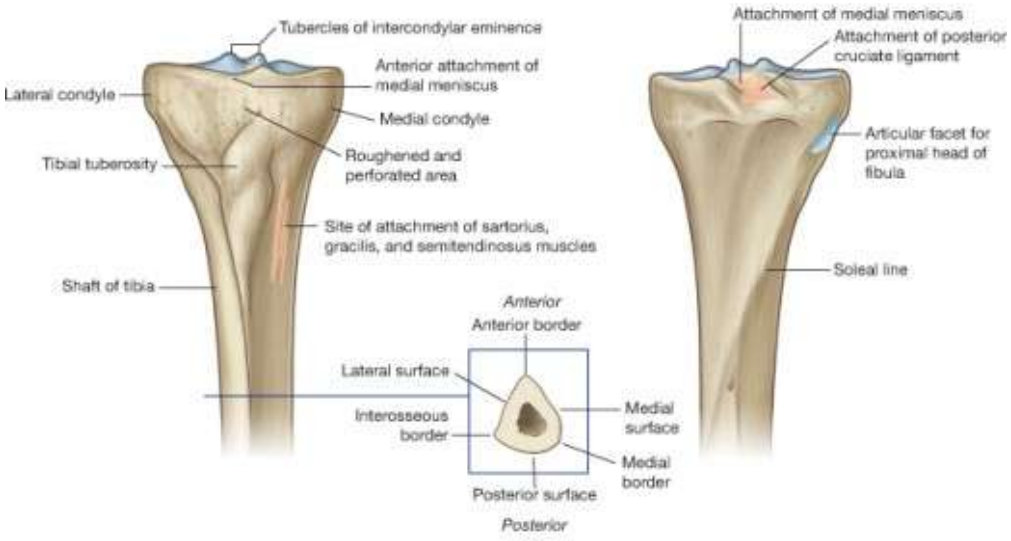


Figure 3 : Anatomy proximal tibia

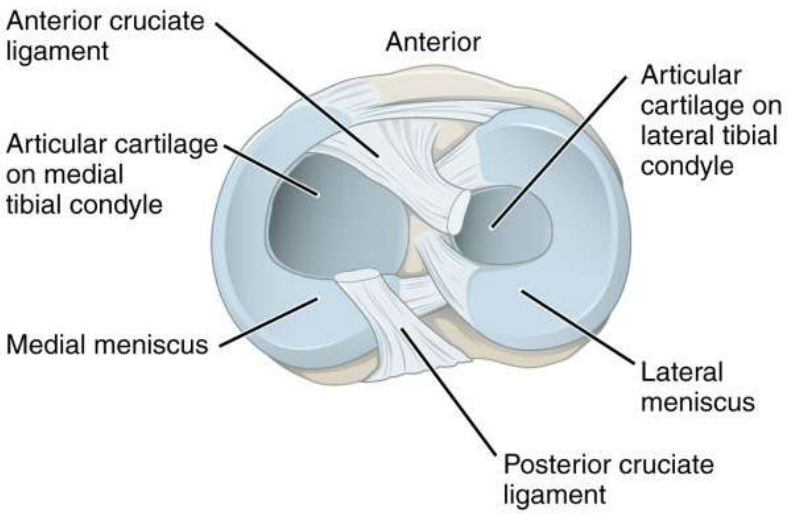


Figure 4 : Superior view of the right tibia in the knee joint, showing the menisci and cruciate ligaments

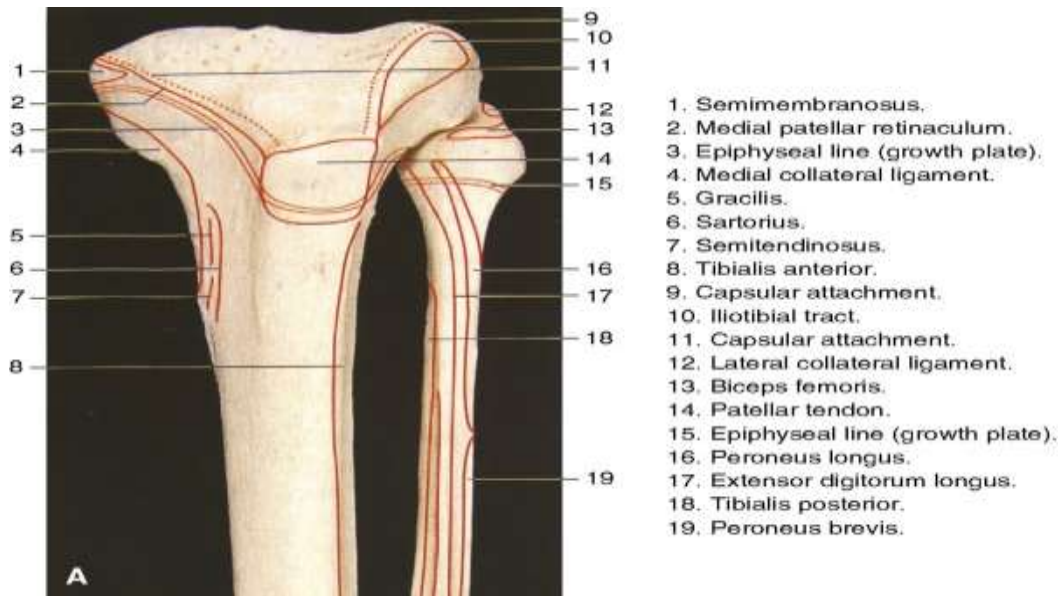


Figure 5 : Muscle attachments of tibia fibula

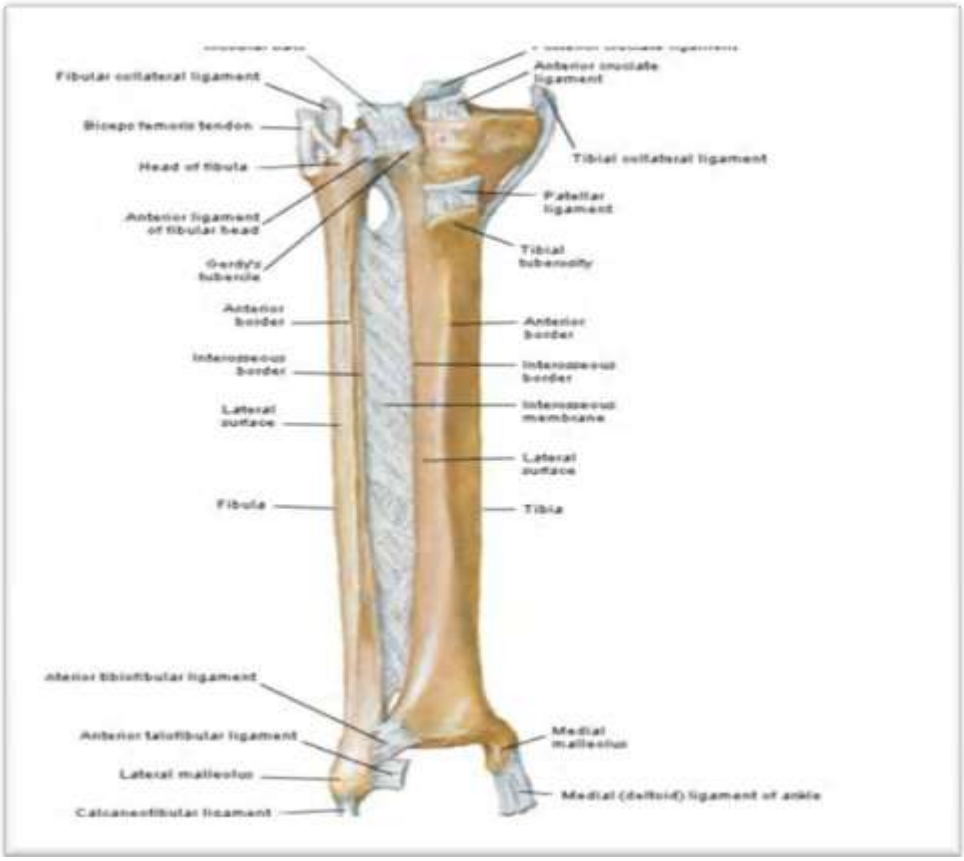


Figure 6 : Ligament attachments

The upper end of the tibia is expanded into the *medial* and *lateral condyles*,the former having the greater surface area of the two. Between the condyles is the *intercondylar area* which bears, at its waist, the *intercondylar eminence*,projecting upwards slightly on either side as the *medial* and *lateral intercondylartubercles*.The *tuberosity* of the tibia is at the upper end of the anterior border of the shaft and gives attachment to the ligamentum patellae.

The anterior aspect of this tuberosity is subcutaneous, only excepting the infrapatellar bursa immediately in front of it.The shaft of the tibia is triangular in cross-section, its anterior border and anteromedial surface being subcutaneous throughout their whole extent.The posterior surface of the shaft bears a prominent oblique line at its upper end termed the *soleal line*, which not only marks the tibial originof the soleus but also delimits an area above into which is inserted thepopliteus.The lower end of the tibia is expanded and quadrilateral in section,bearing an additional surface, the *fibular notch*, for the lower tibiofibularjoint.The *medial malleolus* projects from the medial extremity of the bone and is grooved posteriorly by the tendon of tibialis posterior.The inferior surface of the lower end of the tibia is smooth, cartilage covered and forms, with the malleoli, the upper articular surface of the ankle joint.

Compartments Of Leg

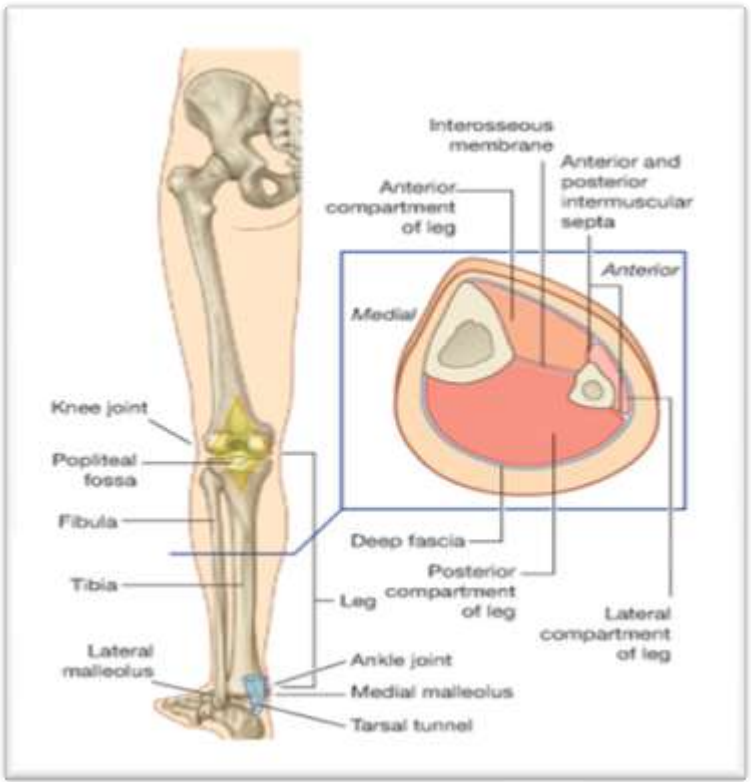
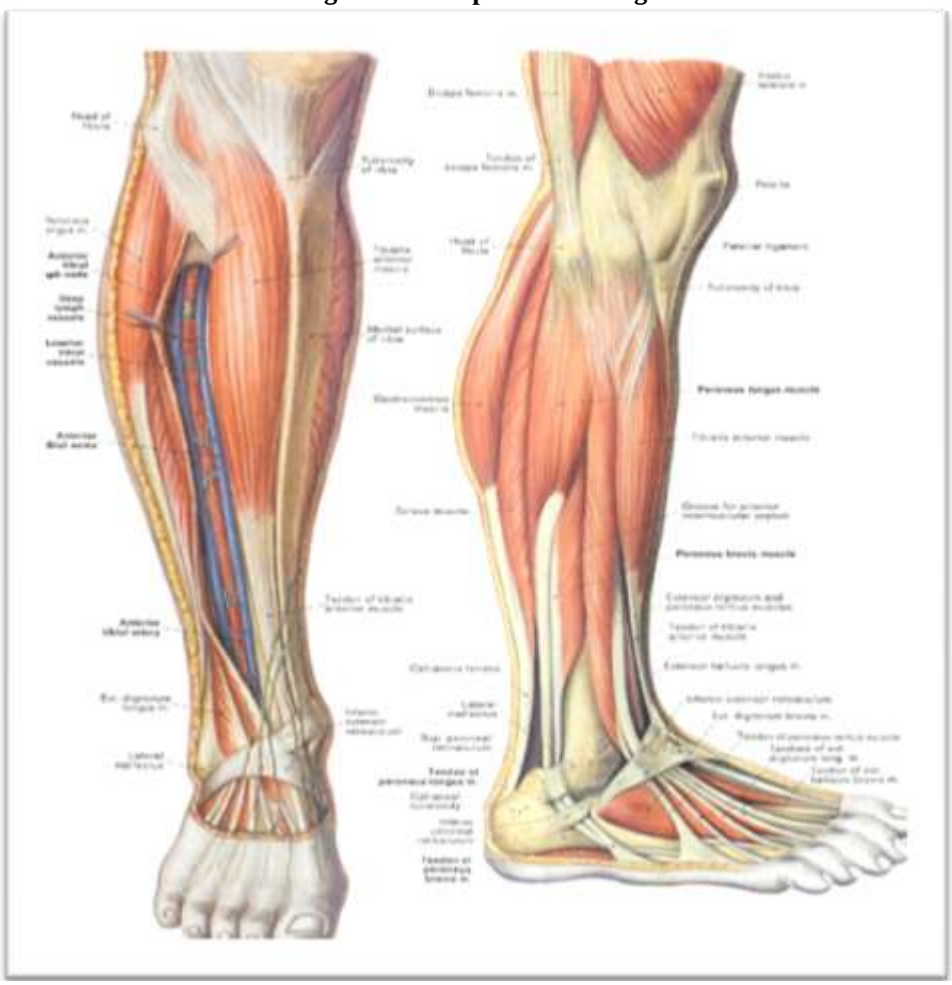


Figure 7 : Compartment of leg



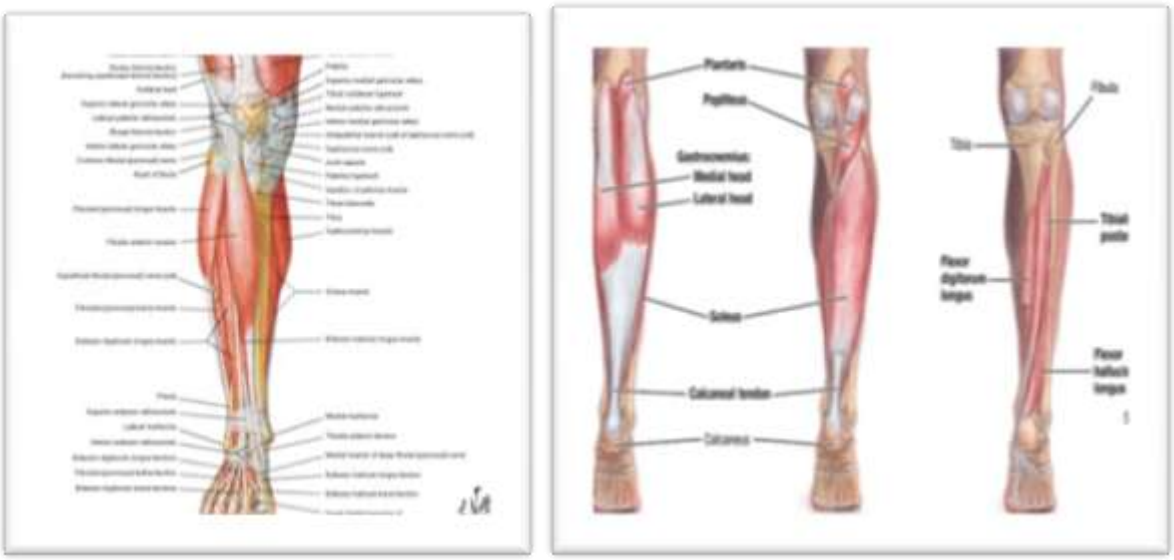


Figure 8 : Muscles of leg

Nutrient Artery

- arises from posterior tibial artery as it enters into the posterior tibial cortex, distal to the soleal line at the middle 1/3;
- enters posterolateral cortex of the tibial at the origin of the soleus muscle;
- artery may transverse distance of 5.5 cm before entering its oblique nutrient canal;
- artery divides into three ascending branches & a single descending branch, which gives off smaller brances to the endostreal surface;
- provides the endosteal blood supply to the inner tibial cortex;
- may be damaged in segmental frx;
- this makes bone dependent on soft tissue envelope for blood supply, & stripping of soft tissues may render the bone avascular;
- anterior tibial artery:
- may be vulnerable to injury after its division from popliteal artery, where it passes through hiatus in upper interosseous membrane;
- periosteum has abundant blood supply from anterior tibial artery branches as it courses down interosseous membrane.

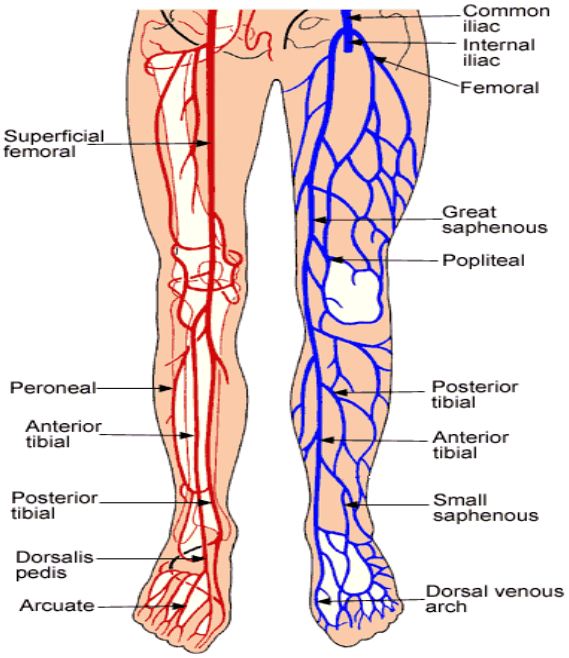


Figure 9 : Blood supply of lower limb

III. Clinical Features

1. The upper end of the tibial shaft is one of the most common sites for acute osteomyelitis. Fortunately, the capsule of the knee joint is attached closely around the articular surfaces so that the upper extremity of the tibial diaphysis is extracapsular,involvement of the knee joint therefore only occurs in the late and neglected case.
2. The shaft of the tibia is subcutaneous and unprotected anteromedially throughout its course and is particularly slender in its lower third. It is not surprising that the tibia is the commonest long bone to be fractured and to suffer compound injury.
3. The extensive subcutaneous surface of the tibia makes it a delightfully accessible donor site for bone-grafts.

IV. Material And Method

The present study was undertaken at the department Orthopaedics, Yenepoya medical college. This study involved both male and female patients with distal tibia fractures, who presented to Yenepoya Medical College.

30 patients who had distal tibia fractures and met the selection criteria were treated with minimally invasive percutaneous plating during the period from May 2013 to November 2014 were included in the study.

All the cases were fresh fractures and were traumatic in nature. On admission general condition of the patient was assessed with regards to hypovolemia, associated orthopaedic or other systemic injuries and resuscitative measures were taken accordingly. A thorough clinical examination was performed including detailed history relating to age, sex,mode of injury, past and associated medical illness.

Routine investigations were done for all the patients. All patients were evaluated clinically and radiologically to assess for any other injuries. Radiographs were taken in two planes, AP and Lateral views. Patients were operated as early as possible, once the general condition of the patients was stable and patients were fit for surgery.

Inclusion Criteria:

- Age >20 years (skeletally mature patients).
- Known case of diabetes, Hypertension, Peripheral vascular disease.
- Past history of smoking/Alcohol/Tobacco.
- Fractures distal third tibia.
- Closed displaced unstable fcturares.

Exclusion criteria:

- Open fractures of distal third tibia.
- Neurovascular injury.
- Fractures proximal third and mid third tibia.
- Pathological fractures.
- Skeletally immature patients.

SOURCE OF DATA: Patients attending YENEPOYA MEDICAL COLLEGE HOSPITAL AND ASSOCIATED HOSPITALS

SAMPLE SIZE: 30 PATIENTS.

Infected Case Using MIPPO **Infected case - ORIF**

Figure 10 : Clinical photos

V. Analysis And Results

The present study includes 30 distal tibial fractures treated with minimally invasive percutaneous plate osteosynthesis from May 2013–Nov 2014 in the Department of Orthopaedics,Yenepoya Medical College. The patients were followed up for an average of 12 months. All the patients were available for follow up.

Thirty patients who had distal tibial fractures were included in our study group. The duration of follow-up ranged from 6 weeks to12 months. There were 25 men and 5 women, ranging in age from 20 to 50 years old, with an average age of 35 years. In our study there were 20 right sided and 10 left sided distal third tibia fractures. Most of the patients in our study group were below 50years, and the most common mode of injury was Road Traffic Accidents. Majority of the patients were male (70%) and only 30% were females. The major cause of fracture in our study was Road Traffic Accidents (80%). All the fractures in our study were closed. Majority were of A1 type (40%) followed by A2 type (30%).

Most of our cases were uneventful and the only complication of superficial wound infection was noted in 3 cases (15%) which subsided on treatment with regular dressing and intravenous antibiotics. It is clear that MIPPO results in less surgical trauma to the soft tissues and less operative time. The time of partial weight bearing was decided on the type of fracture, adequacy of fixation and the radiological picture at the time of follow up. Most patients started partial weight bearing around 7-8 weeks post-surgical fixation. The time of full weight bearing was usually between 7-14 weeks with an average time of full weight bearing of 10.2weeks in our study group.

Union was defined as the presence of bridging callus on two radiographic views and the ability of the patient to bear full weight on the injured extremity. All the fractures united. The time to union was between 17 to 30 weeks with an average of 23.75 weeks in our study group.

A malunion was defined as angulation in coronal plane (Varus–valgus) of more than 5 degrees, in the saggital plane (Anterior–posterior) angulation of >10 degrees, or more than 10mm of shortening. None of the patient with distal tibia fracture had a valgus or varus malalignment of more than 5 degrees.

None of the patients had more than 10degree of angulation in saggital plane and none had a shortening of more than 10mm. Detailed analysis of function of the patients with distal tibia fractures was done on the basis of Ankle evaluation scoring system –AOFAS [American Orthopaedic Foot and Ankle Society Ankle–Hind foot Scale].

In our study of patients with fractures of distal tibia treated with MIPPO, 10% patient had Fair result, 10% patient had good results, 80% patients had excellent results.

Ao Classification Of Distal Tibia Fractures

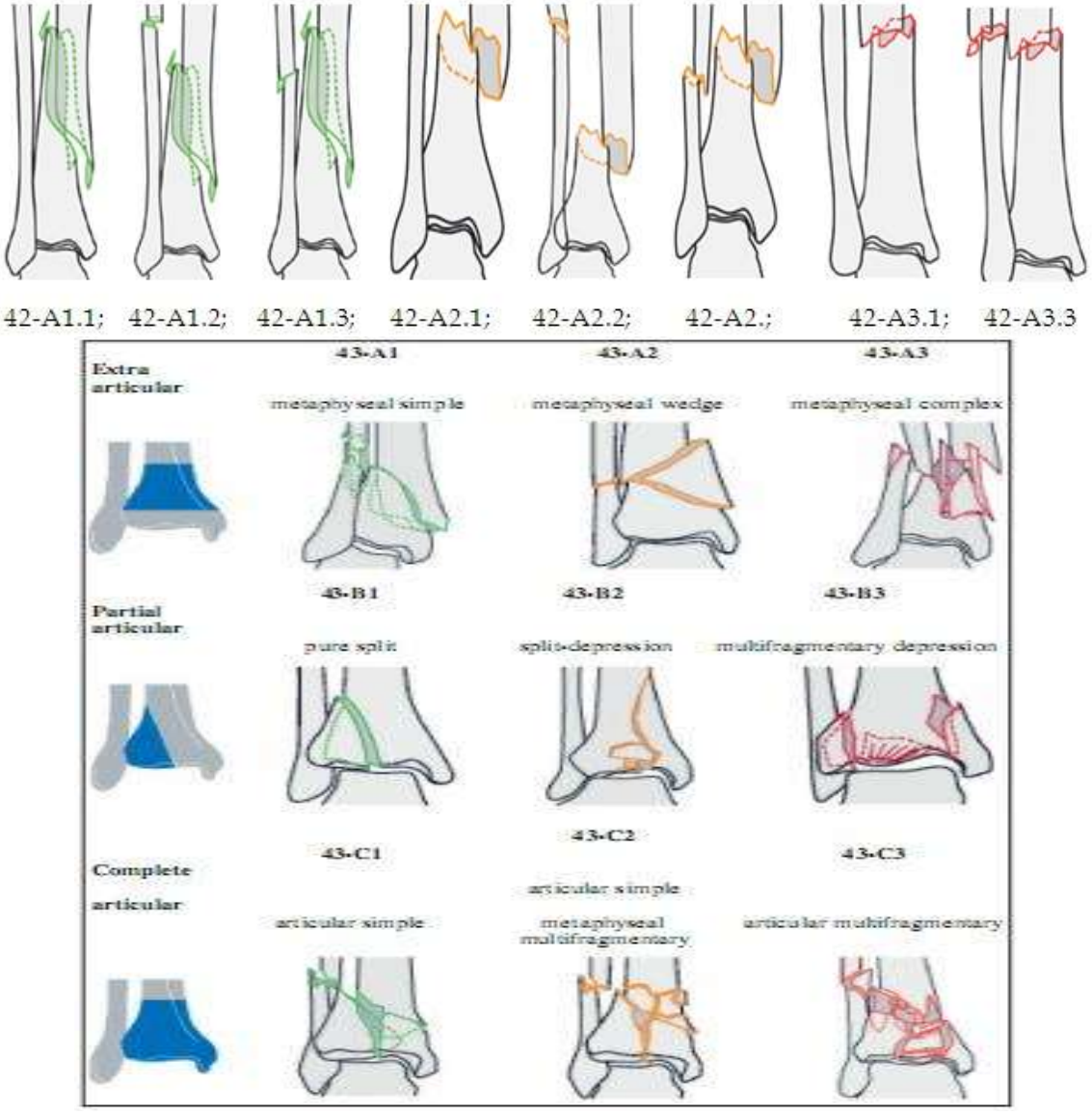


Figure 11 : AO Classification of fracture of distal tibia

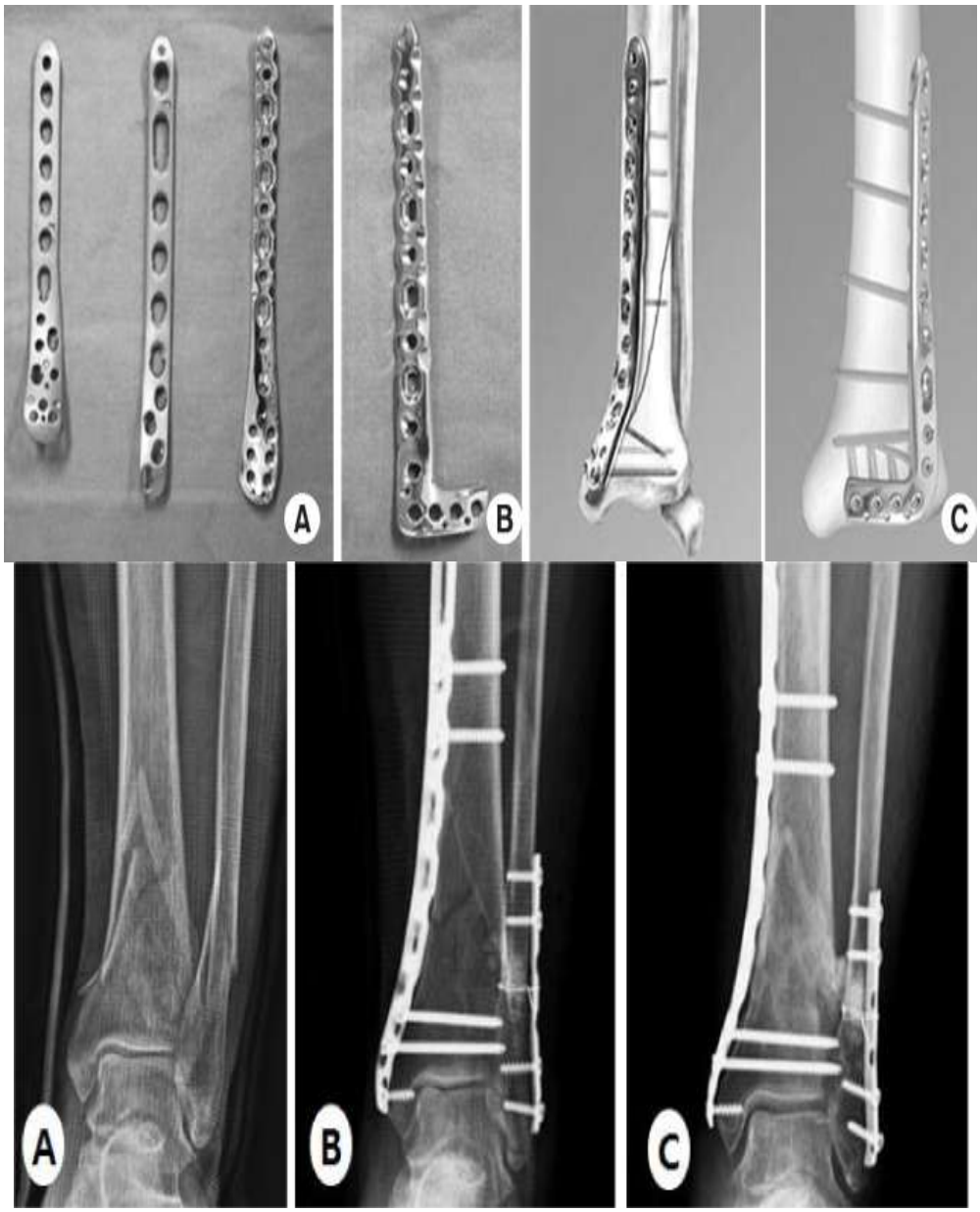


Figure 12 : LCP and fixation of distal tibia fracture using LCP

TABLES

Table 1 : Mean Age

Statistics		
AGE		
N	Valid	30
Mean		41.41
Median		45.00
Std. Deviation		9.225
Minimum		21
Maximum		55

Table 2 : Frequency Distribution

	SEX	Percent
F	5	17.2
M	25	82.8
Total	30	100

Table 3 : Mode Of Injury

	MODE OF INJURY	Percent
ASSAULT	2	6.9
FALL FROM HEIGHT	6	20.7
RTA	22	72.4
Total	30	100

Table 4 : Type Of Injury

	TYPE OF INJURY	Percent
TYPE A1	28	94
TYPE A2	02	06

Table 5 : Co-Morbid Factors

	CO-MORBID FACTORS	Percent
DM	3	10.3
DM &HT	1	3.4
HT	3	10.3
NO	22	72.4
PVD	1	3.4
Total	30	100

Table 6 : Addiction

	ADDICTION	Percent
NO	13	41.4
SMOKER	10	34.5
TOBACCO	7	24.1
Total	3O	100

Table 7 : Follow 6 Weeks, 3 Months, 6 Months And 12 Months

CALLUS	6WEEKS	Percent
PRESENT	30	100

CALLUS	3MONTHS	Percent
NOT SUFFICIENT	2	6.9
PRESENT	28	93.1
Total	30	100

	6MONTHS	Percent
INFECTION,NONUNION	1	3.4
MALUNITED	2	6.9
NONUNION	2	6.9
UNITED	25	82.8
Total	30	100

	12MONTHS	Percent
INFECTION,NONUNION	2	6.9
NONUION	1	3.4
WB MOBILIZATION	27	89.7
Total	30	100

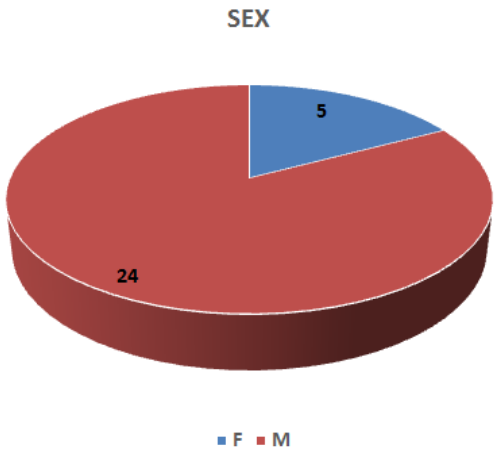
Table 8 : Wound

	WOUND	Percent
HEALED	27	89.7
POOR HEALING	3	10.3
Total	30	100

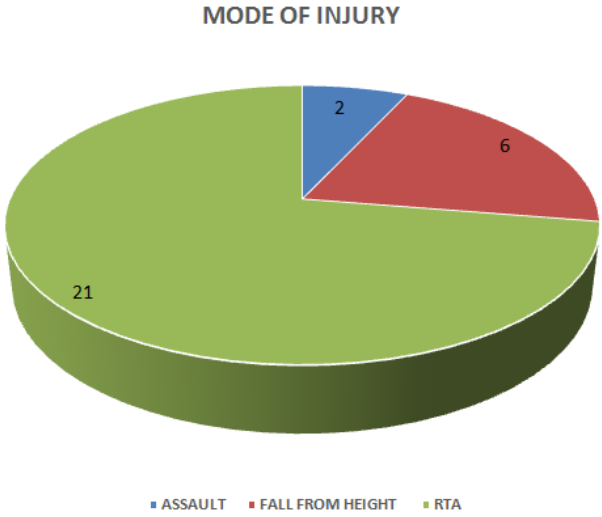
Table 9 : Result S

	RESULTS	Percent
BAD	1	3.4
EXCELLENT	25	82.8
VERY GOOD	2	6.9
GOOD	2	6.9
Total	30	100

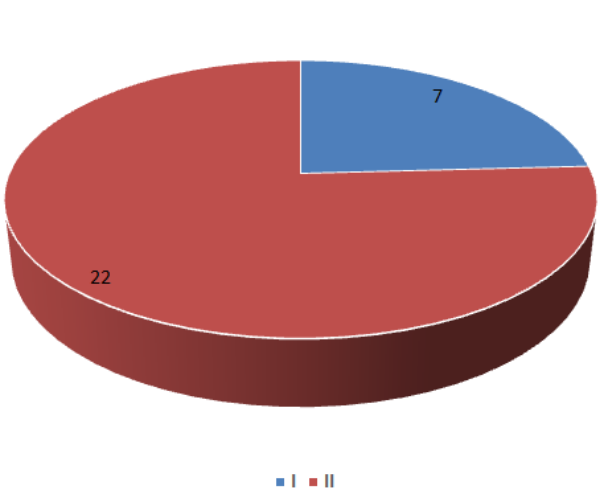
Graphs



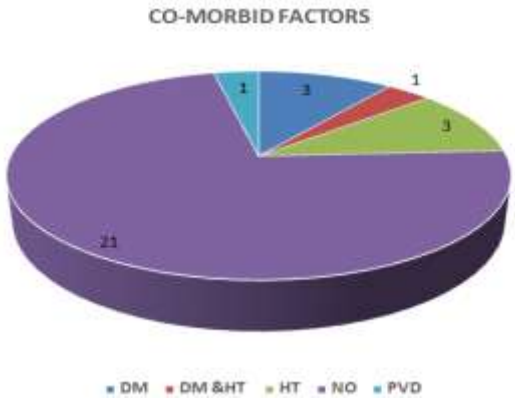
Graph 1: Sex distribution



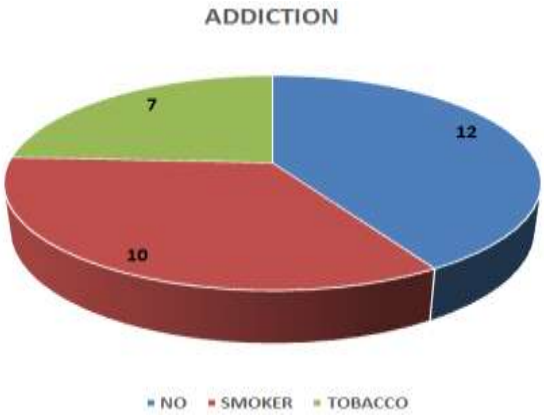
Graph 2 : Mode of injury



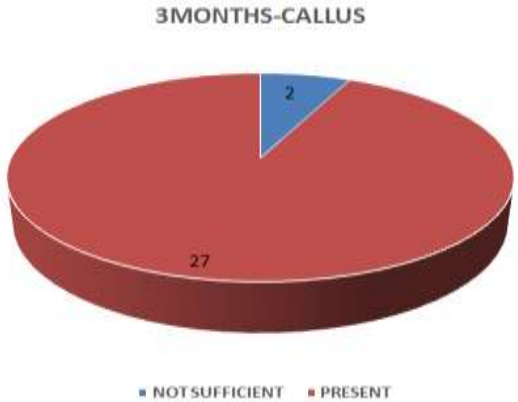
Graph 3 : AO classification



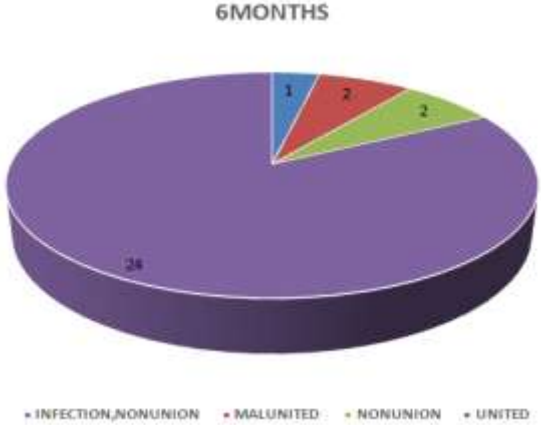
Graph 4 : Co-Morbid Factors



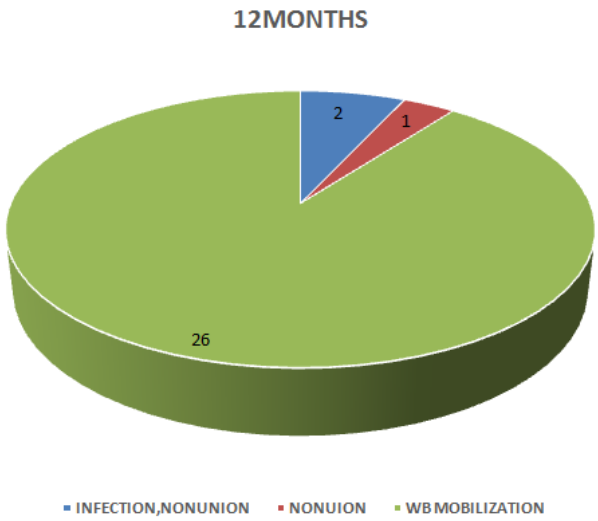
Graph 5 : Addiction



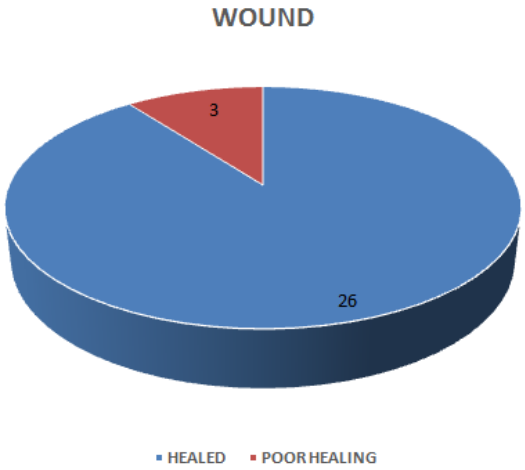
Graph 6 : 3 months-Callus



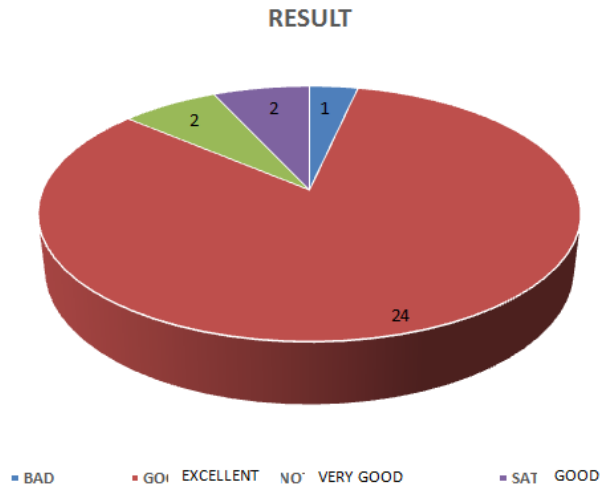
Graph 7 : 6 months-Callus



Graph 8 : 12 months-Callus



Graph 9 :Wound



Graph 10 : Result

VI. Discussion

Distal tibial fractures remain one of the most substantial therapeutic challenges that confront the orthopaedic traumatologist. Though conservative management of these fractures has been described these methods have been largely superseded by operative techniques for displaced or irreducible fractures, and fractures with intra-articular extension.

MIPPO is by now an established technique of management of fractures of the distal tibia. Minimally invasive percutaneous plating techniques reduce the iatrogenic soft tissue injury and damage to bone vascularity, and also preserve the osteogenic fracture hematoma. Minimally invasive techniques are based on principles of limited exposure, indirect reduction methods and limited contact between bone and implant. As a result of these principles this technique, as seen in present study, avoided major soft tissue complications and shortened the length of the patient's stay in the hospital. Biological fixation of distal tibia fractures is beneficial and technically feasible.

The advantages are:It minimises soft tissue injuries, it does not compromise bone vascularisation and presents a low complication rate, especially when compared to open reduction and internal fixation.

The present study was undertaken to evaluate the results of Minimally Invasive Percutaneous Plate osteosynthesis (MIPPO) in treatment of distal third tibial fractures.

Thirty patients with closed distal third tibial fracture with or without intra articular extension (AO classification: 12type 43A1, 7 type 43A2, 1type 43A3, treated with MIPPO with LCP were prospectively followed for average duration of 12 months (Range 8-12 months).

We evaluated our results and compared them with those obtained by various other studies utilizing different modalities of treatment, our analysis is as follows:

Age distribution: Our study revealed the average age of patients with such injuries to be 35years (20-50).

Sex Distribution: The sex distribution in our study in the treatment of distal tibial fractures with MIPPO showed that there were 25 men and 5 women.

Nature of Violence: Majority of the cases sustained fractures from road traffic accidents i.e. 16 cases (80%). 4 patients had sustained fracture after a fall. R.T.A was most common mode of injury in present series.

Results: The age of the patients ranged from 20 to 50years with mean age of 35years. Most of the patients were in the age group of 20-50years.The mode of injury in the majority of the patients was road traffic accidents. The majority of the fractures operated in our study were extra-articular fractures, i.e. AO/OTA 43-A (100%).5 patients (25%) had a both bone leg fracture, with majority of the fibular fractures occurring at the level of the tibial fracture, suggesting a bending mechanism. Out of the 5 patients with an associated fibular fracture, only 1 patient needed fixation of the fibula (5%), and was fixed with one third tubular plate. The average duration between trauma and surgery was 4.5 days with a range of 3-7days.

Most of the cases were operated upon within 4days of injury (86%). The average operative time was 60 min with a range of 70-120min. The majority of the fractures were operated within 100 min of operative time (90.0%). Operative time was longer in fractures in which needed fixation of the fibula. The average fluoroscopy time was 50 sec with a range of 34 sec-60sec. Post operatively the limb was elevated and a removable below knee slab was given. Toe touch weight bearing and knee range of motion was started on the 2nd postoperative day. Sutures were removed at 11th postoperative day, slab was continued for 4 to 6weeks.

Weight bearing was increased depending on the progress of clinical and radiological fracture healing. Full weight bearing was allowed at fracture union, which was defined as union in 3 cortices and painless weight bearing.

The mean time for radiological union was 23.75weeks with a range of 34 to 60weeks. On union, all of the 12 patients had an AOFAS score of 90 or greater out of a possible 100 points. The mean score was 90.25. We encountered superficial infection in one of our patient which was managed with dressings and appropriate antibiotics. As the study progressed we realised that the key to preventing infection was gentle handling of the soft tissues. On long term follow up of the patient's the superficial infection healed well. The infection rate using MIPPO (5%) is favourable compared with ORIF with plates (15-35 % deep infection rates) and also with external fixation (20–50% pin track infection).

A malunion was defined as angulation in a coronal plane (Varus –valgus) >5 degrees, saggital plane (Anterior –posterior) angulation of >10 degrees or > 10 mm of shortening. In our series, none of the patients had more than 10 degree of angulation in saggital plane and none had a shortening of more than 10mm. These results are comparable with the results of similar studies where in the malunion rate is reported to be 2–5%.

In our series no patient had implant failure. This is also comparable to other similar studies, Bonker et al which have reported a 0–10 % incidence of plate exposure, most commonly at the distal insertion site. In most of the other studies the implant distal tibial locking plate removal is mainly due to symptomatic skin impingement over the medial malleolus.

In our series, no patient developed fat embolism, compartment syndrome, peroneal nerve palsy or reflex sympathetic dystrophy.

All patients were happy with the cosmetic results because very little residual swelling was noted and the surgical wounds were rather small and healed without much scarring.

VII. Conclusion

- The MIPPO technique is a reliable fixation approach to fractures of the distal tibia, preserving most of the osseous vascularity and fracture haematoma and thus providing for a more biological repair.
- This technique can be used in fractures where locked nailing could not be done like distal tibial fractures with small distal metaphyseal fragments, vertical split and markedly comminuted fractures.
- Due to preserved vascularity, there is low incidence of delayed union and non-union.
- There was reduced incidence of infection due to limited exposure. Infection was also prevented by careful handling of soft tissues and by minimising the operating time.

Summary

- A short series of result of our study were analyzed and the overall results have encouraged us in preferring the MIPPO over conventional ORIF with plate and screws.
- Real advantages lie in the prevention of soft tissue problems and the possibilities for earlier and even single-stage operative procedures, contributing to a favourable outcome.
- The MIPPO technique is a reliable fixation approach to fractures of the distal third tibia, preserving most of the osseous vascularity and fracture haematoma and thus providing for a more biological repair.
- This technique can be used in fractures where locked nailing could not be done like distal tibial fractures with small distal metaphyseal fragments, vertical split and markedly comminuted fractures.
- Due to preserved vascularity, there is low incidence of delayed union and non-union.
- There was reduced incidence of infection due to limited exposure. Infection was also prevented by careful handling of soft tissues and by minimising the operating time.
- Minimal hospital stay and early returns to activities.
- Following were the other post operative benefits such as Simpler and lesser follow-up, lesser check radiographs leading to lesser radiation exposure
- Cost effective as less in hospital stay, lesser outpatient care, earlier return to work.

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Annexures
Annexure I
Proforma
Personal Data:
Name:
Age:
Sex:
Occupation:
Address:
Ip Number:
Date Of Injury:
Date Of Admission:
Date Of Surgery:
Date Of Discharge:

HISTORY:
1) NATURE OF TRAUMA
a) RTA c) Sports injuries
b) Fall from height d) Assault

2) MECHANISM OF INJURY
a) Direct b) Indirect

3) DURATION SINCE INJURY
PAST HISTORY:
1) History of Diabetes mellitus , Hypertension , Epilepsy Tuberculosis , Asthma
2) Previous history of fractures
3) Smoking, Alcohol, tobacco.

General Physical Examination :
General Condition:
Pulse Rate
Blood Pressure
Respiratory Rate

Pallor, icterus, cyanosis , clubbing , lymphadenopathy , edema
SYSTEMIC EXAMINATION:
CVS/RS/CNS/PA:
PRESENCE OF ASSOCIATED INJURIES:

Local Examination:
- Swelling
- Presence of wound
- Presence of infection
- Tenderness
- Presence of distal pulsations
- Condition of skin
- Simple or open fracture
- Deformity
- Crepitus
- Neurovascular deficits

Relevant Investigations:
- X-RAY
- COMPLETE BLOOD COUNT

- RBS
- URINE ROUTINE
- BLOOD GROUPING AND TYPING
- SEROLOGICAL TESTS

Treatment:
First Aid:

- Immobilization of the limb (P.O.P Slab)
- Analgesics

Definitive Treatment:

- Relevant investigations and medical fitness for surgery
- Intra-operative:
- Anaesthesia
- Plating or interlocking nailing
- Antibiotic therapy: Pre-op and Post-op
- Analgesics

Complications:

- **Intra operative**

- Difficulty in reduction of fracture
- Excessive bleeding
- Wrong placement of implants
- Difficulty in wound closure

- **Immediate post operative**

- Bleeding
- Infection
- Delayed healing of wound

- **Delayed complications**

- Non-union
- Mal-union
- Breakage of implants
- Chronic infection
- Neurovascular deficits

Follow-Up

- **Date**
- **Serial number**
- **Time since surgery**
- **Clinical union: pain at the fracture site , abnormal mobility**
- **Radiological union: X-Ray**

Ankle:

Plantar flexion
Dorsi flexion.

Annexure – Iii
Key To Master Chart

M	-	Male
F	-	Female
T	-	Transverse
O	-	Oblique
S	-	Spiral
C	-	Comminuted
A	-	Simple Fracture
A1	-	Spiral
A2	-	Oblique (>30degree)
A3	-	Transverse (<30degree)
B	-	Wedge Fractures

B1 - Spiral Wedge
B2 - Bending Wedge
B3 - Fragmented Wedge
C - Complex Fractures
C1 - Spiral Comminuted
C2 - Comminuted Segmental
C3 - Comminuted Irregular
- Fracture
DM - Diabetes Mellitus
HT - Hypertension

Annexure – Iv
Master Chart

SNO	NAME	SEX	AGE	MODE OF INJURY	TYPE OF INJURY	AO CLASSIFICATION	CO-MORBID FACTORS	ADDICTION	DATE OF SURGERY	CALLUS 6 WEEKS	3 MONTHS	6 MONTHS	12 MONTHS	COMPLICATIONS	WOUND	RESULT
1	PARVATI	F	45	RTA	CLOSED EXTRAARTICULAR	A1	NO	NO	8/30/2013	PRESENT	PRESENT	UNITED	WB MOBILIZATION		HEALED	GOOD
2	HAMEED	M	25	RTA	CLOSED EXTRAARTICULAR	A1	NO	NO	9/28/2013	PRESENT	PRESENT	UNITED	WB MOBILIZATION		HEALED	GOOD
3	HYDER ALI	M	45	RTA	CLOSED EXTRAARTICULAR	A1	DM	SMOKER	10/1/2013	PRESENT	PRESENT	UNITED	SKIN INFECTION	SUPERFICIAL INFECTION	HEALED	NOT SATISFACTORY
4	ZAMEER	M	45	RTA	CLOSED EXTRAARTICULAR	A1	NO	TOBACCO	10/8/2013	PRESENT	PRESENT	UNITED	WB MOBILIZATION		HEALED	SATISFACTORY
5	KRISHNA	M	47	FALL FROM HEIGHT	CLOSED EXTRAARTICULAR	A1	NO	TOBACCO	15-102013	PRESENT	PRESENT	UNITED	WB MOBILIZATION		HEALED	GOOD
6	LALITHA	F	42	FALL FROM HEIGHT	CLOSED EXTRAARTICULAR	A1	DM	NO	10/1/2013	PRESENT	PRESENT	UNITED	WB MOBILIZATION		HEALED	GOOD
7	MELVIN	M	21	RTA	CLOSED EXTRAARTICULAR	A1	NO	NO	10/30/2013	PRESENT	PRESENT	UNITED	WB MOBILIZATION		HEALED	GOOD
8	FAROOQ	M	48	ASSAULT	CLOSED EXTRAARTICULAR	A1	HT	SMOKER	2/2/2014	PRESENT	NOT SUFFICIENT	UNITED	SKIN INFECTION	SUPERFICIAL INFECTION	HEALED	NOT SATISFACTORY
9	HENRY	M	40	RTA	CLOSED EXTRAARTICULAR	A1	NO	TOBACCO	2/10/2014	PRESENT	PRESENT	UNITED	WB MOBILIZATION		HEALED	SATISFACTORY
10	JAYARAM	M	55	FALL FROM HEIGHT	CLOSED EXTRAARTICULAR	A1	HT	SMOKER	2/16/2014	PRESENT	PRESENT	UNITED	WB MOBILIZATION		HEALED	GOOD
11	JOSEPH	M	32	RTA	CLOSED EXTRAARTICULAR	A1	NO	NO	30-02-2014	PRESENT	PRESENT	UNITED	WB MOBILIZATION		HEALED	GOOD
12	JAISON	m	40	RTA	CLOSED EXTRAARTICULAR	A1	NO	NO	3/4/2014	PRESENT	PRESENT	UNITED	WB MOBILIZATION		HEALED	GOOD
13	ABDUL	M	50	ASSAULT	CLOSED EXTRAARTICULAR	A1	DM	SMOKER	3/9/2014	PRESENT	PRESENT	UNITED	WB MOBILIZATION		HEALED	GOOD
14	KUNJIMON	M	48	RTA	CLOSED EXTRAARTICULAR	A1	NO	SMOKER	3/20/2014	PRESENT	PRESENT	UNITED	WB MOBILIZATION		HEALED	GOOD
15	IQBAL	M	47	FALL FROM HEIGHT	CLOSED EXTRAARTICULAR	A1	HT	SMOKER	3/21/2014	PRESENT	PRESENT	UNITED	WB MOBILIZATION		HEALED	GOOD
16	MOHAMAD	M	50	RTA	CLOSED	A1	NO	TOBACCO	4/2/2014	PRESENT	PRESENT	UNITED	WB		HEALED	GOOD