"MANAGEMENT OF LOWER THIRD TIBIAL FRACTURES WITH INTRAMEDULLARY INTERLOCKING NAIL"

By

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DISSERTATION SUBMITTED TO SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH CENTER, KOLAR, KARNATAKA

In partial fulfilment of the requirements for the degree of

MASTER OF SURGERY

IN

ORTHOPAEDICS

Under the Guidance of

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ABSTRACT

BACKGROUND

There has been rapid increase in the volume of traffic over the last decade, which has resulted in increase in the number of road traffic accidents. Fractures of tibia are among the commonest fractures sustained in the road traffic accidents and are complicated by delayed union, mal-union, non-union and infection. These problems are more common with the fractures lower third of tibia as it is less vascular and has less soft tissue coverage.

Intramedullary interlocking(IMIL) nailing is a common method of fixation for the lower third tibial fractures and is associated with superior outcomes and less complications compared to external fixation and non operative methods. Therefore the present study has been under taken to evaluate its management in our patients in rural set up.

OBJECTIVES OF STUDY

1. To evaluate the functional outcome following the use of intramedullary interlocking nail for the fractures of lower third of tibia.

2. To study the duration of union of fractures of lower third of tibia fixed with intramedullary interlocking nail .

MATERIALS AND METHODS:

This study is a hospital based prospective study conducted in Department of Orthopaedics at R.L J hospital and research centre, Kolar, from November 2014 to February 2016 in which 30 patients with lower third tibial fractures were managed with closed reduction and internal fixation with intramedullary interlocking nail and were followed up for 6 months at regular intervals.

RESULTS:

In our study most of the patients were in the age group of 31-50 years of age (40%), majority were male, right side was common(53.3%), closed fractures were predominant accounted for 63.3%, open fractures were 36.7% and 16.7% of the patients had complications like delayed union, infection, non-union, malunion and proximal static screw breakage. We had excellent outcome in 60% of the patients, 23.3% had good outcome, 10% had fair outcome and 6.7% had poor outcome

CONCLUSION

Closed reduction and internal fixation with IMIL nailing is also one of the ideal method of fixation of fractures of the lower third of tibia as there is minimal blood loss, minimal soft tissue damage, stable fixation, early mobilization and union. Hence it can be effective, reliable and useful technique with good functional outcome in the fixation of fractures of lower third of tibia.

LIST OF ABBREVIATIONS

AO	Arbeitsgemeinschaft fur Osteosynthesefragen
AP	Anteroposterior
BT	Bleeding time
CT	Clotting time
CRIF	Closed reduction and internal fixation
DOA	Date of admission
DOS	Date of surgery
DOD	Date of discharge
Fig	Figure
IMIL	Intramedullary interlocking
IP No	Inpatient number
Lt	Left
LCP	Locking compression plate
ORIF	Open Reduction and Internal Fixation
POP	Plaster of Paris
RTA	Road traffic accident
Rt	Right

CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Fractures of lower third tibia are one of the most common fractures encountered by the orthopaedic surgeon in his daily practice. This is because the bone is subcutaneous with less protection from the muscles and is prone for open fractures.

The fractures of the lower third of tibia mainly occur following motor vehicle accidents and can also occur due to assault, falls, direct blows and sports injuries.

Lower third tibial fractures show a bimodal distribution with peak in the young males and elderly females. In young patients, it is due to high energy trauma which often leads to associated soft tissue damage, while in the elderly patients it is due to osteoporosis.

This study is taken up in the rural population to determine the efficacy of the intramedullary interlocking(IMIL) nailing in the fractures of the lower third of tibia .

There has been rapid increase in the volume of traffic over the last decade, which has resulted in increase in the number of road traffic accidents. Fractures of tibia are among the commonest fractures sustained in the road traffic accidents and are complicated by delayed union, mal-union, non-union and infection[1].

Fractures of the lower third of tibia are one of the difficult and most challenging problems faced by the orthopaedic surgeon. The problems arise with these fractures as lower third of tibia is less vascular and has less soft tissue coverage[2].

Intramedullary interlocking nailing of lower third fractures of tibia is associated with superior outcomes and less complications compared to external fixation and non operative methods. Also IMIL nailing is the most common method of fixation for most of the open tibial fractures[4].

Introduction of closed intramedullary nailing has changed the management policies of fracture tibia. The treatment for fracture tibia by intramedullary nailing has gained popularity mainly by introduction of closed nailing facilities. After reaming of medullary canal, a large diameter nail can be used without jamming and a smaller diameter nail can be used without reaming. This procedure gives better outcome anatomically and functionally with early mobilization and short stay in the hospital[5].

For the lower third fractures of tibia use of blocking screws, unreamed nails through which three locking bolts can be placed into the distal fragment , as well as removal of the tip of the traditional reamed nails allows predictable placement of the two locking screws into the distal fragment[6].

Intramedullary interlocking nailing of tibia features favourable mechanical properties and biological advantages due to the preservation of the vascularity of the fracture site and integrity of the surrounding soft tissues[7].

An increased risk of complications were found in fractures due to high-energy trauma, with use of stainless steel nails rather than titanium nails, fracture gaps, and immediate post operative full weight-bearing. Patients with open fractures had a higher risk of complications if they had reamed nailing. There was an increased risk of complications for fracture gaps of more than 1cm but not for those with gaps of less than 1cm. Results in sprint study indicate full weight bearing may stimulate fracture union by autodynamization[9].

Obremskey(2004) showed that the distal tibia fractures can be treated with intramedullary nailing with good results. Internal fixation of the fibula is considered only if the fracture extends to the ankle mortise, which may aid in preventing malalignment of $<5^0$ in any plane[10].

OBJECTVES OF STUDY

- To evaluate the functional outcome following the use of intramedullary interlocking nail for the fractures of lower third of tibia.

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REVIEW OF LITERATURE

Fractures have been recognized and treated as long as the history is recorded. History of the fractures and its knowledge dates back to the Egyptian mummies of 2700 BC.

For thousands of years the only option of management of the fractures was some form of external splintage. 5000 years ago Egyptians used palm bark and linen bandages for the management of the fractures. Clay and lime mixed with the egg white was also used, but the most commonly used material was the wood.

Treatment of the fractures dates back to the Sushruta, scholar of medicine, between 6 and 9 century B.C. Hippocrates also taught about the fractures, their details and management about two thousand years ago. In the treatment of the fractures he applied traction with a wind lass and supported with a bench. His work had historic worth and is also the back ground of the many principles of the modern orthopaedic surgeries.

In the 19century for treatment of fractures Orthopaedicians were dependent on braces, casts, manipulation and exercises. In 1852 Mathysen used bandages impregnated with plaster of paris for the treatment of fractures.

John Hilton(1804-1878) advocated absolute bed rest for the fractured limb. At the dawn of the 20 century there is rapid evolution of the surgery in the Orthopaedics. The art of correcting the deformities and bone injuries was given scientific outlook.

The term orthopaedics comes from the Greek literature, and is coined by the French physician Nicolas Andry. He published a book by name “la orthopaedic” which means the correction of the deformities in the children. The 19 century saw the emergence of the orthopaedics as a speciality and the orthopaedic centres for treating the fractures and correction of the deformities were started.

Histological evolution of the intramedullary interlocking nail dates back to the 16th century. The Spanish archives briefly mentions that the Incas and Aztecs used the resinous wooden pegs in the medullary canal of the long bones for the treatment of the non-unions[11].

Ivory pegs were used by the Birches and Ophers in 1886 and also by the Koenig of Germany in 1913. Hoglund used bone pegs instead of ivory pegs in 1917[11].

Nicolaysen of Norway described the biomechanical principles of the intramedullary devices in the treatment of the proximal femur fracture. He proposed that the length of the intramedullary device should be maximised to provide the best biomechanical advantage[11].

Hey-grooves of England used the intramedullay nail fixation for the fixation of the femur fractures from the gunshot wounds during the First World War[11].

In 1930 Gerhard Kuntscher developed the V nail and clover shaped nails but it was after 50 years the rigid intramedullary nails became a widely accepted treatment for the tibial fractures. Later Herzog modified the straight Kuntscher nail to have a proximal bend to accommodate the eccentric proximal portal[12].

In 1937 Rush brothers, used the intramedullary Steinmann pin for the treatment of the compound fractures. They also developed the flexible nail systems with pins of four different diameters, which can be used for any long bone in the body, later known as the “Rush Nail”[11].

In 1950s, Lottes developed a rigid nail that could be inserted without reaming using either a closed or open technique. Lottes reviewed the treatment of tibial fractures with his triflanged intramedullary nail and reported infections in only 0.9% of the closed fractures and 7.3% of the open fractures. He reported a non-union rate of 2.3% in his overall series using the closed method of nailing. He developed his technique without image intensifier or fracture tables and was able to perform closed nailing in the 99% of the fractures[12].

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Flexible intramedullary nails also have been used successfully to treat the tibial shaft fractures. Wiss et al, suggested that fractures from 7.5cm below the knee and 7.5cm above the ankle, with atleast 25% of the cortical apposition, can also be treated with the enders pin[12].

In 1970s, Grosse and Kempf and Klemm and Schellmann developed nails with interlocking screws, which expanded the indications for the nailing to include proximal, distal and unstable fractures[12].

This is the most accepted surgical modality of the treatment today. Healing is rapid with abundant callus. These are load sharing devices, fixation is along the mechanical axis, hence induced osteopenia is not encountered. Kuntscher's V nail, Ender's nail, Rush nail were the nails most oftenly used. To get a better fit in the medullary canal, reaming is done in the tibial shaft fractures. Non reamed nails cause less damage to the medullary circulation.

In tibia nailing is done from the proximal tibial plateau into the shaft, which is far from easy due to the curve. Hence the tibia nails with various bends for easy insertion are in use. The incidence of the joint stiffness is less and the functional outcome is very good.

In the closed nailing the fracture haematoma is not disturbed and has an advantage over open nailing in early rate of fracture healing with low rate of infection and less soft tissue damage. But closed nailing is technically demanding. The advent of the C-arm have made the nailing of the tibia fractures a routine procedure.

Yaligod et al found that use of multiple distal locking screws in different planes in the fixation of the fractures of distal tibia with intramedullary interlocking nail gives stable fixation for early mobilization, ambulation and can minimize the complications. Impacting the unreamed nail till the subchondral bone of the distal tibia enhances the stabilization and reduces the theoretical risk of damage to endosteal blood supply. Hence intramedullary nailing is a safe, feasible and simple method of stabilization of the distal tibia fractures. This method is definitely a better alternative to external fixator and plating techniques in management of open distal tibial fractures[2].

Gerhard B.G. Kuntscher(1958) opined that intramedullary nailing represent the ideal treatment of the fractures and does not require additional external support. The basic principle in this method is stable osteosynthesis through a flexible impingement of the nail in the bone[13].

Nicoll(1964) concluded the important factors affecting the union are

(1) The amount of the initial displacement
(2) The degree of comminution
(3) Infection
(4) The severity of the soft tissue injury

Nicoll also found that the presence or absence of the fibula fracture did not affect the prognosis. The intact fibula is significant only in so far as it affects the degree of the initial displacement and fracture stability[14].

Hooper et al(1991) reviewed fractures of tibia treated with conservative management and closed intramedullary nailing. The results showed that closed intramedullary nailing gives more rapid union with less malunion and shortening, less time off work, with a more predictable and rapid return to full function. Out of 62 fractures, 33 were treated conservatively and 29 were treated with the closed intramedullary nailing, time of union in the patients operated with nailing was earlier than patients treated consevatively[15].

Robinson et al(1995) showed that despite the soft tissue injury being more severe in the distal third tibial fractures than in the diaphyseal fractures, the ultimate functional outcome after the intramedullary nailing was satisfactory and the incidence of the ankle problems was also low[16].

Schmidt et al(2003) showed fixation of the distal fragment in the distal third tibia fractures is facilitated by newer nail designs that have three distal interlocking screw-holes and that have holes closer to the end of the nail. Fibular fixation does not seem to be needed to achieve fracture-healing and itself may contribute to increased morbidity. Fibular fixation is necessary if there is instability of the talus associated with a distal fibular fracture[17].

Vallier et al(2008) treated seventy-six fractures with an intramedullary nail,and thirty-seven were treated with a medial plate. Delayed union or nonunion was more common after intramedullary nailing .However, with concurrent fixation of the fibula, nonunion was more common in the intramedullary fixation group[18].

In a study conducted in Ontario, Canada showed a possible benefit of reamed intramedullary nailing in terms of decrease in secondary surgical intervention in patients with closed fractures of tibia. Delaying reoperation for nonunion for at least six months may substantially decrease the need for reoperation[19].

Mohammed et al(2008) stated that using one distal locking screw will lead to non-union and therefore recommended use of two distal locking screws in intramedullary interlocking nail fixation of distal third tibia fractures[20].

Tyllianakis et al(2009) stated that intramedullary interlocking nailing is a reliable method of treatment of the fractures of the distal tibia provided there is at least a 3cm distal fragment with no intra-articular incongruity and concomitant malleolar fractures are to be anatomically reduced and fixed. Appropriate insertion of the nail in the distal part of the tibia is helpful for the axial restoration and satisfactory functional outcome[21].

Horn J et al(2009) showed that intramedullary nails with an angular stable locking option showed higher stiffness values and lesser fracture gap angulation under uni-axial static load compared to a intramedullary nails with a conventional locking option in a distal tibia fracture model. It is assumed that a higher stability is favourable for the fracture healing process although there is still some uncertainty about the optimal mechanical environment for fracture healing[22].

Ajay Krishnan et al(2009) showed that concurrent intramedullary nailing of distal tibia fractures and plate osteosynthesis of fibula is effective in preventing malalignment. Plate osteosynthesis for the fibula provides additional stability even when a single distal locking bolt is used to fix the intramedullary nail to the tibia[23].

Ruecker AH et al(2009)stated that intramedullary nailing of distal tibial fractures is a reliable method of fixation, possessing the advantages of closed reduction and fracture stabilization of an area with a delicate soft tissue situation[24].

Labronici et al(2009) showed that fractures treated with fibular fixation associated to tibial fractures treated with intramedullary nail helped to re-establish length and alignment[25].

Bonnevialle et al(2010) have demonstrated that fixation of the fibula was useful to increase the stability of the tibial fixation. It confirms the value of double surgical fixation as a complement to stability but also as assistance to reduction when the external fixation or nailing is indicated. The fibula fixated first restores the length to the leg bones and a certain degree of frontal sagittal reduction. If both tibia and fibula fractures having rotational instability are fixed, the fibular osteosynthesis first reduces any horizontal displacement of tibia. He unreservedly proposed nailing for distal tibial fractures 2 - 3 cm above the subchondral bone [26].

Guo et al(2007)showed that both a closed IMN and LCP with MIPPO can be used safely to treat distal metaphyseal fractures of the tibia. Closed nailing has the advantage of shortened operating time, reduced exposure to radiation and ease of removal of hardware. Hence adopted closed intramedullary nailing as preferred method of treating these fractures[27].

Ehlinger et al(2010) conducted study on IMIL nailing on 51 patients with distal third fractures alone and showed that IMIL nailing of the distal metaphyseal fractures of the tibia provide highly beneficial results and reported a high rate of bone union, a low number of complications like infections and good quality functional recuperation. But the radiological results showed 14 cases of angular and rotational malunion and 1 case of shortening of 1cm. He also recommended that fibula fixation can be done to to control the length and rotation[28].

Hanu et al(2011) showed, that implantation of a recombinant human bone morphogenetic protein-2 (rhBMP-2)-impregnated collagen sponge at the fracture site resulted in a markedly lower rate of non-union at the distal third tibia fractures[29].

Theriault et al(2012) showed that adult patients who have $>10^0$ of tibial malrotation following locked intramedullary nailing for the treatment of an isolated tibial diaphyseal fracture have similar functional outcomes when compared with patients who have symmetric tibial rotation and there is no significant intermediate functional outcome[30].

Isk et al(2012)showed that if distal metaphyseal tibial fractures are reduced in an acceptable position and static locking is performed by placing at least 2 screws both distal and proximal to the fracture during intramedullary nailing, angulations that may develop during that period until union remain within the accepted reduction criteria, even if Poller screws, plate fixation of the fibula, or casting after nailing are not used[31].

Salem KH(2013) stated that biomechanical nature of the distal tibia and its limited soft tissue coverage that makes open fixation modalities risky, undreamed nailing may offer a treatment alternative in terms of closed reduction and biological fixation with a low risk of wound problems in high-energy fractures and with a high rate of bone healing[32].

Sengodan et al(2014) found that in interlocking nailing of distal third tibial fractures, supplemented with blocking screw, level of fibula fracture did not influence the stability or the functional outcome. There is no need for excessive soft tissue dissection or additional hardware like unicortical plating or fibular plating. There is no significant increase in radiation exposure for applying blocking screws[33].

Natarajan et al(2014) demonstrated that plate osteosynthesis by minimally invasive technique and Intramedullary interlocking nailing are equally effective methods of stabilisation of distal tibia fracture when considering the rate of union and final functional outcome. None of the patients suffered from the loss of reduction in the study conducted, demonstrating that it is not necessary to fix the fibula in the fractures of distal tibial metaphysis. However in recent times, plate fixations by MIPPO technique for distal tibia fractures showed minimal incidence of wound gaping and implant failure[34].

Attal R et al(2014) found that an multidirectional locking nail with four locking options in three planes is significantly more stable than conventional nails that facilitate locking in two planes, and additional fibular plating does not increase stiffness. If fibular plating is not required to restore length and aid reduction of the fracture, soft-tissue damage and the potential complications of bone healing associated with this additional fixation can be avoided[35].

Vaza et al(2014) showed that union time was shorter with IMN compared to plate and screw method. Locked intramedullary nailing has an advantage in restoration of ankle motion and reduced wound problems. Better alignment can be achieved with the use of locked intramedullary nails by careful attention to the technique of central guide wire placement and avoiding eccentric reaming. Use of blocking screws improves alignment and strength of bone implant construct. Simple intra-articular extension is not contraindication to locked Intramedullary nailing. Intramedullary nail being load sharing device, comparatively early mobilization can be started. Functional ankle scores were higher in nailing group compared to plating group[36].

Gadegone et al(2015) showed that interlocking nail provides sufficient stability by three-point fixation at either ends and also in the diaphysis by its bony contact. The minimal surgical trauma and flexible fixation allow prompt healing when the blood supply to bone is maintained. The mechanically incompetent and biologically viable fragments heal around the nail to promote union and early recovery and hence concluded that Intramedullary nailing is a safe and effective technique for the treatment of distal metaphyseal tibial fractures[37].

Nandakumar(2015) showed that IMN is an efficacious method of treatment for distal tibial fractures provided that there is no intra-articular fracture and incongruity. Good surgical technique, close insertion of the nail, proper alignment, use of two distal screws, and early weight bearing will achieve axial restoration, satisfactory functional outcome, high rate of union, and low incidence of complications[38].

Sharma et al(2015) conducted a study on the outcome of the fractures of the distal tibia fixed with the interlocking intramedullary nail in 17 patients between January 2012 to June 2014 and showed that, all fractures united within the study period with a mean time of union 21.76 weeks, 6 patients had a mean angulation of 2.75 degrees in coronal plane and 3.5 degrees (2-8 degrees) on the sagittal plane and with no rotational malalignment. None of the patients developed angulation outside the acceptable range and had excellent functional outcome. Hence intramedullary interlocking nailing with two distal locking bolts in case of distal third tibia fracture leads to good to excellent functional outcome and good rate of union[39].

Hattarki et al(2016) showed that intramedullary nail being load sharing device, comparatively early mobilization can be started, where as prolonged duration of protected weight bearing was required in patients treated with locked plate and screws. Functional ankle scores were higher in nailing group compared to plating group. Additional procedures required to achieve union were higher in locked plates.

Anterior knee pain is noted only with intramedullary nailing technique and no knee complications were noted with plating group[40].

Phadke et al(2016) showed that intramedullary nailing is an effective alternative for the treatment of distal metaphyseal tibial fractures. A proper patient selection, adjuvant fixation of fibula and use of atleast two distal interlocking screws is suggested for better outcome[41].

Bihani et al(2016) showed that high-energy dia-metaphyseal fractures Gustilo I, II, IIIA & B in the lower 1/3rd of tibia can be managed effectively by intramedullary cannulated distal tibial nail with high percentage of good to excellent results and with low complication rates, although it is more technically demanding than nailing diaphyseal tibial fractures. Fracture of lower 1/3rd of the fibula should only be fixed if there is a syndesmotic instability[42].

Agathangelidis et al(2016) mentioned that recently introduced tibial intramedullary nails allow a number of distal screws to be used to reduce the incidence of malalignment and loss of fixation of distal metaphyseal fractures. In this study he showed that, when using the expert tibial nail for unstable distal tibial fractures, the classic configuration of 2 parallel distal screws could provide the necessary stability under partial weight-bearing conditions and study results showed that 2 parallel mediolateral screws provide comparable stability to more complicated locking options. In the clinical setting, this may suggest that it is not necessary to lock a nail with 3 or 4 distal screws, thus avoiding radiation exposure, extra cost, and prolonged operative time[43].

SURGICAL ANATOMY

The anatomy of the leg makes tibia susceptible to fractures. The entire medial border is subcutaneous and is covered by skin and subcutaneous tissue.

SHAFT OF THE TIBIA

The shaft of tibia is a long tube of heavy bone, which is abruptly broadened at its upper end to support the condyles and is moderately expanded at its lower end to rest on the talus. The extremities are cancellous in structure and the cortex is thin but the main portion of the shaft is composed of thick compact bone. In the upper portion the shaft is triangular in cross section and in the lower it becomes more rounded or roughly quadrilateral on cross section and is considerably narrowed. The lower third of shaft of tibia is the weakest portion in the shaft and here is majority of the fractures occur.

The shaft of the tibia has three borders and three surfaces. The anterior border or the crest is sharp in its upper two third and is subcutaneous throughout its length. The medial border is more rounded and can be palpated throughout its length. The lateral border is sharp for the attachment of the interosseous membrane. It is covered by the muscles and cannot be palpated. The medial surface is subcutaneous throughout its length. The posterior and the lateral surfaces are covered by the muscles, where as the anterior, medial surfaces and medial borders are more subcutaneous and more prone for the open injuries.

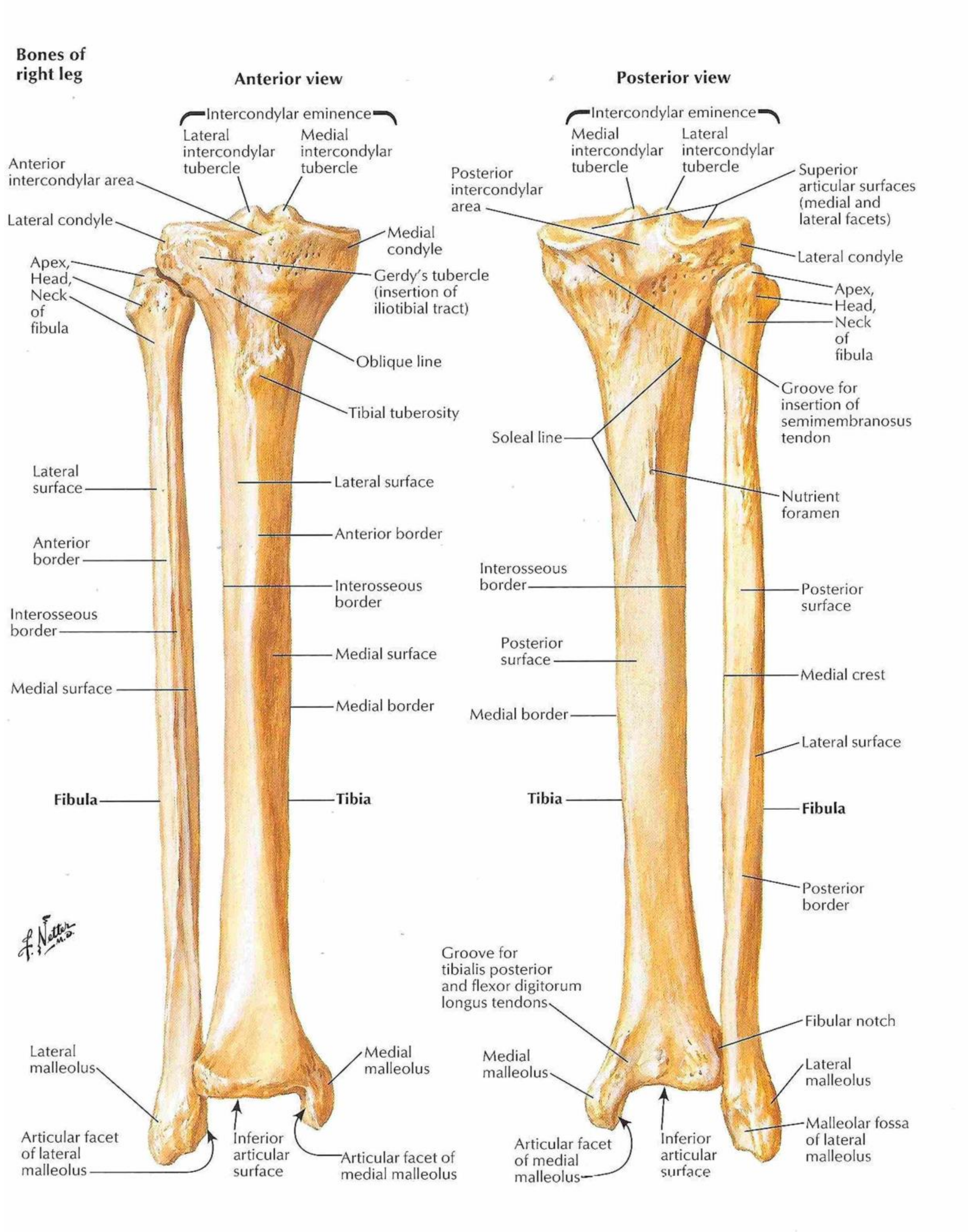


Fig 1 : Lower limb- Bones of the leg

MUSCLES OF THE LEG

Tibia is surrounded by muscular envelope which are divided into four compartments by the deep fascia of the leg.

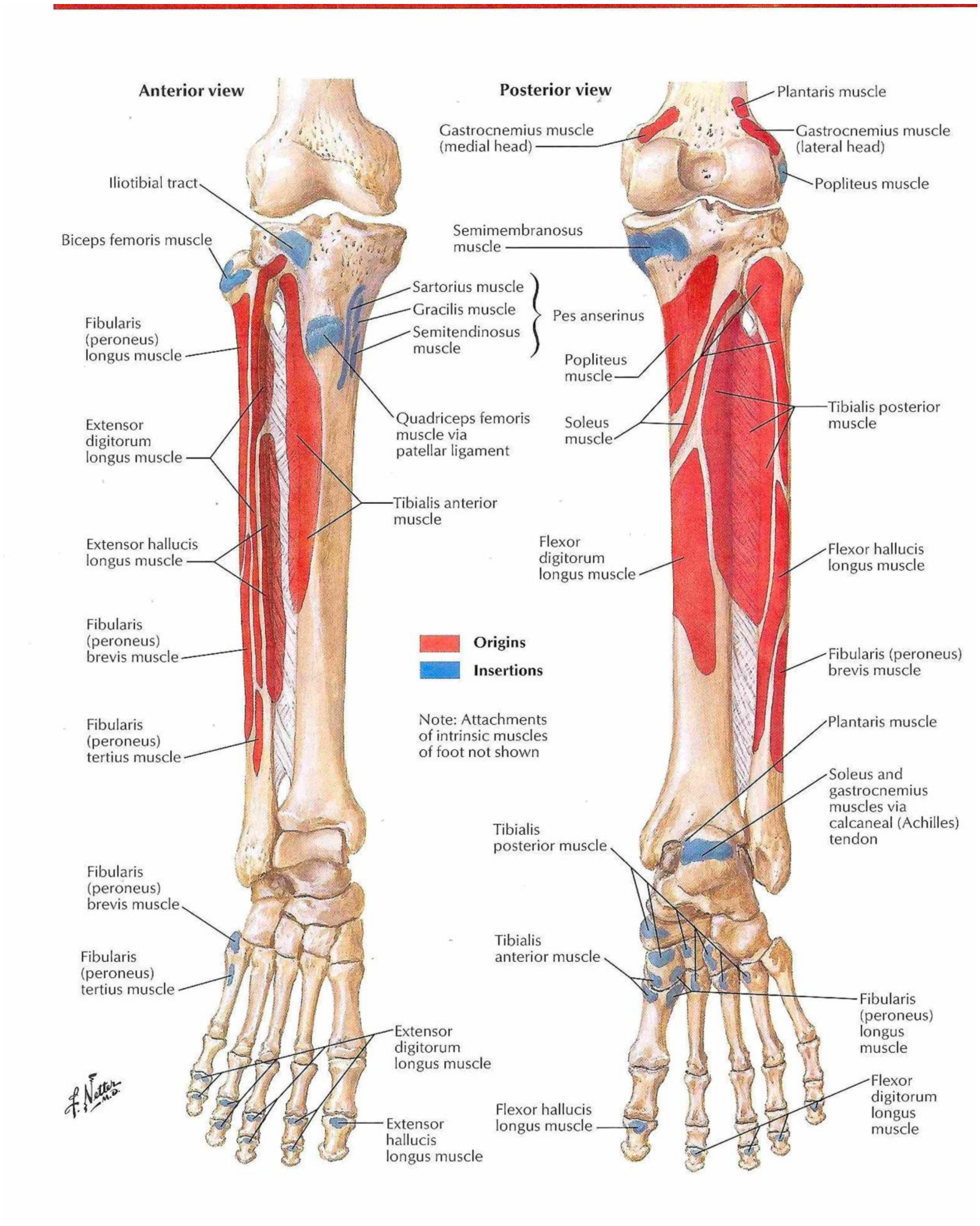


Fig 2 : Muscles of the leg

ANTERIOR COMPARTMENT

The four muscles of the anterior compartment of the leg are tibialis anterior, extensor hallucis longus, extensor digitorum longus and peroneus tertius. Anterior compartment also contains anterior tibial artery and deep peroneal nerve. They are enclosed in a relatively unyielding compartment made up of tibia medially, fibula laterally, interosseous membrane posteriorly and tough anterior investing fascia. Both artery and nerve pass deep to the muscles proximally and become superficial near the ankle.

Due to the tough fascia of the anterior compartment increased tissue pressure may lead to anterior compartment syndrome.

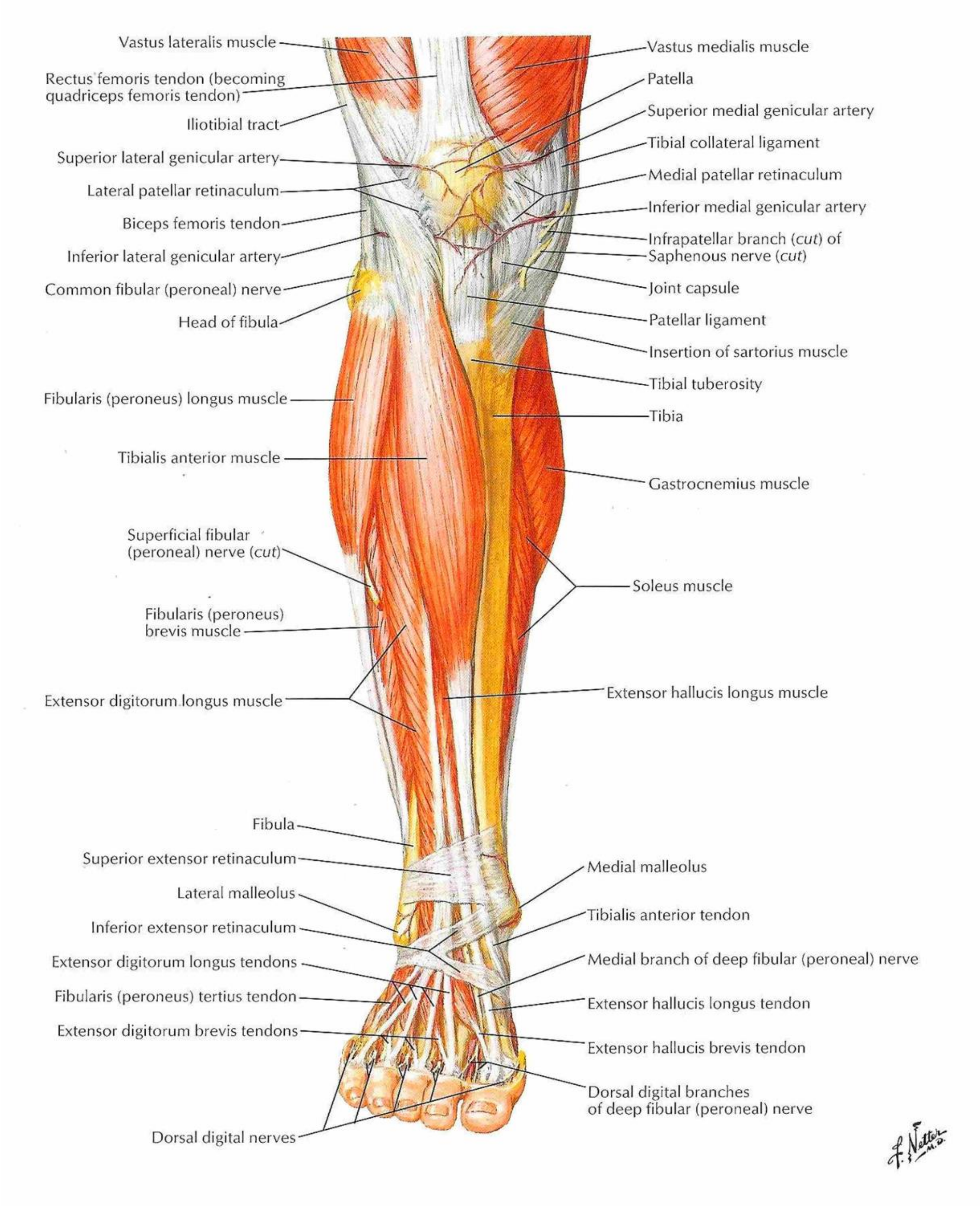


Fig 3 : Anterior compartment of the leg

LATERAL COMPARTMENT

The peroneus longus and peroneus brevis muscles are present in the lateral compartment of the leg. They protect whole of the fibula shaft except near the ankle, so only isolated fractures of fibula are uncommon owing to direct trauma. The superficial peroneal nerve lies in between the peronei and the extensor digitorum longus muscles and is rarely involved in fractures of the fibular shaft, although it is at risk for the fractures of the neck of the fibula.

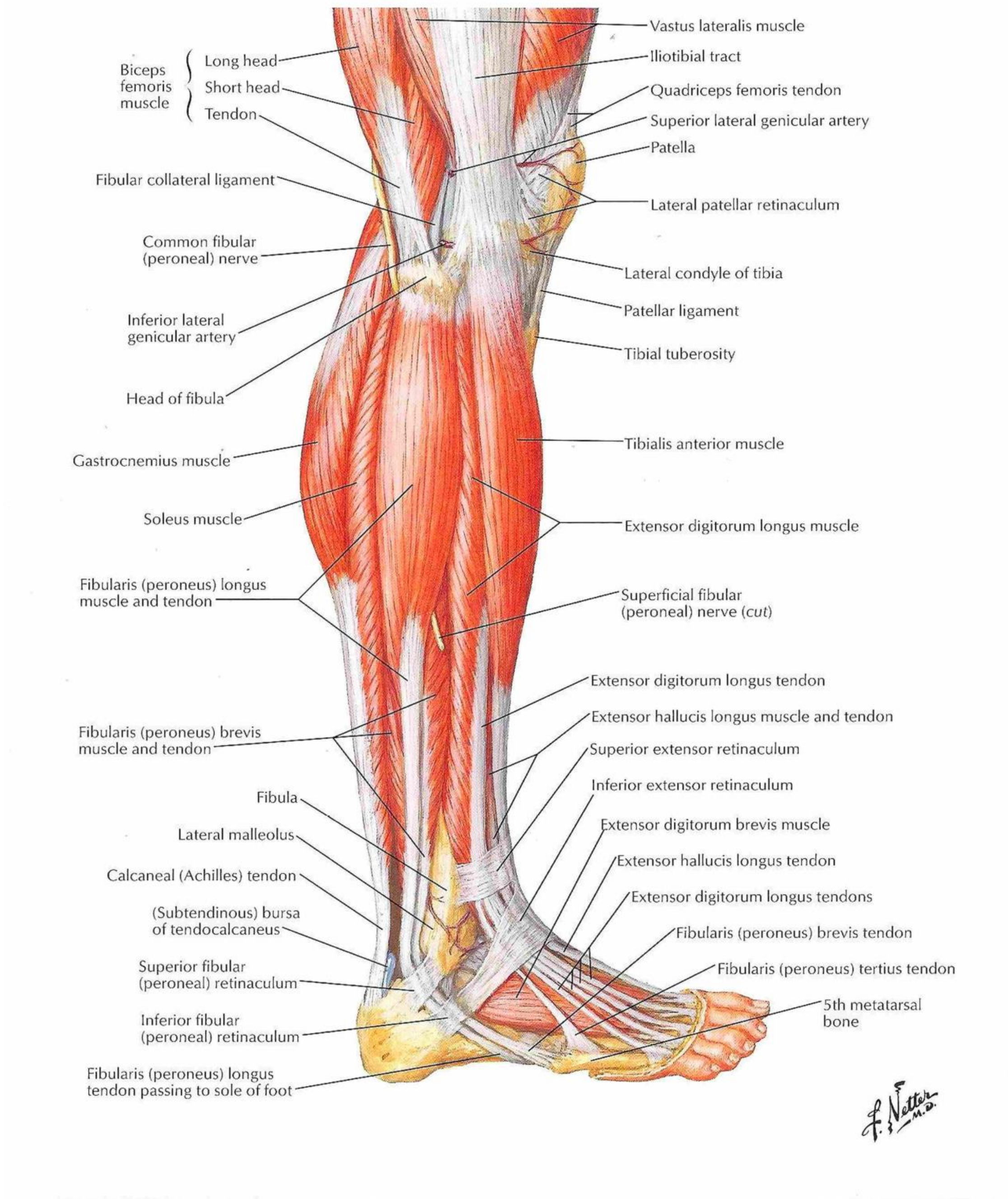


Fig 4 : Lateral compartment of the leg

POSTERIOR COMPARTMENT

The muscles of the posterior compartment of the leg are gastrocnemius, plantaris, soleus of the superficial layer and tibialis posterior, flexor hallucis longus, flexor digitorum longus and popliteus. The posterior tibial artery and posterior tibial nerve lie in the posterior compartment of the leg and are well protected by the muscles of the posterior compartment of the leg. As the posterior compartment is elastic and large the symptoms of the posterior compartment syndrome are less prominent.

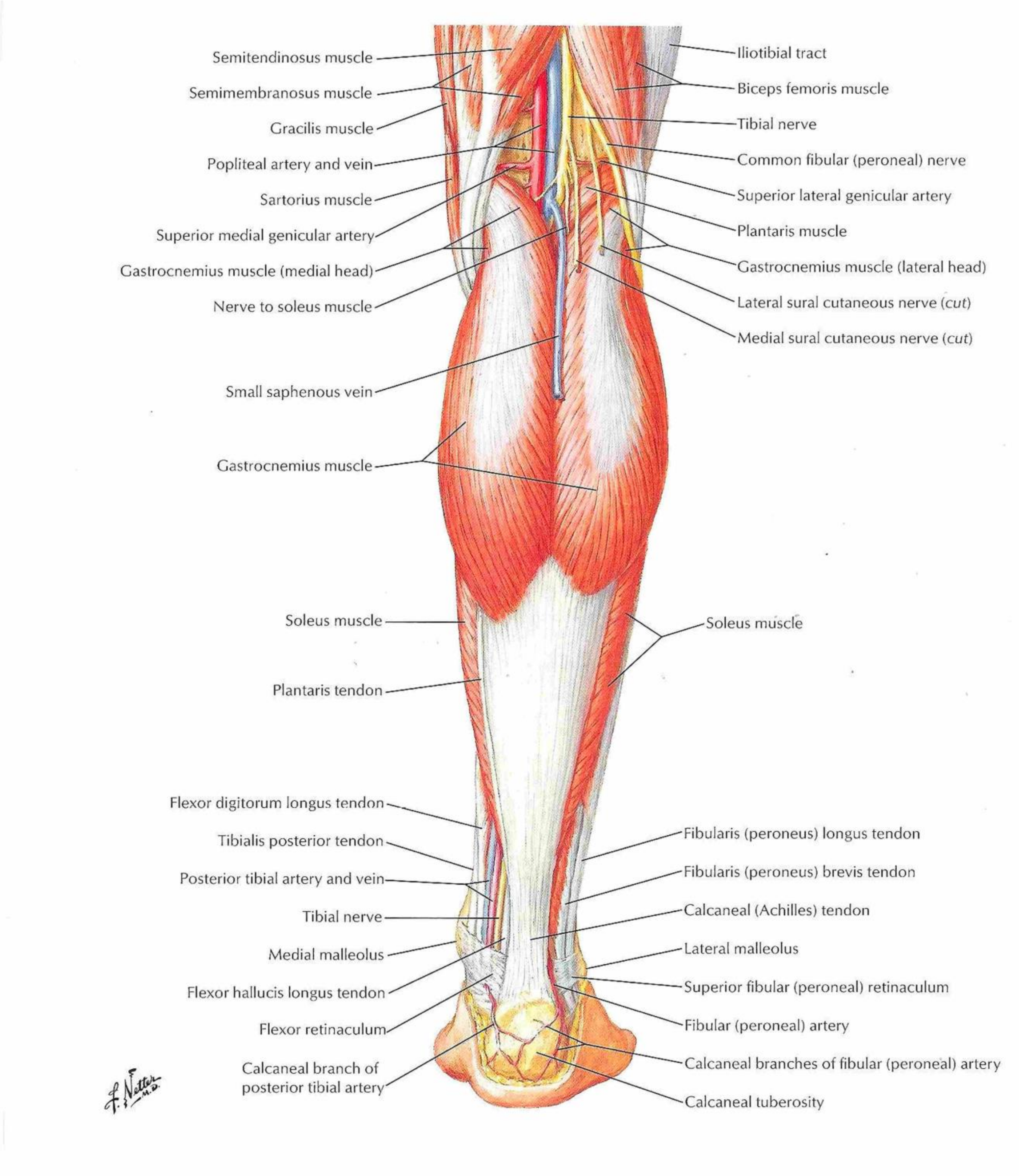


Fig 5 : Superficial posterior compartment of the leg

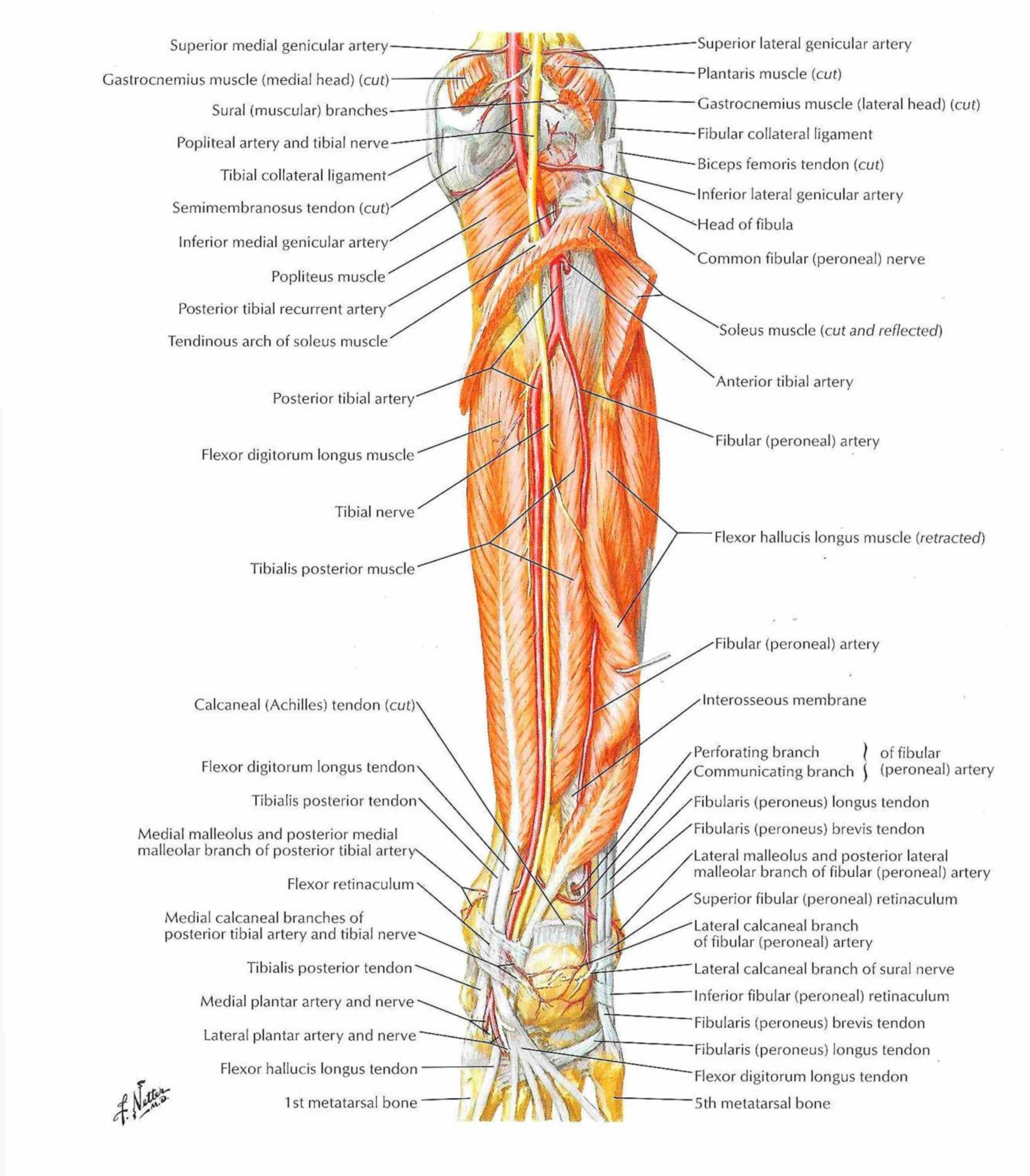


Fig 6 : Deep posterior compartment of the leg

BLOOD SUPPLY OF TIBIA

The anterior tibial artery, posterior tibial artery and the peroneal arteries are the main blood vessels of the leg. The anterior tibial artery is one of the terminal branch of the popliteal artery and passes forward through the opening in the interosseous membrane to reach the anterior compartment of the leg, where it passes downwards on the interosseous membrane to terminate as the dorsalis pedis artery. The posterior tibial artery is the continuation of the popliteal artery. It passes through the space between the deep flexor muscles and calf muscles to terminate in the plantar arteries. The peroneal artery passes downwards in close relation to the posterior surface of the tibia. The blood supply of the tibia like all other bones is endosteal and periosteal. The periosteal blood supplies the outer one third of the cortex and endosteal supplies inner two thirds of the cortex.

The periosteal blood supply is from the surrounding musculature while the endosteal blood supply is from the nutrient artery which is a branch of the posterior tibial artery. Usually the blood is centrifugal , but in case of a fracture the endosteal blood supply is damaged and blood flow is reversed and centripetal from centrifugal. When the intramedullary nailing is done the endosteal blood supply is interrupted so the soft tissue attachment is to be preserved , so only closed intramedullary nailing is preferred.

Nutrient artery divides into three ascending branches which supply the proximal two third of the tibia and give a smaller descending branch to the distal one third of the tibia. Hence proximal tibia has got endosteal blood supply while the distal one third has poor blood supply. This differential pattern of the blood supply makes the tibia susceptible to the atrophic non-union at the junction of the distal and middle one third of the tibia.

INTEROSSEOUS MEMBRANE

This is a sheet of fibrous tissue, which encloses the space between the tibia and fibula except at its upper end for the passage for the anterior tibial vesssels. During the fractures it prevents the separation of tibia and fibula unless it is torn. Since majority of its fibres are running downwards and outwards, interosseous membrane help to distribute the force acting on the tibia to the fibula.

ROLE OF FIBULA

When the fibula is intact the fracture is stable. It acts as internal splint and maintains the length of tibia in comminuted fractures of tibia with bone loss.

MECHANISM OF INJURY

Direct injury

The main causes of injury are falls, sports injuries, road traffic accidents, direct blows and gunshot injuries.

The highest incidence is seen in the road traffic accidents usually affecting the motor cyclists, pedestrians and automobile occupants.

The falls include the fall from height, fall from stairs or slopes and fall on the patients height.

AXIAL LOADING INJURIES

Bone is viscoelastic, the rate of load shifts the strain curve. Rapid axial loading shifts, absorbs and at the failure releases more energy. The released energy is imparted to the soft tissue. Part or the entire articular surface may be involved. The injury may be confined to the epiphyseal area just above the joint, it may involve the epiphysis and metaphysic or it may have n extension into the diaphysis. The direction of the force and position of the foot when it is applied will lead to the variation in the fracture pattern.

CLASSIFICATION OF FRACTURES

To minimise the complications and optimize the outcome, the surgeon must accurately match the treatment techniques with the fracture types and soft tissue injury pattern, for this the fractures are classified and the group in to which it falls should give a guide risk of complications during the treatment, so that the management will be designed so that they will optimize the outcome and minimize the complications.

For many years, surgeons have formally classified the fracture patterns of the distal tibia. More recently the investigators have attempted to classify the soft tissue injury. Unfortunately the fracture classification in current use have shown to have poor observer reliability and reproducibility. This problem gave a poor indication of the risk of complications occurring and prognosis.

Formal classification in current use

Two classifications are currently used and are part of the literature. Rudei and Allgower's classification was the first in common use

1. Non displaced large fracture of the joint
2. Displaced but minimally comminuted fracture
3. Highly comminuted and displaced fracture

The Rudei and Allgower's classification may have prognostic significance because the incidence of complications and the outcomes have been to be different for Rudei type I nad II fractures when compared with the most comminuted type III fractures. This suprising finding may be partially caused by poor observer reliability using the classification.

The Rudei and Allgower's classification system has largely been supplemented by the AO/OTA classification system and this is now universally used for the fractures of the distal third of tibia. In this system, distal tibia fractures are divided into the following categories

Type A : Non articular fractures

Type B : Partially articuular fractures

Type C : Total articular fractures

Each category is divided into three groups based on the amount comminution. These groups are further divided into three subgroups by other characteristics of the fracture such as direction, location of the fracture line, the presence or absence of the asymmetrical metaphyseal impaction and the location and amount of comminution.

There are 27 subgroups in all, a large and difficult to manage.

Distal tibia fractures AO classification

Type A	Extra articular
Groups	A1 Metaphyseal simple fracture
	A2 Metaphyseal wedge fracture
Subgroups	A2.1 Metaphyseal wedge with posterolateral impaction
	A2.2 Wedge fragment is located anteromedially
	A2.3 Wedge fragment extends into diaphysis
	A3 Metaphyseal complex
subgroups	A3.1 Fractures have three intermediate fragments
	A3.2 Fractures have more than three intermediate fragments
	A3.3 Fractures extend into the diaphysis

PARTIAL ARTICULAR

Type B1 Pure split

Subgroups B1.1 Pure split in frontal plane

B1.2 Pure split in sagittal plane

B1.3 Pure split fracture is metaphyseal multifragmentary

Type B2 Split depression

Subgroups B2.1 Split depression in frontal plane

B2.2 Split depression in sagittal plane

B2.3 Depression of central fragment within articular splits

Type B3 Multifragmentary depression

Subgroups B3.1 Fractures are anterior and is frontal plane

B3.2 Fractures are sagitally oriented

B3.3Multifragmentary impaction and metaphyseal extension

COMPLETE ARTICULAR

Type C1	Articular simple
Subgroups	C1.1 Two large split articular fragments
	C1.2 Additional epiphyseal depression
	C1.3 Fractures extend into the diaphysis
Type C2	Articular simple, metaphyseal multifragmentary
Subgroups	C2.1 Asymmetric impaction and tilting of articular surface present
	C2.2 No asymmetric impaction
	C2.3 Plafond is impacted and fracture extends to diaphysis
Type C3	Articular multifragmentary
Subgroups	C3.1 Multiple fracture lines in articular surface
	C3.2 Multifragmentary involvement of plafond and metaphysis
	C3.3 Multifragmentary fracture extends from the articular surface to the diaphysis

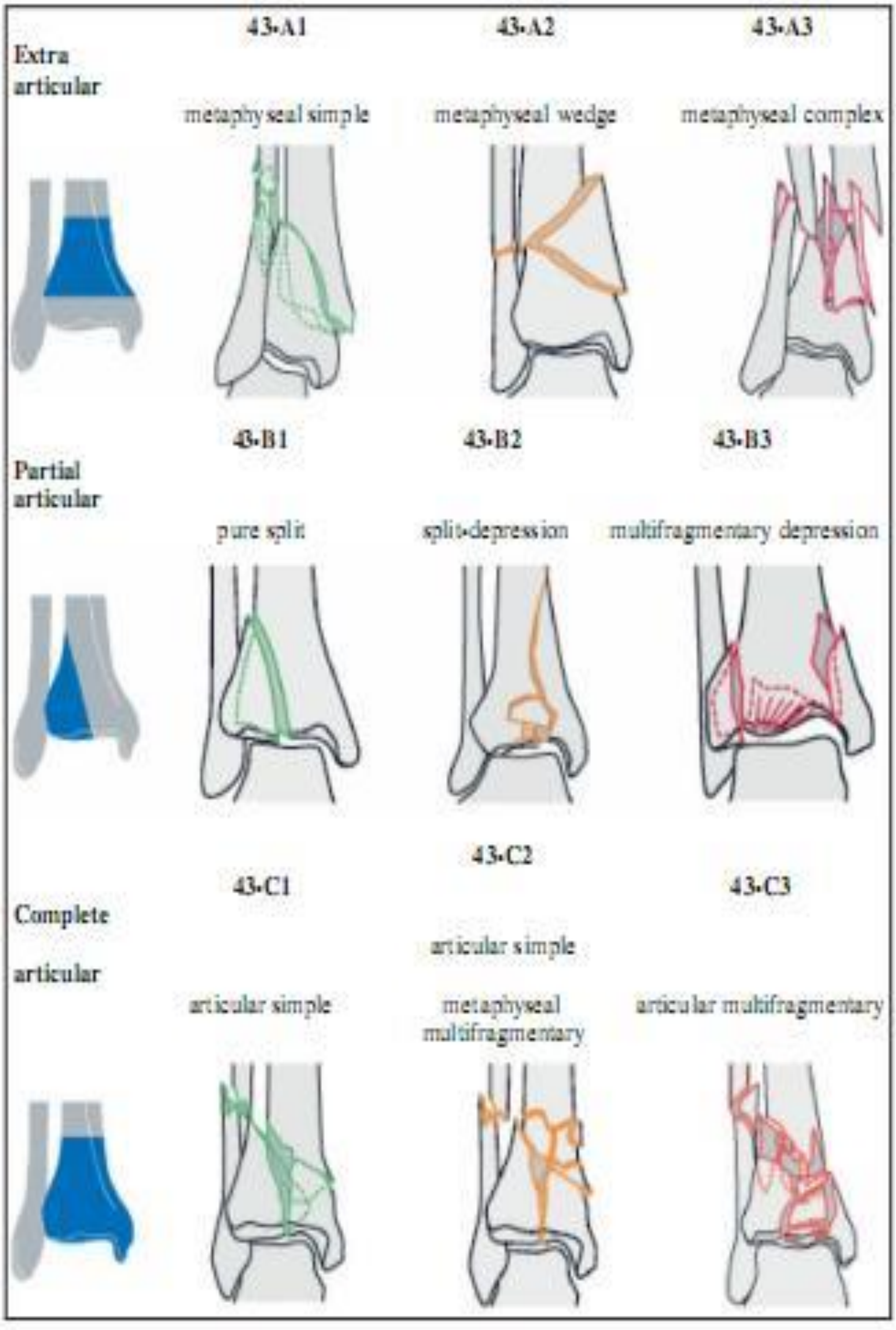


Figure 1. AO classification system, type 43 – distal tibial fractures.

Fig 7 : AO classification of distal tibia fractures

CLASSIFICATION OF OPEN FRACTURES

Gustilo and Anderson in 1976 described their treatment of 1025 open fractures with application of a grading system that provided prognostic information about the outcome of the infected fractures. In 1984 this system was updated and is currently in use. The modified classification is based on the size of the wound, level of contamination, soft tissue injury, bone injury and the vascularity.

Type I : Clean skin opening of <1 cm usually a poke hole, usually from inside to outside, minimal muscle contusion, low energy simple spiral or short oblique fracture.

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

Type III : Extensive soft tissue damage, including the muscles, skin and neurovascular structures, often a high energy injury with a severe crushing component

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

Type IIIB : Extensive soft tissue injury with periosteal stripping and bone exposure requiring soft tissue flap closure and is usually associated with severe contaminate on

Type IIIC : Vascular injury requiring repair.

BIOMECHANICS OF THE INTRAMEDULLARY INTERLOCKING NAILS

All the intramedullary nails, regardless of their types act as the flexible intramedullary splints providing stability of the fracture segments within.

It is a load sharing device in which the stress shielding is minimal due to the fact that, it is situated close to the neutral axis of the bone where the strain is minimal. The strain induced now is considered the most important factor in the later stages of the fracture callus remodelling.

Intramedullary nails in addition to the three point fixation and elastic impingement provide the stability, anchorage of the bone proximal and distal to the fracture site by the interlocking screws. The mechanical behaviour of the intramedullary nails depends upon the material, width, curvature, locking capacity, configuration and the geometry of the design.

Curvature of the tibial nail is designed to accomodate the insertion portals offset from the centre of the intramedullary nail

MATERIALS

Include 316L steel, titanium, aluminium, vanadium and titanium aluminium niobium alloys. Recently the bio-absorbable nails have been introduced but are not cost effective. Except in the nails of small diameter used without reaming the material property is less significant in terms of fracture healing, nail diameter and wall thickness and the biological viability of the bone. The smaller diameter nails should be made of the alloys that have a superior fatigue strength

Cross sectional geometry

Intramedullary nail can be solid or hollow, open or closed sectional cylindrical, rectangular or diamond configured. The wall thickness in a hollow intramedullary nail may be variable to the alter the strength and stiffness. Hollow nails are ideal after the canal preparation by reaming and inserted over by a guide wire

Solid nails are useful for the placement without the canal preparation by reaming. Abolishing the open slot in the cross section increases the rotational stiffness. Bending strength and stiffness in torsion can be increased by using a unslotted thick nail with a large diameter

LOCKING CAPACITY AND CONFIGURATION

Cross locking is done at both ends, so that the screws can be placed through the nail and bone above and below the fracture for additional stabilization.

The closer to the end of the nail that the screws are located, the more distal fractures can be treated with the device. Two to three screws are used in the distal locking of the nails

The ASIF tibial nails has the possibility of one of its three distal screws being oriented 90 to the other two, extending the indication to include more distal fractures. Dynamic fixation allows near full axial load transfer by the bone, at the same time it controls the bending and rotational deformity. Dynamic locking is done in the non unions and the stable fractures. Static fixation controls the rotation, bending and causes axial loading and makes the implant load bearing, with the potential for the fatigue failure. Static locking is useful in the comminuted and the segmental fractures

Dynamization is the conversion of the statically locked nail into the dynamic mode by the removal of the less critical transverse screw. This done in case of the delayed usually at the end of the 6 weeks. It increases the fatigue life of the nail.

We have to balance between the fracture stability biological effect and clinical practicality in the fracture fixation. The rigidity and the stiffness of the cylindrical structure in bending and rotational is proportional to the fourth power of the radius and the quality of the material. As the diameter of the nail increases the bending stiffness increases.1mm increase in the diameter increases the by 30 to 45% and the bending strength is doubled by a 25% increase in the diameter of the nail.

Working length of the nail is the unsupported segment of the nail. Short working length improves the nail rigidity in bending and torsion.

Gripping strength is the resistance to the slipping of the bone implant interface and is essential for the transmission of the torque between the fracture fragments. Grip can be increased by the cortical reaming to increase the length of the cortical contact. Interlocking nails optimize the grip by rigidly affixing the nail to the bone with screws

MATERIAL PROPERTIES

When the load is applied to the device, it deforms. This deformation is termed as elastic, when the when the device returns to its original shape as the load is removed.

The plastic deformation of an IMIL nail, is the strain of the metal exceeding the elastic limit. The amount of bending tolerated without plastic deformation is smaller in the larger diameter nails compared to the smaller nails.

At some point, the fixation becomes overloaded and enters the plastic range. If the load is released after entering the plastic range, some amount of the deformity persists. The point where the deformity begins is known as the yield point.

The material properties are defined geometrically in the stress-strain curve. The stress is defined as the load per unit area and the strain is the change in the length divided by the original length.

Titanium nails are 1.6 times stiffer and the elastic modulus is 50% lower than steel nail. Titanium alloy has a modulus of elasticity that approximates the cortical bone.
The elastic modulus(Young's modulus)is found by dividing the stress applied to a material by the resulting strain

Stress strain curve :

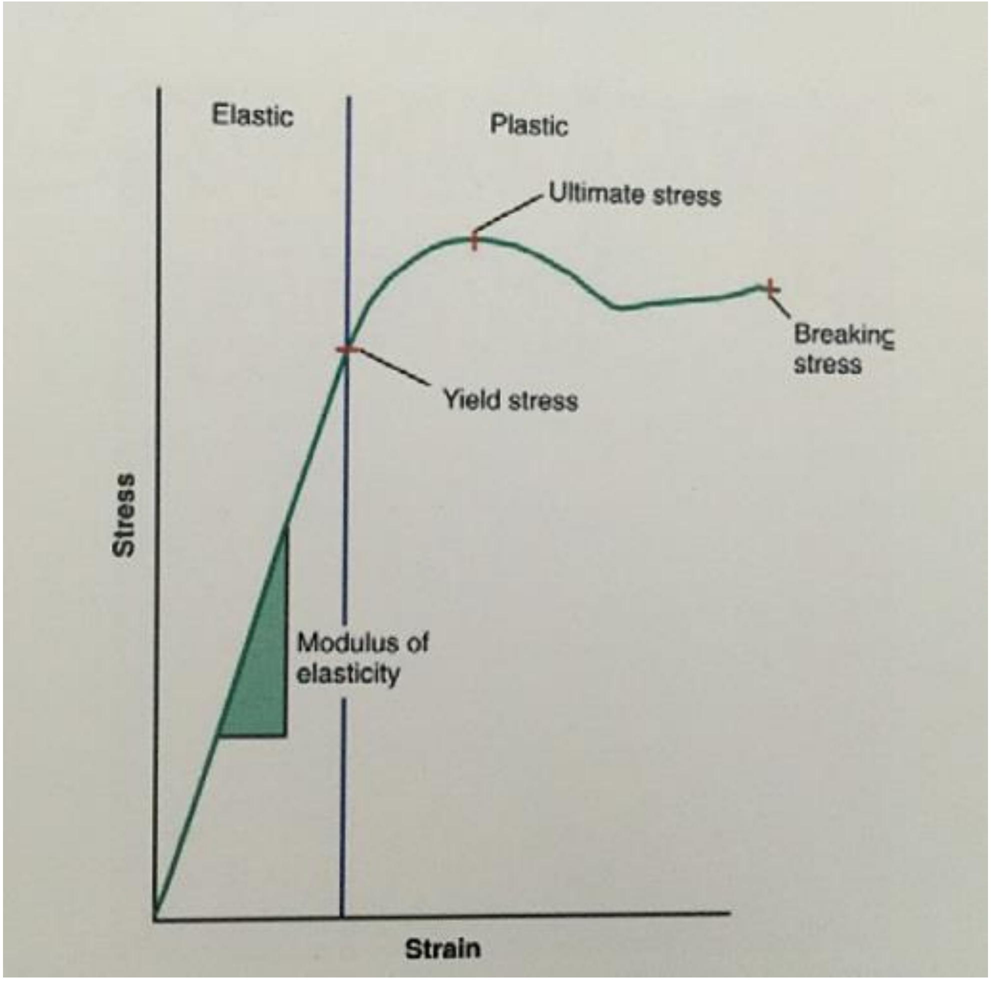


Fig 8 : Stress strain curve

The slope of this curve is called the "Modulus of the Elasticity"(Young's modulus). It is the constant proportionality between the stress and the strain. It is a material property. Ex :A material with high modulus is stiff ; for high stress little strain is produced. The modulus of the titanium is about one half of the stiffness of stainless steel.

When an implant is loaded to failure, the resulting load deflection curve would show the structural properties of the implant.

Load deflection curve

The shape of the curve is divided into

Elastic phase

Plastic phase

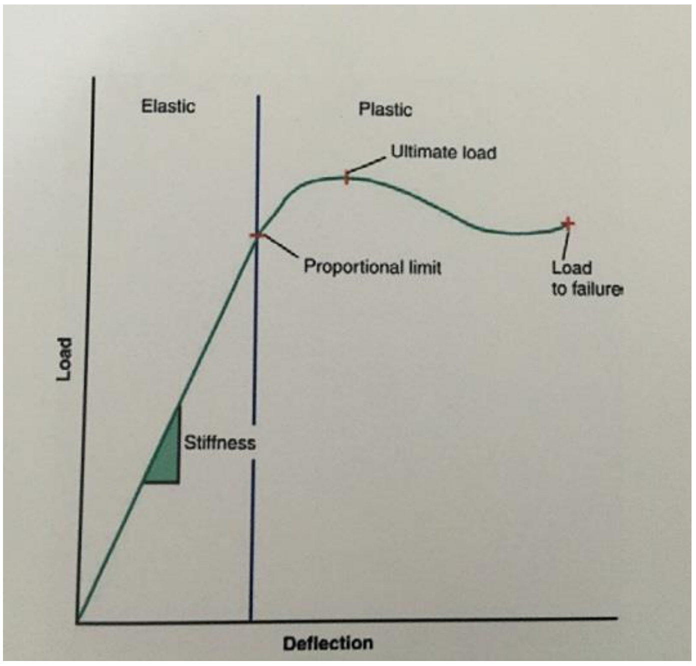


Fig 9 : Load deflection curve

The elastic phase is the working area of the medullary implant. Part of the elastic portion is the stiffness of the object. The higher the stiffness, the more rigid the object. As the stiffness decreases the object becomes more flexible . An object will return to its original shape following the load removal. Once the load exceeds the proportional limit, a plastic deformation takes place and shape of the object changes. Hence, the implant should not be loaded beyond its proportional limits.

Advantages of the Intramedullary Interlocking Nailing

- It is a load sharing mechanism
- Healing occurs biologically
- Fracture haematoma is preserved
- Periosteal vascular damage is minimal
- Provided method of treatment in nonunion and delayed union
- Effective in open fractures open type I and II
- Even in grade IIIA fractures it can be used (initially treated with external fixator and later secondarily it can be changed to the intramedullary interlocking nailing)
- Additional bone grafting is not needed
- Stability and strength is well maintained
- Rotational instability is controlled by the locking screws
- Joint motion is preserved
- Early mobilization and early weight bearing can be started
- No skin necrosis

Disadvantages of the Intramedullary Interlocking Nailing

- Long learning curve is present, it is technically demanding and therefore larger period of exposure and training is required
- Exposure irridation occurs by using the C arm
- It is not suitable for the intraarticular and proximal third fractures of the tibia

COMPLICATIONS OF INTRAMEDULLARY INTERLOCKING NAILING

A.DURING THE INTRAOPERATIVE PERIOD

1) Fracture comminution
2) Improper fixation
3) Vertical splitting of the tibia
4) Shock

B.DURING POSTOPERATIVE PERIOD

1) Compartment syndrome
2) Tourniquet palsy
3) Thromboembolism
4) Infection
5) Fat embolism

DURING FOLLOW UP

1)Anterior knee pain

This is the most common complication. Causes of the anterior knee pain may be due to prominent nail or heterotrophic ossification of the patellar tendon.

Keating et al reported a 57% incidence of the anterior knee pain. Court Brown reported 56.2% incidence of the anterior knee pain

2)Neurological complications

2% incidence of the sural nerve and the saphenous nerve damage can occur due to the distal cross screw insertion as noted by the Court Brown et al.

Common peroneal nerve lesion have been encountered in 19% of the cases and resolved in 80% of the cases, due to the incorrect positioning of the knee on the nailing table.

3)Hardware failure

Screw breakage is common in the unreamed nails, which use the smaller screws. Titanium has lower screw breakage rates. Broken screws may lead to the non-union.

4)Thermal necrosis

It is uncommon and is caused by the usage of the blunt reamers and the excessive use of the force. Tourniquet can be used as it prevents the heat transfer by shutting down the global blood flow to the whole limb.

5)Vascular damage

It is seen as a result of the damage of the popliteal artery in the area of the arterial trification due to the drilling.

6)Bone damage

Incorrect entry point or improper aiming of the nail may damage the bone and splinter the proximal or he distal fragments

7)Delayed union and non union

Several factors are implicated in the cause of the delayed and non-union of the tibial fractures, most of which are inherent in the nature of the velocity. High velocity injuries, open fractures with skin or bone loss and fractures with 100% displacement are more likely to go for non-union. There is increased rate of the non-union in the fractures that develop infection following open fractures. Distraction at the fracture site and an intact fibula also leads to non-union and delayed union.

8)Malunion

The important criteria for the judgement of the alignment of the tibia are the angulation in the antero-posterior and medio-lateral planes and rotational malignment. More external rotation is acceptable than the internal rotation. Internal rotation of more than 10 degrees causes gait disturbances, whereas the external rotation of about 20 degrees is acceptable and doesn't cause much gait disturbance.

9)Infection

The incidence of the infection of the wound in the patients with open fractures correlates directly with the extent of the soft tissue damage

BIOMECHANICS OF TIBIAL FRACTURE

To understand why the bone fractures, bone in some points is weakest in tension and strongest in compression

When a force creates a tensile stress in a particular region in the bone, that region can be expected to fail first resulting in crack which then progresses transversely through the outer and inner cortices, resulting in the transverse fracture. Compressive load causes failure of the cortical bone by shear. Oblique fracture is a combination of both compression and bending forces.

Torsional fractures are low energy fractures that have a good prognosis. Comminuted and short oblique fractures are high energy fractures that have a poor prognosis. The basic forces are compression, bending, transverse loading and torsion. They cause the bone to deform. Compressive forces results in shortening of the bone, while tension elongates it and torsion cause rotation of the bone about its long axis.

BIOLOGY OF FRACTURE HEALING WITH INTRAMEDULLARY NAIL

Intramedullary nail follows the process of natural bone healing, since the fracture haematoma is preserved. Here the initial bridging callus, is seen to form abundantly unlike in a plate fixation and the union will be rapid.

The periosteal activity is increased and adds to external callus formation in a reamed nail, secondary to slight suppression in the intial medullary flow, which subsequently improves. Fracture healing proceeds mainly by the formation of the periosteal callus.

By a stable fixation which provides angular and rotational stability it helps in the differentiation of the osteoid tissue and resorptive activity of the osteoclasts take over, osteoblasts then appear and concentric new bone is laid and remodelling occurs. The locked intramedullary nail provides early fracture stability, which improves vascularisation that is vital for the fracture healing. Preservation of the periosteum also helps in the fracture healing process.

METHODOLGY

SOURCE OF DATA

The present study was undertaken at the department of orthopaedics R. L. J hospital attached to Sri Devaraj Urs Medical College, Tamaka, Kolar, Karnataka.

30 patients who had lower third tibial fractures, treated with closed reduction and intramedullary interlocking nailing of tibia from November 2014 to April 2016 were included in this study.this prospective study was done over a period of 11/2 years with regular follow ups.

METHOD OF COLLECTION OF DATA

Sample size : 30 cases meeting the inclusion criteria are taken for the present study.

Sampling size : simple random sampling

All cases presenting to the casualty and outpatient, fulfilling the below mentioned criteria were taken up for the study.

INCLUSION CRITERIA:

- Patients diagnosed with fractures of lower third of tibia
- Adult more than 18 years of age
- Both open and closed type of fractures.

EXCLUSION CRITERIA

- Pathological fractures.
- Patients not fit for surgery.
- Except Gustilo Anderson type IIIB and IIIC.

On admission the general condition of the patient is assessed with regards to the head injury, shock, associated orthopaedic and systemic injuries and resuscitation measures were taken accordingly. All the patients received Inj Tetanus Toxoid, Inj diclofenac and IV antibiotics were given for the open fractures were given. A detailed clinical examination was done, including the detailed history relating to the mode of injury, age, sex occupation and medical comorbities were taken.

The injured limb initially immobilised in a Thomas Splint and later the above knee slab is applied after the X ray is done

Routine investigations were done for all the patients. All the patients were assessed clinically and radiologically to assess the injuries. X rays were taken in two planes AP view and Lateral view. Patients were operated at the earliest possible once the general condition of the patient is fine and fitness for the surgery obtained from the anaesthetist.

Preoperatively the length of the nail was measured from the tibial tuberosity to tip of the medial malleoli. Medullary canal is measured at the isthmus on the x ray for the nail diameter. Accordingly the nails with length 2cm above and below the measures length and 1mm above and below the diameter of the nail are arranged for the procedure.

PRE OPERATIVE PREPARATION

- Patients were kept nil by mouth for 6 hours prior to the surgery
- Preparation of the whole of the extremity to be operated along with preparation of the private parts and back was done.
- Written informed consent was taken.
- Inj ceftriaxone was given half-an-hour prior to the surgery
- Betadine and savlon scrub was given
- Adequate amount of blood is arranged.

SURGICAL TECHNIQUE

Patients were operated under spinal/general anaesthesia. Patient placed in the supine position over the operating radiolucent table. The injured leg is positioned hanging freely, with knee flexion of 90^0 degrees over the edge of the table for the gastro soleus to relax and to allow the traction by gravity. The uninjured leg is placed in abduction to allow the free movements of the image intensifier to take AP and lateral views of the operating leg. The table is then adjusted to comfortable height of the operating surgeon. Pneumatic tourniquet is applied for the patients. Then scrub is given for the operating limb from the mid-thigh to the foot with betadine scrub solution and savlon. The limb is then painted with betadine solution from mid thigh to the foot. Then draping is done for the rest of the body using the sterile drapes. sterile glove or sterile drape is applied around the foot.

PROCEDURE

Vertical incision is given from the inferior pole of the patella to the tibial tuberosity, about 5cm long. At times it may be necessary to extend the incision farther proximally through the skin and subcutaneous tissue only to protect the soft tissues around the knee during the reaming and nail insertion. Patellar tendon is split vertically in the middle and retracted to reach the proximal part of the tibial tuberosity.

This followed by the insertion of a curved awl through the metaphysis anteriorly to gain access to the medullary canal. The tip of the curved bone awl is placed at the proximal to the tibial tubercle at the level of the fibular head (about approximately 1.5cm below the knee joint) and in line with the centre of the medullary canal on the anteroposterior view.

The position of the bone awl is confirmed on the antero-posterior and lateral views taken on the C arm. The bone awl is then inserted under the C arm guidance. A true Antero posterior view of the tibia is to be obtained while passing the bone awl. If the limb is externally rotated, the entry portal may be placed too medially and may cause injury to the intermeniscal ligament. A entry portal made too distally may cause injury to the patellar tendon insertion or cause the nail to enter the tibia at a step of angle, which leads to splitting of the tibia or may cause the nail to penetrate the posterior cortex.

The bone awl is directed perpendicular to the shaft when it first penetrates the cortex, but gradually it has to be brought down to a position more parallel to the shaft as it is inserted more deeply to prevent the violation of the posterior cortex.

After widening the medullary canal of the proximal third of the tibia with the bone awl, the ball tipped guide wire of size 3mm diameter and 950mm length is inserted in to the medullary canal of the proximal fragment and is passed across the fracture site into the distal fragment under the C arm guidance once the fracture is reduced by the manual traction. The fracture fragments should be well reduced when the guide wire is passed into the distal fragments and is considered as an important step. After reduction, the tip of the ball tipped guide wire was about 0.5cm to 1cm above the ankle joint under the guidance of the image intensifier.

Medullary canal was then reamed starting from 8mm reamer size to 0.5mm to 1mm larger than the diameter measured on the radiograph. Reaming was done in 0.5mm increments. Reaming is done with the knee in flexion to avoid the excess reaming of the anterior cortex. The fracture fragments are held in reduction during the reaming to avoid the iatrogenic comminution. Minimal reaming must be preferred, with no more than 2mm of reaming after the cortical contact was initiated.

The nail diameter chosen should be 1 to 1.5mm smaller than the last reamer used. The entry point is reamed large enough to accept the proximal diameter of the chosen nail. The tourniquet must be deflated during the reaming, otherwise it may lead to thermal necrosis of the bone and soft tissue, especially in the individuals with the smaller diameter of the medullary canals.

The canal diameter can be measured radiologically but is less accurate. The nails with diameter larger than that of the medullary canal must never be inserted. If nail with smaller diameter than the medullary canal diameter are used it will be less stable, and the smaller implants are not as strong and may be prone to the hardware failure.

When the reaming is completed, exchange the ball tipped guide wire for one with a smooth tip guide wire for the nail insertion. Solid nails are inserted without a guide wire. Determine the length of the nail by placing the tip of the guide wire of the same length at the most edge of the entry portal. Subtract the length of the overlapped portions of the guide wire from the full length of the guide wire to determine the length of the nail, with the fracture held in the position during the measurement of the nail length. A radiopaque ruler can be used to measure the distance between the anterior edge of the entry portal and a point 0.5cm to 1cm proximal to the ankle joint.

The fluoroscopic beam must be perpendicular to the tibial shaft to obtain the accurate measurement. When the ruler is properly placed over the distal tibia under the fluoroscopic guidance, it should not be moved until the measurement is taken. A haemostat is placed at the distal edge of the entry portal ensures a more accurate reading. Comminuted fractures require preoperative radiographic measurement of the contralateral tibia to assess the length properly. Approximately about 5mm should be subtracted from the measured length to allow the countersinking of the nail.

Attach the insertion device(jig) and the proximal locking screw guide to the nail. Direct the apex of the proximal bend(Herzog bend) in the nail posteriorly, and mount the drill guide to direct the screws from medial to lateral. Some of the nail systems use the oblique proximal locking screws, which are directed anteromedial to posterolateral and anterolateral to posteromedial. Insert the nail with the knee in flexion to avoid the impingement of the patella.

Evaluate the rotational alignment by aligning the iliac crest, patella and second ray of the foot. Tremendous force should not be used to insert the nail. Moderate manual pressure with a gentle back and forth twisting motion usually is sufficient for the nail insertion. If mallet is used, then the nail should advance with each blow by the mallet. If the nail does not advance with each blow then the nail is removed and further reaming is performed or nail of smaller diameter is used. It is important to keep the fracture well aligned during the nail insertion to prevent the iatrogenic comminution of the distal fragment and misalignment.

When the nail is passed well in to the distal fragment, the guide wire is removed to avoid the incarceration. The fractures shouln't be shorten excessively with the segmental comminution. When the nail is fully inserted the proximal end of the nail should lie approximately about 0.5cm to 1cm below the entry portal. This position is best seen on a lateral fluoroscopic view.

If the nail protrudes too far proximally, knee pain and difficulty with kneeling will occur. Excessive countersinking of the nail should be avoided because it makes the nail removal difficult. The distal tip of the nail should lie approximately about 0.5cm to 2cm from the subchondral bone of the ankle joint. Distal tibia fractures require nail insertion near the more distal end of this range.

Insert the proximal locking screws using the jig attached to the nail insertion device. Place the drill sleeve through a small incision down to bone. Measure the length of the screw from the calibration on the drill bit or depth gauze is used. The screw should protrude approximately 5mm beyond the far cortex to enable the screw too be removed more easily if breakage occurs. Tighten all the connections between the insertion device, drill guide and nail before the insertion.

The distal locking of the nail is performed using a free hand technique after the perfect circles are obtained by the fluoroscopy. In the lateral position adjust the fluoroscopic beam should be adjusted until it is directed straight through the distal screw holes and the holes appear perfectly round.

Place the drill bit through a small incision overlying the hole and centre the tip of the hole. Care should be taken to not to move the location of the tip of the drill bit, bring the drill bit in line with the fluoroscopic beam and drill the near cortex. The drill is detached from the drill bit and the position of the drill bit is checked under the fluoroscopy to ensure that it is passing through the screw hole. When the proper position is confirmed the drill bit is drilled through the lateral cortex.

After the screw insertion, obtain a lateral image to ensure that the screws are inserted through the screw holes. Two distal locking screws are used in most of the fractures.

Some of the nail systems have the option of placing the anteroposterior distal locking screw. Perfect circles are obtained in the antero-posterior fluoroscopic view. Tendon of the tibialis anterior should not be injured. The incision should be made medial to the anterior tibial tendon, and the tendon is retracted laterally as necessary to allow the drill bit to be entered through the screw hole. A drill sleeve protects the tendon further.

Before interlocking, the fracture site is inspected for any distraction. In case the fracture is displaced the distal locking screws are placed first.

After the distal locking is complete, impaction at the fracture site is done by carefully driving the nail backward watching the fracture site under fluoroscopy. The knee is flexed until the nail is inserted and the instruments are removed to avoid the damage to the soft tissues around the patella.

Most of the nails are statically locked. Minimally comminuted transverse diaphyseal fractures can be dynamically locked, however the metaphyseal and comminuted fractures should be statically locked. If there is any doubt regarding the stability, static locking is done. As the nail will not prevent the misalignment of the unstable fracture before it is locked, therefore it is crucial to maintain the accurate reduction until the proximal and distal locking is done

Incised wound is washed with normal saline and wound is sutured in layers with vicryl and skin closure is done using ethylon or staples. Sterile dressing is done and compression bandage is applied. Tourniquet is deflated. Distal pulses are checked.

PHOTOS OF THE OPEARTIVE PROCEDURE

Fig 10 Instruments

Fig 11 Position

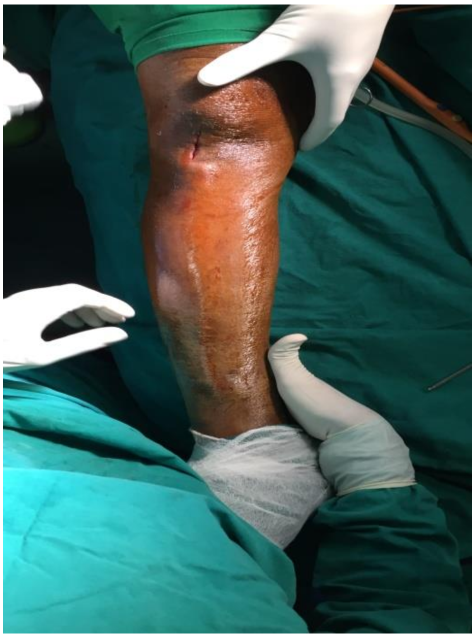


Fig 12 Incision

Fig 13 Entry Point with bone awl

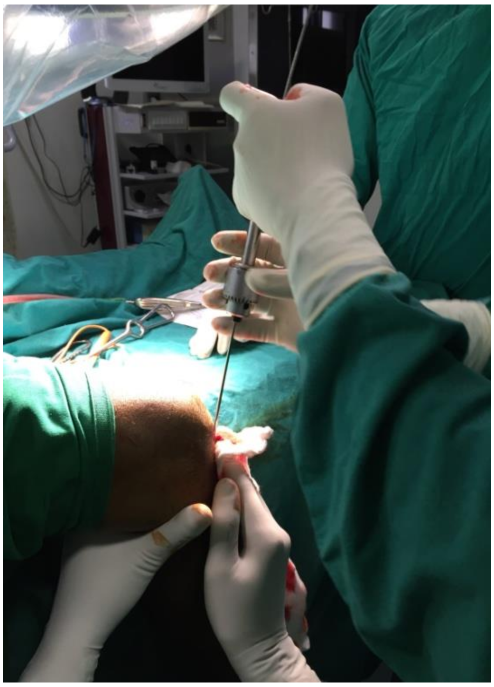


Fig 14 Guide wire insertion

Fig 15 Reaming

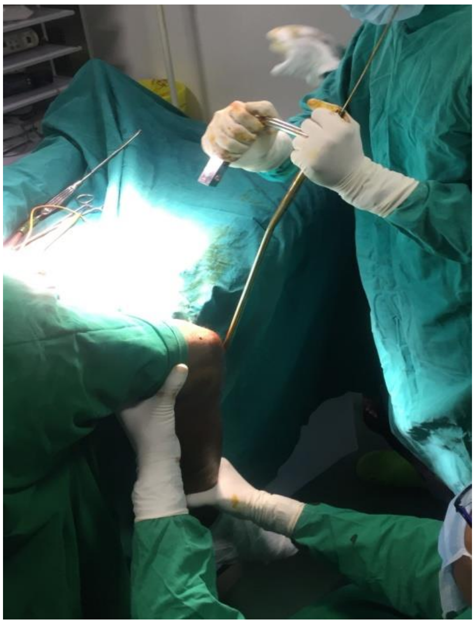


Fig 16 Nail Insertion

Fig 17 Distal Locking

POST OPERATIVE CARE

- Nill orally for 6 hours postoperatively
- IV fluids /Blood transfusion if required
- IV antibiotics are given for 3 days post-operatively followed by oral antibiotics
- IM analgesics are given post-operatively for 2 days followed by oral analgesics
- Limb elevation with pillows
- Active toe and ankle movements
- To watch for any active bleeding
- TPR/BP monitoring every hourly upto 24 hours post operatively
- Input/output chart
- Check X ray of the operated limb with ankle joint, AP and lateral views

IV antibiotics were given for 2 days for all fractures and then continued for the open fractures as required. Post operatively the limb elevation was given. Analgesics and calcium supplementations were given. Active knee, ankle and toe movements were started on the post-operative day one.

Wound inspection was done on the post-operative day two. If any discharge is present from the wound, it is sent for the culture and sensitivity and appropriate antibiotics were started based on the report. Patient was allowed for non-weight ambulation with the walker on the post-operative day one, based on the general condition and tolerance of the patient. Skin sutures/staples were removed on the post-operative day 10-12 day based on the wound and skin condition.

Partial weight bearing was started at the end of 2 weeks post-operatively depending upon the type of fracture, rigidity of fixation and associated injuries.

Further follow-up of the patient was adviced and done at intervals, at the end of 1month, 3 months and 6 months post-operatively. Each patient is then assessed and evaluated individually and radiologically according to the proforma.

RESULTS

The present study includes 30 fractures of the distal third tibia fractures surgically treated with intramedullary interlocking nailing during the period from November 2014 to Febraury 2016 in the department of orthopaedics attached to the R.L.J HOSPITAL attached to Sri Devaraj Urs Medical College and Research Centre, Kolar, Karnataka. All the patients were followed up for 6 months.

Statistical analysis:

Data was entered into Microsoft excel data sheet and was analyzed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions. Chi-square was used as test of significance. Continuous data was represented as mean and standard deviation. ANOVA (Analysis of Variance) was the test of significance to identify the mean difference between more than two groups. p value <0.05 was considered as statistically significant

Table 1: Age distribution

		Number	%
Age	< 30 years	8	26.7%
	31 to 50 years	12	40.0%
	> 50 years	10	33.3%

Mean age of subjects in the study was 43.93 years. Majority of the subjects were in the age group 31 to 50 years. The youngest patient was of 19 years age and the eldest patient is 70 years of age.

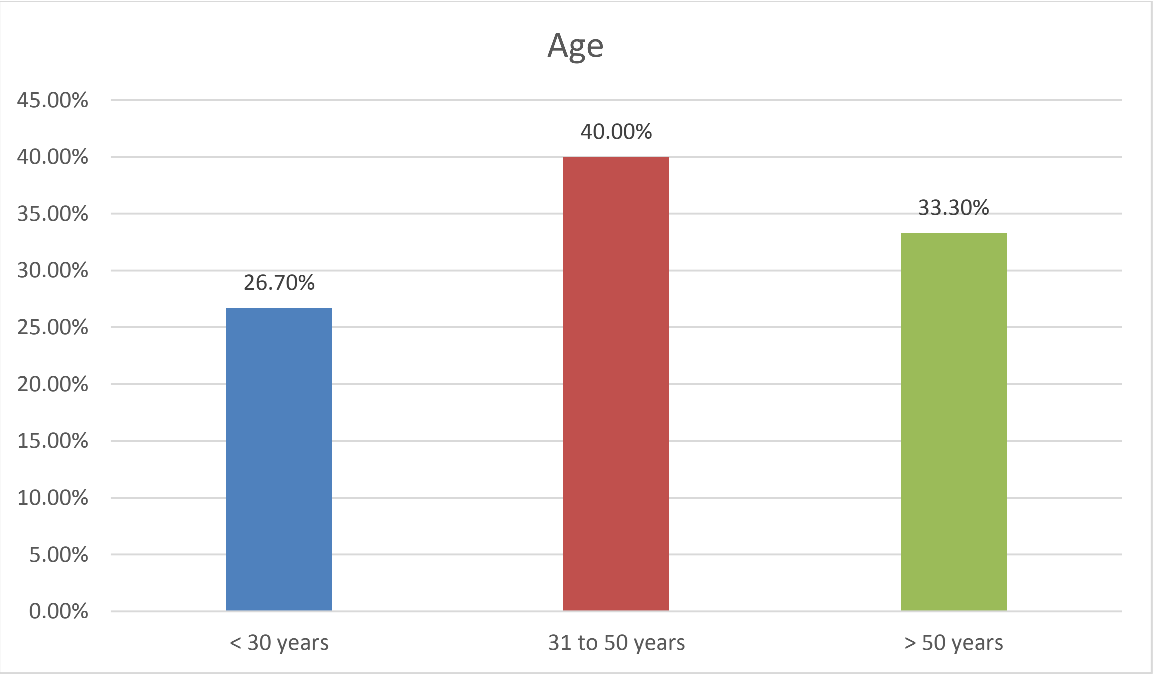


Figure 1 : Bar diagram showing Age distribution

Table 2: Gender distribution

		Number	%
Gender	Female	4	13.3%
	Male	26	86.7%

In this study 86.7% of the patients were males and 13.3% were females. The majority of the patients in this study are male patients.

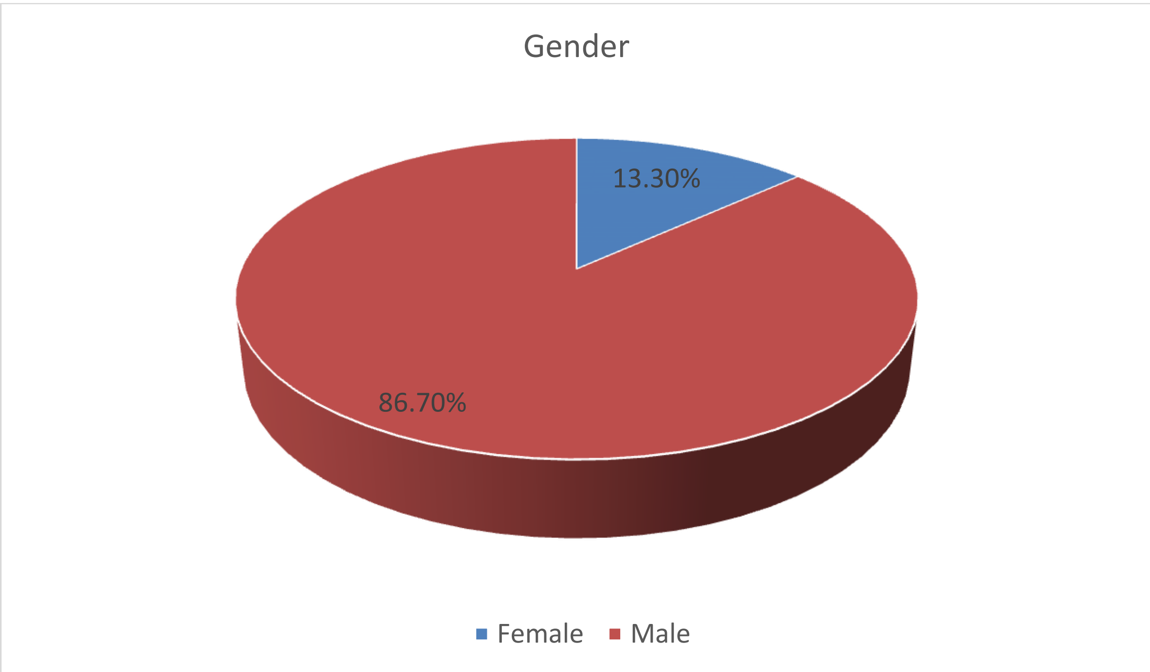


Figure 2: Pie diagram showing gender distribution

Table 3: Type of Fracture

		Number	%
Type of Fracture	Closed	19	63.3%
	Open	11	36.7%

In this study 63.3% of the fractures were closed fractures and 36.7% of the fractures were open fractures. Majority of them were closed fractures.

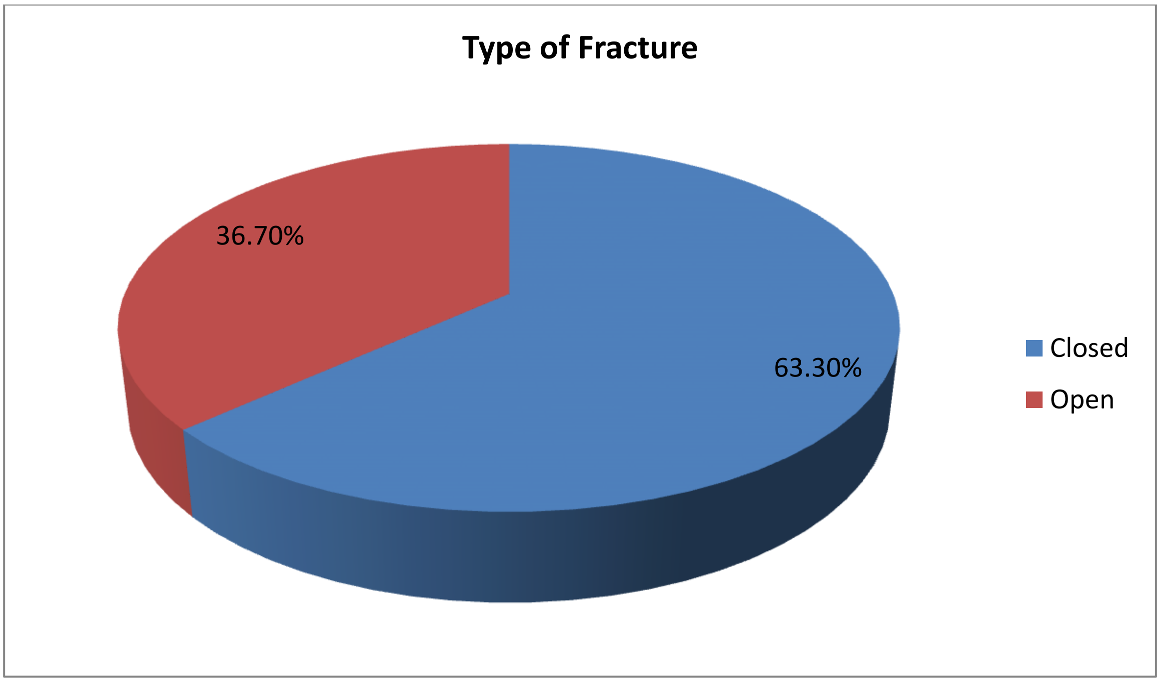


Figure 3: Pie diagram showing type of fracture

Table 4: Gustilo Anderson Classification of Fractures

		Count (n= 11)	%
Gustilo Anderson Classification	Open Type I	7	63.6%
	Open Type II	3	27.3%
	Open Type IIIA	1	9.1%

In the present study 63.3% of fractures were closed type, 23.3% were open type I, 10% were open type II and 3.3% were open type IIIA. In the open fracture majority of the cases are open type I fractures.

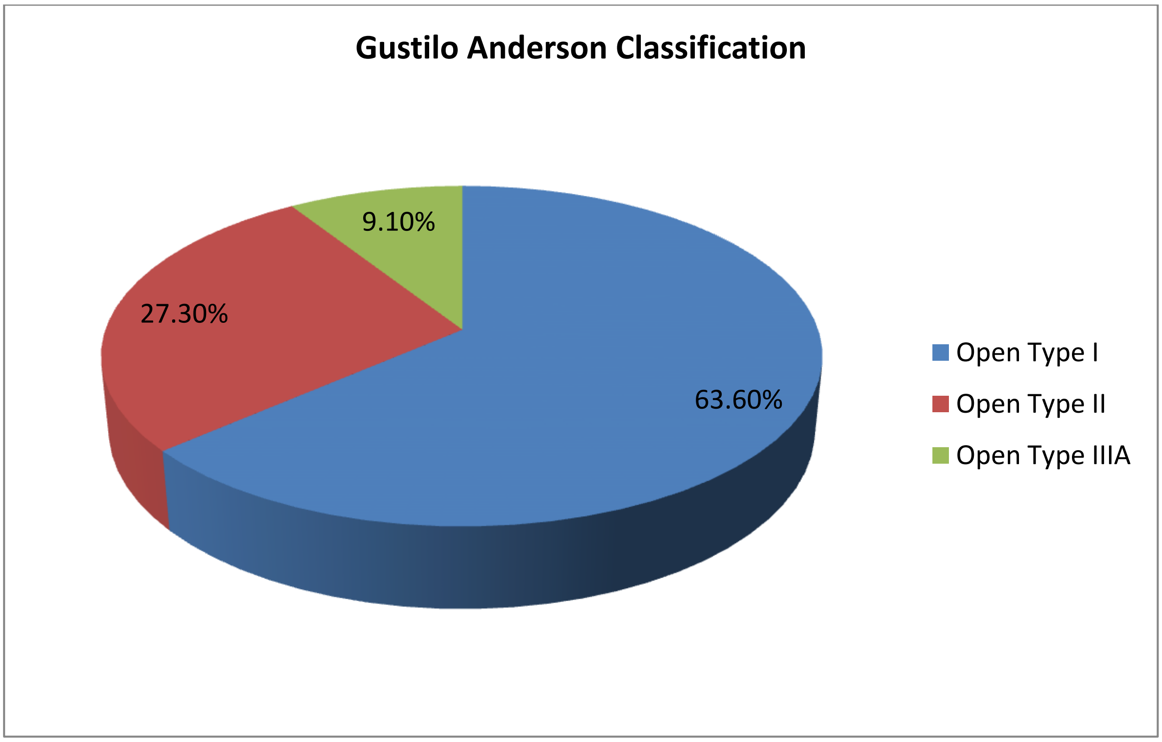


Figure 4: Pie diagram showing Gustilo Anderson Classification of Fractures

Table 5: Mode of injury

		Number	%
Mode of Injury	RTA	24	80.0%
	FALL	6	20.0%

In our study 80% of the fractures are due to RTA and 20% of the fractures are due to fall.

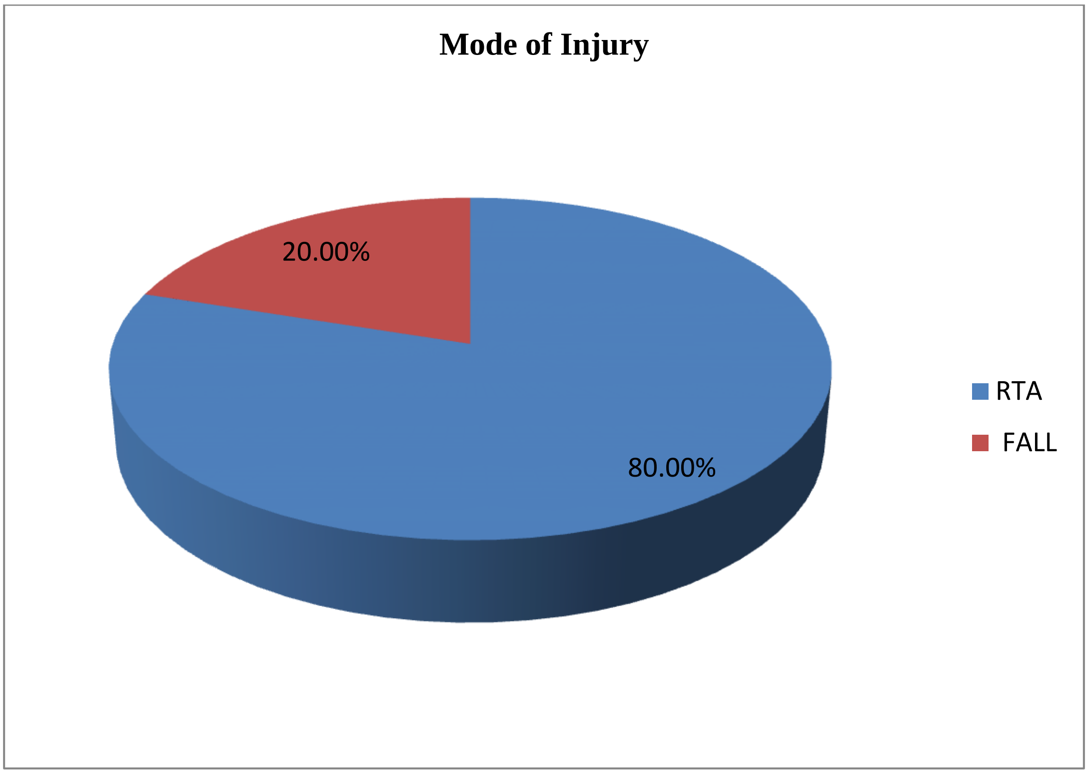


Figure 5: Pie diagram showing Mode of injury

Table 6 : Side affected

		Number	%
Side affected	LEFT	14	46.7%
	RIGHT	16	53.3%

In the present study 16(53.3%) patients sustained fracture of the right tibia and 14(46.7%) patients sustained fracture of the left tibia. In this study majority of the patients sustained fractures of the right tibia.

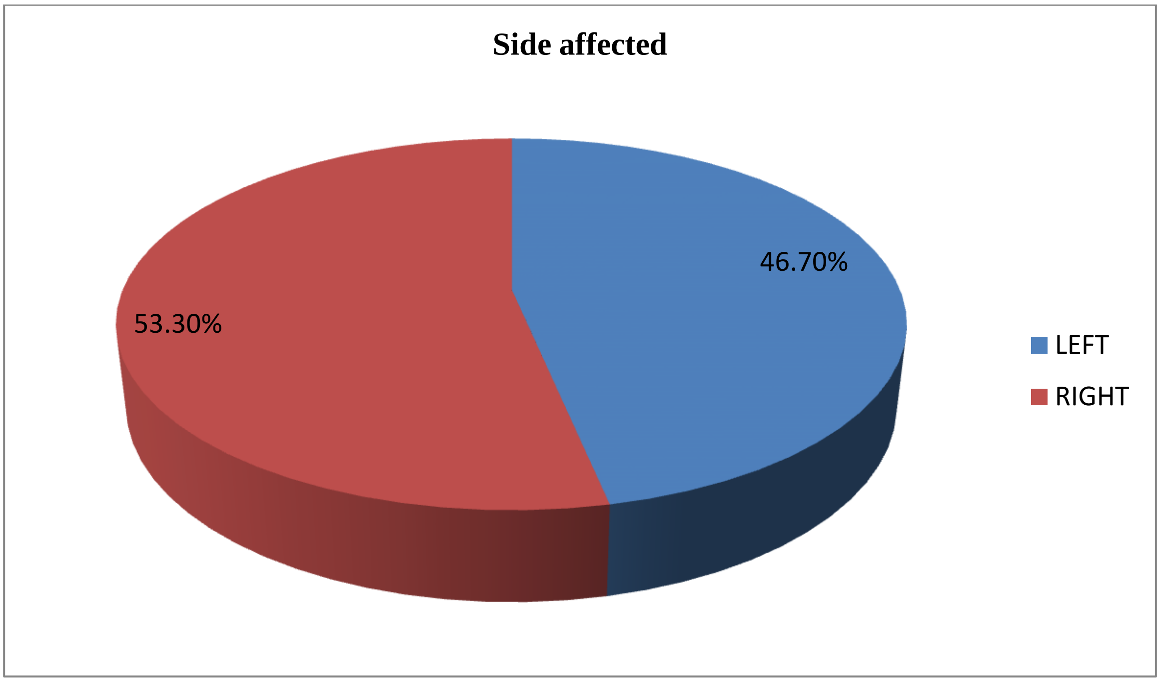


Figure 6: Pie diagram showing Side affected

Table 7: Time from injury to surgery :

Days	No of patients	%
<1 day	22	73.4%
1-3 days	7	23.3%
>3 days	1	3.3%

In this study all the open fractures were operated within 24 hours from the time of injury. Others were operated within 3 days and one case operated on the fourth day as he had head injury.

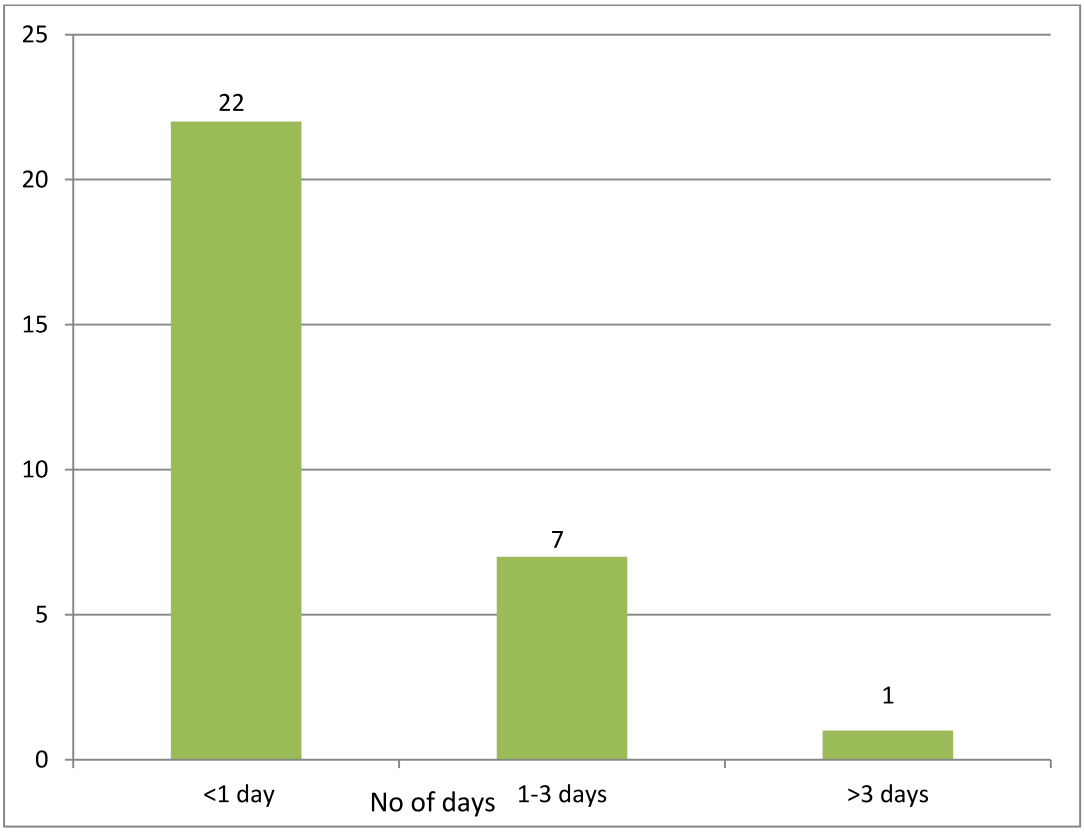


Figure 7 : Bar diagram showing time from injury to surgery.

Table 8 : Duration of surgery

	Duration of surgery (min)
Mean	96.00
N	30
SD	15.669

Mean duration of the surgery in this study is 96 ± 15.6 min.

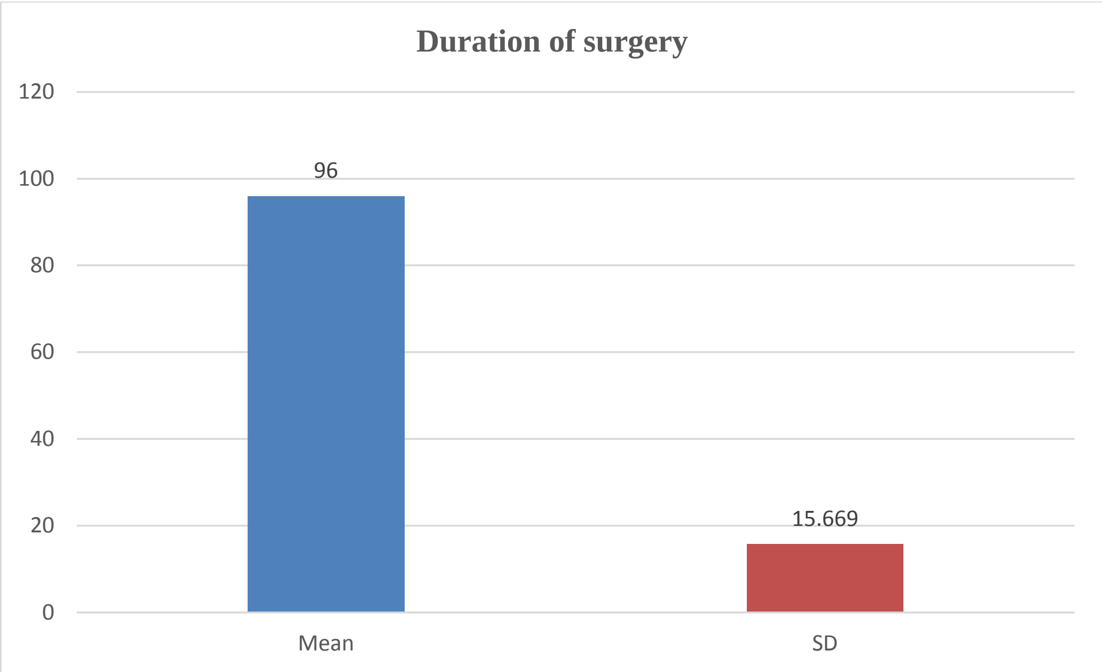


Figure 8 : Bar diagram showing Duration of surgery

Table 9: Radiological union

	Radiological union (weeks)
Mean	19.00
N	30
SD	2.613

Mean radiological union in this study is 19 ± 2.6 weeks

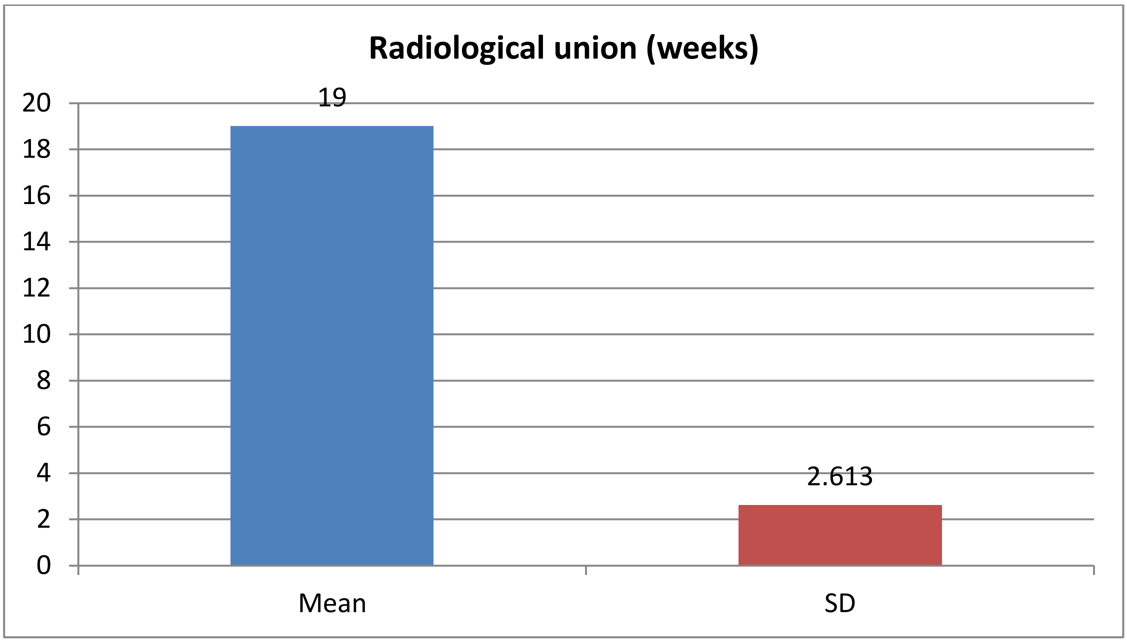


Figure 9: Bar diagram showing Radiological union

Table 10 : Associated injuries

		Number	%
Injuries	None	24	80%%
	Femur fracture	2	6.6 %
	Scapula fracture	1	3.3%
	Metacarpal fractures	1	3.3%
	Traumatic brain injury	1	3.3%
	Pelvic fracture	1	3.3%

24(80%) of the patients no other injuries, while 2(6.6%) patients had femur fracture and were operated with IMIL nailing, 1(3.3%) patient had a body of scapula fracture treated conservatively, 1(3.3%) patient had metacarpal fractures fixed with k wires, 1(3.3%) patient had a traumatic brain injury treated conservatively and 1(3.3%) patient had a pelvic fracture treated conservatively.

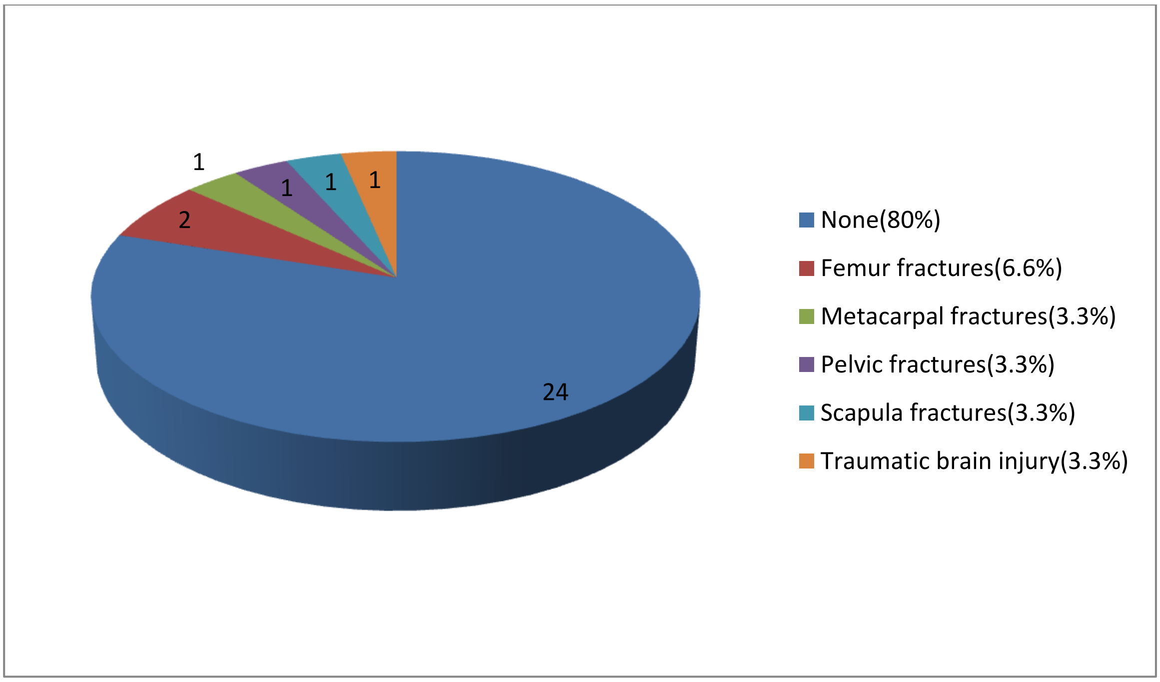


Figure 10 : pie diagram showing associated injuries.

Table 11: Complications

		Number	%
Complications	None	25	83.3%
	Delayed Union	1	3.3%
	Proximal screw broken	1	3.3%
	Malunion	1	3.3%
	Non union	1	3.3%
	Infection	1	3.3%

Post operatively 5 (16.7%) patients had complications which included 1(3.3%) delayed union, 1(3.3%) proximal screw breakage, 1(3.3%) malunion, 1(3.3%) non-union and 1(3.3%) infection.

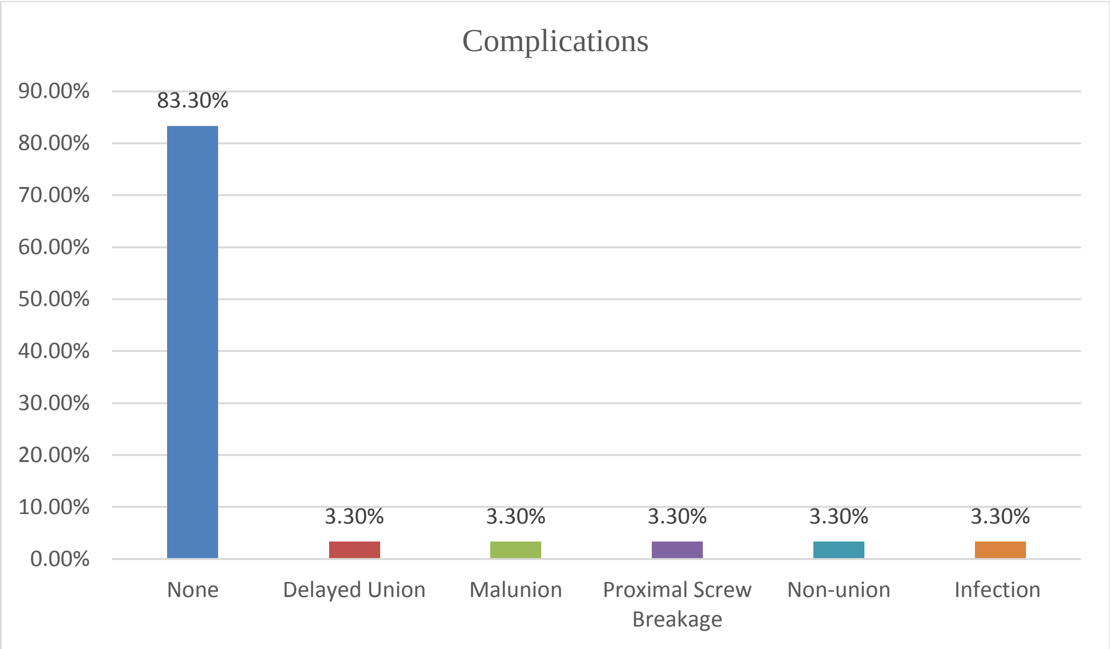


Figure 11: Bar diagram showing Complications

Table 12: Secondary procedures

		Number	%
Secondary procedures	Dynamisation	2	6.7%
	Dynamisation And Fibular Plating	1	3.3%
	None	27	90.0%

6.7% required Dynamisation and 3.3% required Dynamisation and Fibular Plating.

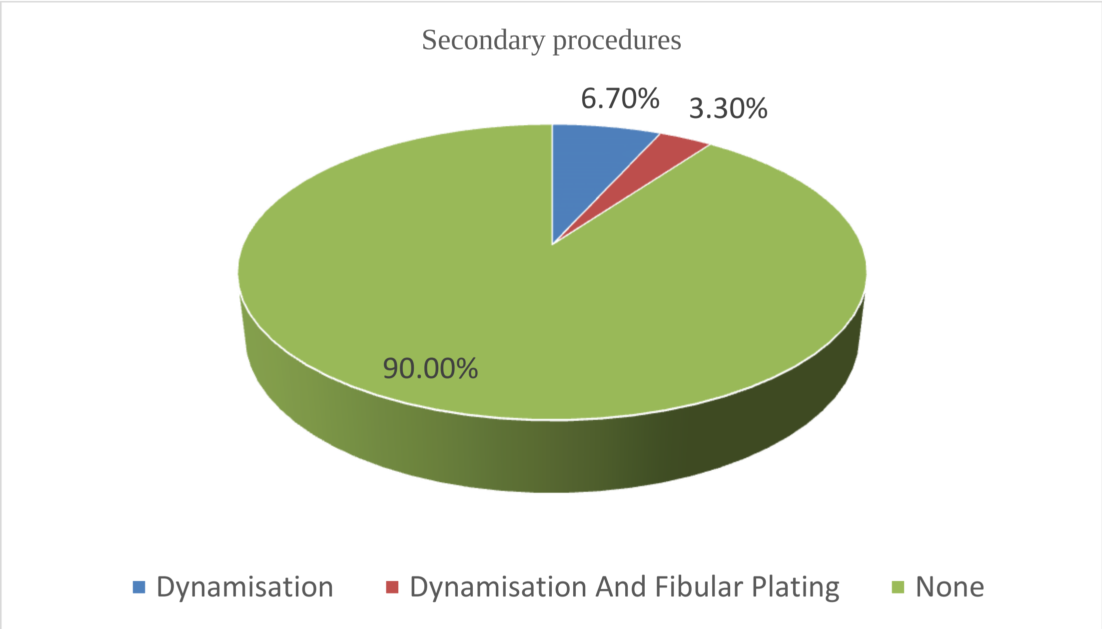


Figure 12: Pie diagram showing Secondary procedures

Table 13 : Range of Movements of Knee

		Number	%
Range of Movements Knee	>90%	2	6.7%
	>80%	2	6.7%
	Normal	26	86.7%

Majority of patients had normal range of knee movements 26(86.7%), 2 (6.7%) patients had more than 90% and 2(6.7%) patients had >80% of the range of knee movements

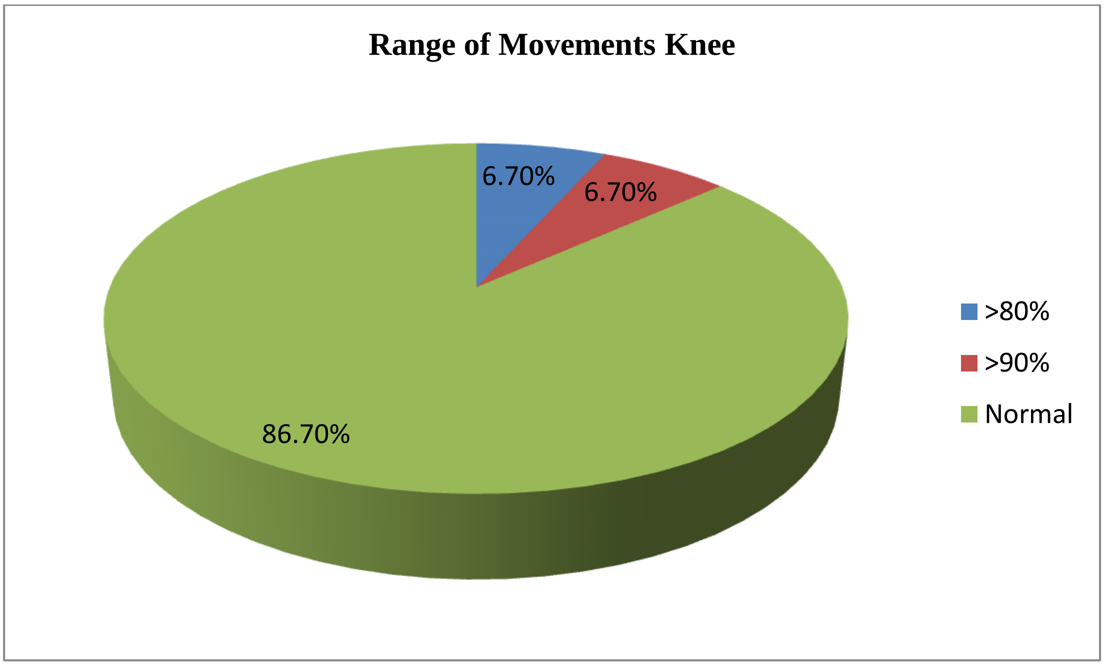


Figure13: Pie diagram showing Range of Movements in Knee

Table 14: Range of Movements of Ankle

		Number	%
Range of movements of ankle	>90%	3	10%
	>80%	2	6.7%
	Normal	25	83.3%

Majority of patients had normal range of ankle movements 25(83.3%), 3(10%) patients had >90% and 2(6.7%) patients had >80% of the range of ankle movements

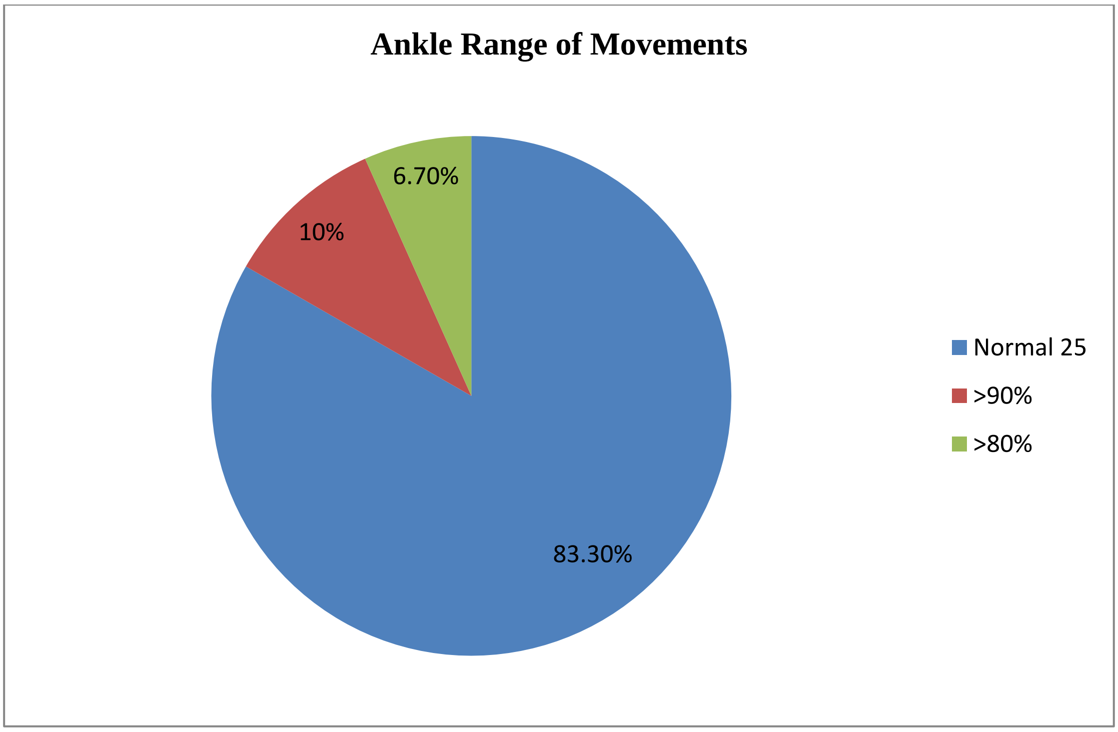


Figure 14: Pie diagram showing Range of Movements of Ankle

Table 15 : Final outcome

		Number	%
Final outcome	Excellent	18	60.0%
	Good	7	23.3%
	Fair	3	10.0%
	Poor	2	6.7%

60% had excellent outcome, 23.3% had good outcome, 10% had fair outcome and 6.7% had poor outcome.

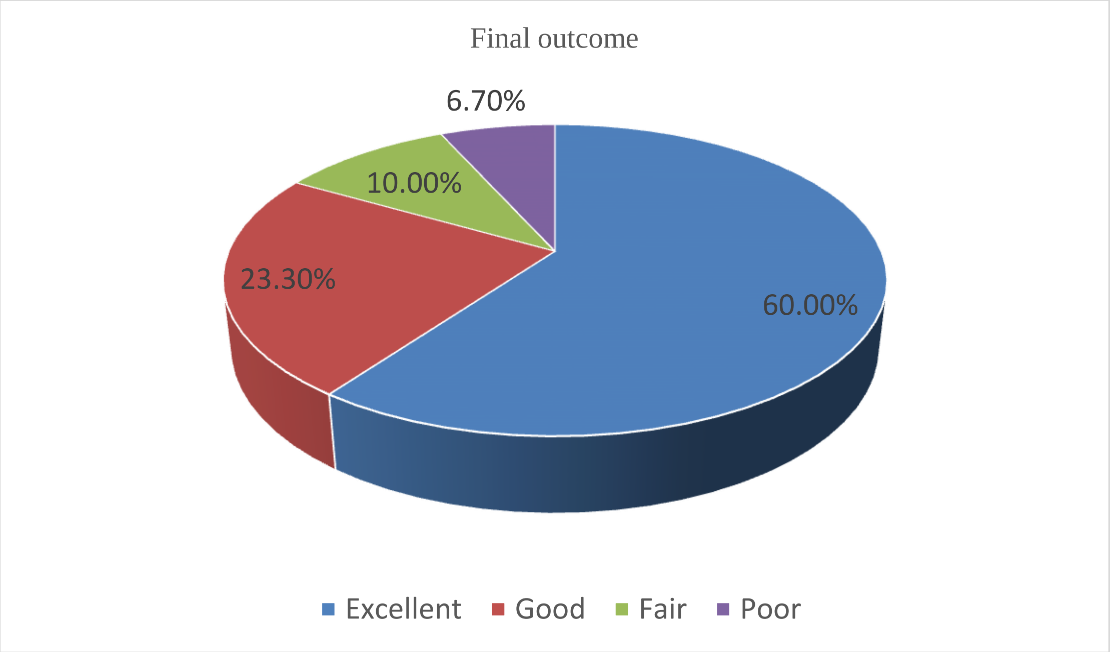


Figure 15 : Pie diagram showing Final outcome

DISCUSSION

The fractures of the distal tibia are among the most difficult fractures to treat. The status of the soft tissues and the degree of comminution affect the long term clinical results. This study was under taken to determine efficacy, rate of union and outcome of intramedullary interlocking nailing for the treatment of the distal third tibia fractures.

In this study 30 fractures of the shaft of the tibia were treated surgically with closed reduction and internal fixation with the intramedullary interlocking nailing. The patients were followed up for 6 months.. The cases in this study belong to different age groups, occurred in both the sexes and also included both open and

closed fractures.

AGE :

The average age of all the cases in this series is 43 years. The fracture is more common in the age group of 31-50 years .The average age in different studies is given as follows Average age comparison in different studies

STUDIES	YEAR	AVERAGE AGE
Phadke A et al[41]	2016	35.8 years
Sharma S et al[39]	2015	46.2 years
Ehlinger et al[28]	2010	46 years
Robinson CM et al[16]	1995	46.1 years
Present study	2016	43.9 years

Sex :

There were 26 males and 4 females in this study, showing that majority of the patients were males similar to the other studies as

STUDIES	YEAR	MALES	FEMALES
Phadke A et al[41]	2016	52.9%	47.1%
Sharma S et al[39]	2015	78.6%	21.4%
Ehlinger et al[28]	2010	62.7%	33.3%
Present study	2016	86%	14%

MODE OF INJURY :

Majority of the fractures in the study were due to RTA (24 patients) and rest(6 patients) due to falls as compared with the other studies

STUDIES	YEAR	RTA	FALL
Sharma S et al[39]	2015	29.5%	60.7%
Yaligod et al[2]	2014	70.6%	29.4%
Ehlinger et al[28]	2010	75%	25%
Present study	2016	80%	20%

UNION :

In this study the average union rate was about 19 weeks which was comparatively less when compared to the other studies mentioned below

STUDIES	YEAR	UNION RATE
Phadke A et al[41]	2016	21 weeks
Nandakumar[38]	2015	20 weeks
Sharma S et al[39]	2015	25.7 weeks
Ehlinger et al[28]	2010	25.7 weeks
Present study	2016	19 weeks

COMPLICATIONS :

In the present study 5(16.7%) patients had complications which was comparatively less than the other studies mentioned below. There were 2 patients with delayed union for whom dynamization was done, 1 patient had proximal screw broken and had localised pain, for which screw removal was done. One patient had malunion and was asymptomatic. one patient had infection and non-union, infection subsided following antibiotic usage and bone marrow injection was adviced subsequently but the patient didn't come for further followups.

In the study conducted by Gadegone W et al reported complications in 33% of the cases that included non union, malunion, delayed union, infection, breakage of the interlocking screws and nail. Mohammed A et al reported complications like superficial wound infection, anterior knee pain, infection of the nail, wound dehiscence, deep vein thrombosis, compartment syndrome and distal screw breakage in 36.9% of cases. Tyllianakis M reported complications like non-union, anterior knee pain and post operative peroneal palsy in 19.5% of the cases.

STUDIES	YEAR	PERCENTAGE
Gadegone W et al[37]	2015	33%
Natarajan GB et al[34]	2014	32.1%
Mohammed A et al[21]	2008	36.9%
Tyllianakis M[20]	2008	19.5%
Present study	2016	16.7%

TIME FROM INJURY TO SURGERY :

In our study all the open fractures(11) were operated within 24hours from the time of injury, closed fractures(18) were operated within 3 days except one which was operated on the fourth day, as he had head injury and fitness for surgery was awaited. In the study conducted by Ehlinger et al 74.5% of the patients were operated within 24 hours from the time of injury and 25.6% were treated after 24 hours. In the study conducted by Mohammed A et al 26.1% of the patients were operated within 24 hours from the injury whereas rest were operated after 24 hours.

STUDIES	YEAR	<24HOURS	>24HOURS
Ehlinger et al[28]	2010	74.5%	25.6%
Mohammed A et al[21]	2008	26.1%	73.9%
Present study	2016	73.3%	26.7%

CONCLUSION

Fractures of lower third tibia are one of the most common fractures encountered by the orthopaedic surgeon in his daily practice. This is because the bone is subcutaneous with less protection from the muscles and is prone for open fractures. The fractures of the lower third of tibia mainly occur following motor vehicle accidents.

In this study 30 patients have undergone closed reduction and internal fixation with the intramedullary interlocking nailing for the fractures of the distal third tibia. Majority of the patients were males who were actively involved in the professional activities and most of the injuries were due to the road traffic accidents.

Closed reduction and IMIL nailing of fractures of the lower third of tibia result in minimal blood loss and soft tissue damage. There is also advantage of early weight-bearing and movement, which stimulated fracture union and prevents the fracture disease. Intramedullary nailing enables closed stabilisation while preserving vascularity of the fracture site and integrity of the soft-tissue envelope.

More than 80% of our patients had excellent to good outcome. Hence IMIL nailing is a safe, successful, effective, reliable and useful technique in the fixation of fractures of lower third of tibia.

SUMMARY

In this study 30 patients with fractures of the lower third tibia were surgically managed by closed reduction and internal fixation using intramedullary interlocking nailing. This study was done in the Department of orthopaedics, R.L.J Hospital attached to the Sri Devaraj Urs Medical College and Research Centre, Kolar, Karnataka during November 2014 to February 2016.

- Patients who fulfilled the inclusion criteria were included in the study.
- All the patients were clinically and radiologically evaluated before and after the surgery for a period of 6 months.
- The patients were between 19 years to 70 years old and the mean age being 43.9 years.
- There were 26 male patients and 4 female patients in the study.
- The fractures of the right tibia (16 patients) were more common than the left(14 patients).
- Majority of the patients19, had closed fractures and the rest 11 patients had open fractures.
- Most of the fractures were due to the were due to RTA(24) and the rest(6) were due to fall.
- Tourniquet was used in all the cases and none had tourniquet palsy.
- Midline incision was used for all the patients and patellar tendon was split for the nail insertion. None of the patients had anterior knee pain and extensor lag.
- All the patients were mobilised partial weight bearing as early as possible post-operatively depending upon the fracture stability, general condition and tolerance of the patient.

- Majority(27) fractures united within five months of injury, 2 patients had delayed union which united in about eight months of time and 1 patient had non union, who was lost for followup.
- Most(26) of our patients had normal range of knee movements, 2 patients had >90% and 2 patients had >80% of the knee motion.
- Majority(25) of the patients had normal ankle movements, 3 patients had >90% and 2 patients had >80% of ankle movements.
- Most(25) of our patients had no complications. One patient had delayed union, one patient had malunion, one patient had proximal screw breakage, one patient had infection and non union.
- We had excellent outcome in 18 patients, good outcome in 7, fair outcome in 3 and poor outcome in 2.
- By the analysis of the data collected in the present study, intramedullary interlocking nail is also an ideal method of fixation of fractures of the lower third of tibia as it preserves vascularity of fracture fragments, protects soft tissue envelope, promotes the fracture healing and early mobilization.

BIBLIOGRAPHY

1.Jain V, Aggarwal A, Mehtani A, Jain P, Grag V, Dhaon BK. Primary unreamed intramedullary locked nailing in open fractures of tibia. Indian J Orthopaedics 2005;39:1:30-32.

2.Yaligod V, Rudrappa G.H ,Nagendra S, Shivanna U. Minimizing the complications of intramedullary nailing for the distal third tibial shaft and metaphyseal fractures. J Orthopaedics 2014;10-18.

3.Holagundi L, Deepak, Dayanand, Ramachandra. Functional outcome with surgical management in distal tibia fractures. J Dental Med Sci 2014;13:83-90.

4.Jafarinejad A, Bakshi H, Haghnegahdar M, Ghomeishi N. Malrotation following reamed intramedullary nailing of closed tibial fractures. Indian J Orthopaedics 2012;46:3.

5.Al-zubaidi AS, Farouk A, Ghani FM. Complications of closed reamed intramedullary nailing in diaphyseal closed fractures tibia. J Kerbala University 2010;8:4.

6.Wysocki R, Kapotas J,Virkus W. Intramedullary nailing of the proximal and distal one third tibial shaft fractures with intraoperative two pin external fixation. J Trauma 2009;66:1135-39 .

7. Kuhn S, Appelmann P, Mehler D, Pairon P, etal. Retrograde tibial nailing a minimally invasive and biomechanically superior alternate to angle stable plate osteosynthesis in distal tibial fractures. J Orthop Sur Res 2014;9:35 .

8.Boulton C, O'Toole RV. Tibia and fibula shaft fractures. Brown CM, Heckman JD, editors. Rockwood and Green's Fractures in Adults. 8th ed. Chapter 57. Lippincott Williams and Wilkins 2014:2415-2471.

9.SPRINT study. Prognostic Factors for Predicting Outcomes After Intramedullary Nailing of the Tibia. Bone Joint Surg Am 2012;94:1786-93

10.Obremskey WT, Medina M. Comparision of the Intramedullary nailing of the distal tibial shaft fractures : Before and after traumatologits. Orthoblue J 2004; 27:1180-84.

11.Mathew R,et al. The history of intramedullary nailing. Bulletin of the NYU hospital for joint diseases 2006; 64(3, 4): 94-97.

12.Rudloff MI. Fractures of lower extremity. Canale ST, Beaty JH, editors. Campbell's operative orthopaedics. 12th ed. chapter 54. Mosby Elsevier 2014: 2617-2724.

13.Gerhard B.G.Kuntscher: The Kuntscher method of intramedullary fixation. J Bone Joint Surgery 1958;40A;17-26

14.Nicoll EA. Fractures of the tibial shaft. A survey of 75 cases. J Bone Joint Surgery 1964;46B:373-87.

15. Hooper et al. Conservative management or closed nailing for the tibial shaft fractures, randomized prospective trial. J Bone J Surgery 1991;73B:83-85.

16.Robinson CM, McLauchlan GJ, McLean IP, Court-Brown CM. Distal metaphyseal fractures of the tibia with minimal involvement of the ankle: Classification and treatment by locked intramedullary nailing. J Bone Joint Surg 1995;77-B:78l-7.

17.Schmidt et al. Treatment of closed tibial fractures. J Bone J surgery 2003;85:352-68.

18.Vallier HA, Le TT, Bedi A. Radiographic and clinical comparisons of distal tibia shaft fractures (4 to 11 cm proximal to the plafond): plating versus intramedullary nailing. J Orthop Trauma 2008;22:307-11.

19.Study to Prospectively Evaluate Reamed Intramedullary Nails in Patients with Tibial Fractures. Randomized Trial of Reamed and Unreamed Intramedullary Nailing of Tibial Shaft Fractures.J Bone Joint Surg Am 2008;90:2567-78.

20. Tyllianakis M et al. Interlocking intramedullary nailing in Distal Tibia Fractures. Orthoblue J 2008;23,8:85.

21. Mohammed A, Saravanan R, Zammit J, King R. Intramedullary tibial nailing in distal third tibial fractures: distal locking screws and fracture non-union. Int Orthop 2008;32:547-49.

22.Horn J, Linke B, Hontzsch D, Gueorguiev B, Schwieger K. Angle stable interlocking screws improve construct stability of intramedullary nailing of distal tibia fractures: A biomechanical study. Int. Care Injured 2009: 767–77.

23.Krishan A, Peshin C, Singh D. Intramedullary nailing and plate osteosynthesis for fractures of the distal metaphyseal tibia and fibula. J Orthopaedic Surgery 2009;17:317-20.

24.Ruecker AH, et al. Distal Tibial Fractures: Intramedullary Nailing. Eur J Trauma Emerg Surg 2009;No. 6

25.Labronici et al. Treatment of distal fractures of the tibia. J Acta Ortop Bras 2009; 17:40-5.

26.Bonnevialle et al. Distal leg fractures : How critical is fibular fracture and its fixation. J orthopaedics and traumatology : surgery and research 2010;96: 667-673.

27.Guo JJ, Tang N, Yang HL, Tang TS. A prospective, randomised trial comparing closed intramedullary nailing with percutaneous plating in the treatment of distal metaphyseal fractures of the tibia J Bone Joint Surg 2010;92-B:7

28.Ehlinger et al. Distal quarter leg fractures fixation : the intramedulary nailing alone option. J Orthopaedics Traumatology 2010;96:674-682.

29.Hanu et al. Recombinant Human Bone Morphogenetic Protein-2: A Randomized Trial in Open Tibial Fractures Treated with Reamed Nail Fixation. J Bone Joint Surg Am 2011;93:801-8.

30.Theriault et al. Functional Impact of Tibial Malrotation Following Intramedullary Nailing of Tibial Shaft Fractures. J Bone Joint Surg Am 2012;94:2033-39.

31.Isik et al. Intramedullary Nailing and Angulation Prevention in Distal Metaphyseal Tibial Fractures. J Helios Orthopaedics 2012;35:12.

32.Salem KH. Unreamed intramedullary nailing in distal tibial fractures. Int Orthop 2013;37:2009–15.

33.Sengodan et al. Distal Tibial Metaphyseal Fractures: Does Blocking Screw Extend the Indication of Intramedullary Nailing. International scholarly research notices Orthopedics 2014; 542623:7.

34.Natarajan GB, Srinivasan DK, Vijayaraghavan PV. Comparison of clinical, radiological, and functional outcome of closed fracture of distal third tibia treated with nailing and plate osteosynthesis. African J Trauma 2014;3:2.

35.Attal R et al. The influence of distal locking on the need for fibular plating in intramedullary nailing of distal metaphyseal tibiofibular fractures. Bone Joint J 2014;96-B:385–9

36.Vaza1 JV, Chauhan BR, Chauhan GR, Chauhan PR. comparative study of plating versus nailing in distal tibia metaphyseal fractures. National J of medical Research 2014;4:340-344.

37.Gadegone W, Salphale Y, Lokhande V. Results of Dynamic Interlock Nailing in Distal Tibial Fractures. J Surgical Science 2015;6: 317-326.

38.Nandakumar R, Mahapatra S. Use of Intramedullary Nail in Distal Metaphyseal Fractures of Tibia. International J Scientific Study 2015;3:79-82.

39.Sharma S et al. Distal third tibia fractures treated with interlocking intramedullary nail. Nepal Med Coll J 2015; 17: 78-82.

40.Hattarki et al. Comparative Study between Intramedullary Interlock Nailing and Plating in Distal Metaphyseal Fractures of Tibia. Surgery Curr Res 2016, 6:3.

41.Phadke A, Badole C, Thakur S, Handa K. Interlocking nailing in fractures of distal tibia. International J of Research in Medical Sciences 2016;4:1132-35.

42.Bihani M, Sravanth PK, Sharma S, Sood S, Fahad BH. Intramedullary fixation of distal tibial fractures around diametaphysis using locked intramedullary cannulated distal tibial nail a prospective study. International J Orthopaedics Sciences 2016; 2: 38-42.

43. Agathangelidis F et al. Distal Locking Screws for Intramedullary Nailing of Tibial Fractures. Ortho J 2016;39: 253-57

CASE ILLUSTRATIONS

CASE NO : 3

X RAY PICTURES-PRE OPERATIVE X RAY

IMMEDIATE POST OPERATIVE X RAY

FOLLOW UP AT 3 MONTHS

FOLLOW UP AT 6 MONTHS

CLINICAL PHOTOS

Full range of knee and ankle movements at the end of 6 months

CASE NO : 8

PRE OPERATIVE X RAYS

IMMEDIATE POST OPERATIVE X RAY

FOLLOW UP AT 3 MONTHS

FOLLOW UP AT 6 MONTHS

CLINICAL PHOTOS

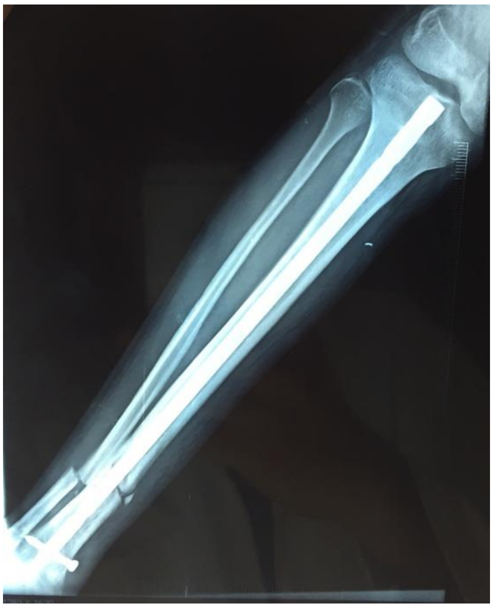
Full range of movements of knee and ankle at the end of 6 months

CASE NO : 17

PRE OPERATIVE X RAYS

IMMEDIATE POST OPERATIVE X RAY

FOLLOW UP AT 3 MONTHS - POST DYNAMIZATION



FOLLOW UP AT 6 MONTHS

CLINICAL PHOTOS

Range of movements of knee and ankle at 6 months of follow-up

ANNEXURE-I

PROFORMA

Name :	Case no :
Age :	Ip/op no :
Sex :	Doa :
Address :	Dos :
Occupation :	Dod :

Chief complaints :

History of presenting illness :

- Mode of the injury- Road traffic accidents , fall , assault ,sports injuries

Past history :

Family history :

Personal history :

General physical examination:

Vital signs	Systemic examination
BP	CVS
RR	RS
PR	CNS
Temperature	PA

Local examination :

- Inspection - Attitude , swelling , deformity , wounds , others .

- Palpation - Local rise of temperature , tenderness , abnormal mobility , crepitus

  .

- Measurements - Length of the leg Right Left

- Movements - Ankle – dorsiflexion , plantar flexion .

- Distal neuro vascular status – Dorsalis pedis ,posterior tibial artery .

  -Sensory disturbances

  -Motor disturbances

- Associated injuries

- Diagnosis:

Investiagations :

Blood :	Haemoglobin	TC
	ESR	DC
	RBS	Blood urea
	S.creatinine	HIV
	HbsAg	sodium
	potassium	

Urine : Alubmin Sugar

ECG :

Radigraphy : x-ray leg full length with ankle

Ap view

Lateral view

Treatment :

Preoperative -Above knee plaster of paris slab

-Antibiotics

-Analgesics

Type of anaesthesia : general anaesthesia/spinal

Surgical procedure

-Duration of surgery

-Tourniquet time

-closed reduction/open reduction

-reamed /unreamed

-Additional procedures

-Intra operative complications

Postoperative - Antibiotics

-Check x-rays

-Complications

-Revision procedures

-Secondary procedures

Follow-up

Duration	Radiographs	Knee movements (flexion and extension)	Ankle movements (dorsiflexion and plantar flexion)
At 1 month			
At 3 months			
At 6 months			

Olerud and Molander scoring system

1. Pain

    -never[25]

    -only while walking on an uneven surface[20]

    -only while walking on an even surface outdoors[10]

    -only while walking indoors[5]

    -constant and severe[0]

2. Stiffness

    -none[10]

    -stiffness[0]

3. Swelling

    -none[10]

    -only evenings[5]

    -constant[0]

4. Stair climbing:

-no problems[10]

-impaired[5]

-impossible[0]

5. Running:

   -possible[10]

   -impossible[5]

6. Jumping:

   -possible[10]

   -impossible[5]

7. Squatting:

   -no problem[10]

   -impossible[5]

8. Supports:

   -none[10]

   -taping, wrapping[5]

   -stick or crutch[0]

9. Work and Activities of daily life:

   -same as before injury[20]

   -loss of tempo[15]

   -change to a simpler job[15]

   -severly impaired work capacity[0]

Patients were graded as excellent , good , fair , poor on scores

Maximum score being 100

Assessment of results:

ANNEXURE-II

INFORMED CONSENT

I………………aged……unreservedly and in my full senses give my consent to take part in above mentioned study which include x ray of leg,routine investigations and IMIL nailing of tibia.

these procedures and complications have been explained to me in my own understandable language. I am willing to pay for the investigations and the procedure. I don’t hold any treating doctor, nursing staff and hospital management for any untoward consequences.

I here by give my consent for the same.

SIGNATURE OF THE SUBJECT

DATE :

ANNEXURE-III

PATIENT INFORMATION SHEET

I……. Patient have been explained about the procedure to be performed (IMIL nailing), also the alternate procedures that can be performed(LCP plating) and complications(delayed union, nonunion, ankle stiffness) associated with the procedure. I am willing to get operated with IMIL nailing for fracture tibia

.

Signature of the patient

Date

ANNEXURE-IV

MASTER CHART

- SL. NO	NAME	AGE	SEX	Hospital number	CLSSSIFICATION GUSTILO ANDERSON	MODE OF INJURY	SIDE AFFECTED	DOA	DOS	DURATION OF SURGERY	RADIOLOGICAL UNION	COMPLICATIONS	Secondary procedures	ROM KNEE	ROM ANKLE	RESULTS
1	chandrasekhar	55	M	116930	CLOSED	RTA	LEFT	28-02-2015	01-03-2015	100 MINUTES	16 WEEKS	NONE	NONE	NORMAL	NORMAL	EXCELLENT
2	Krishnappa	55	M	100430	OPEN TYPE II	RTA	RIGHT	22-01-2015	23-01-2015	120 MINUTES	20 WEEKS	NONE	NONE	NORMAL	NORMAL	FAIR
3	Manjunath	35	M	128538	OPEN TYPE II	RTA	LEFT	30-03-2015	01-04-2015	90 MINUTES	18 WEEEKS	NONE	NONE	NORMAL	NORMAL	EXCELLENT
4	Nagrajappa	50	M	94537	CLOSED	FALL	RIGHT	08-01-2015	10 -01-2015	90 MINUTES	24 WEEKS	NONE	NONE	NORMAL	>80%	GOOD
5	narayanappa	70	M	220582	OPEN TYPE I	FALL	LEFT	13-11-2014	14-11-2014	100 MINUTES	18 WEEKS	NONE	NONE	>90%	NORMAL	GOOD
6	narayanaswamy	55	M	122995	CLOSED	RTA	LEFT	14-03-2015	15-03-2015	70 MINUTES	20 WEEKS	NONE	NONE	NORMAL	>90%	GOOD
7	Srinivas	50	M	128913	OPEN TYPE I	RTA	LEFT	31-03-2015	01-04-2015	80 MINUTES	20 WEEKS	NONE	NONE	NORMAL	NORMAL	EXCELLENT
8	venkateshappa	45	M	125860	CLOSED	RTA	RIGHT	24-03-2015	26-03-2015	60 MINUTES	18 WEEKS	NONE	NONE	NORMAL	NORMAL	EXCELLENT
9	Vinod	26	M	107918	CLOSED	RTA	RIGHT	09-02-2015	13-02-2015	120 MINUTES	16 WEEKS	NONE	NONE	NORMAL	NORMAL	EXCELLENT
10	kalai vanal	28	M	104930	CLOSED	RTA	LEFT	02-02-2015	03-02-2015	90 MINUTES	16 WEEKS	NONE	NONE	NORMAL	>90%	GOOD
11	arun kumar	24	M	143789	CLOSED	RTA	RIGHT	08-05-2015	10-05-2015	110 MINUTES	20 WEEKS	NONE	NONE	NORMAL	NORMAL	EXCELLENT
12	Abdul	50	M	144735	CLOSED	RTA	RIGHT	06-05-2015	08-05-2015	100 MINUTES	24 WEEKS	NONE	NONE	>80%	NORMAL	FAIR
13	Nagaraj	50	M	158939	OPEN TYPE I	RTA	RIGHT	11-06-2015	12-06-2015	100 MINUTES	18 WEEKS	NONE	NONE	NORMAL	NORMAL	GOOD
14	uma rani	37	F	163776	CLOSED	FALL	RIGHT	29-06-2015	30-07-2015	90 MINUTES	16 WEEKS	MALUNION	NONE	NORMAL	NORMAL	EXCELLENT
15	Ganesh	19	M	164699	CLOSED	RTA	RIGHT	01-07-2015	02-07-2015	90 MINUTES	16 WEEKS	NONE	NONE	NORMAL	NORMAL	EXCELLENT
16	ganesh kumar	24	M	164830	OPEN TYPE I	RTA	LEFT	01-07-2015	02-07-2015	110 MINUTES	20 WEEKS	NONE	NONE	NORMAL	NORMAL	EXCELLENT
17	Subramani	24	M	168050	OPEN TYPE I	RTA	RIGHT	09-07-2015	10-07-2015	120 MINUTES	20 WEEKS	NONE	DYNAMIZATION	NORMAL	NORMAL	EXCELLENT
18	vasanthamma	65	F	166204	CLOSED	FALL	RIGHT	05-07-2015	06-07-2015	90 MINUTES	24 WEEKS	DEAYED UNION	NONE	>80%	NORMAL	FAIR
19	Nagappa	70	M	166014	CLOSED	RTA	LEFT	04-07-2015	05-07-2015	100 MINUTES	20 WEEKS	NONE	NONE	>90%	NORMAL	EXCELLENT
20	muniyamma	65	F	191031	OPEN TYPE I	FALL	LEFT	31-08-2015	01-09-2015	80 MINUTES	20 WEEKS	NONE	NONE	NORMAL	NORMAL	EXCELLENT
21	narasimhappa	55	M	194832	CLOSED	RTA	RIGHT	13-09-2015	14-09-2015	90 MINUTES	18 WEEKS	NONE	NONE	NORMAL	>90%	GOOD
22	Laxman	29	M	213154	CLOSED	RTA	RIGHT	26-10-2015	28-10-2015	100 MINUTES	16 WEEKS	NONE	NONE	NORMAL	NORMAL	EXCELLENT
23	Anjappa	45	M	212565	OPEN TYPE I	RTA	RIGHT	25-10-2015	26-10-2015	110 MINUTES	20 WEEKS	NONE	DYNAMIZATION	NORMAL	NORMAL	GOOD

24	Nagaraj	34	M	223804	OPEN TYPE IIIA	RTA	LEFT	22-11-2015	22-11-2015	110 MINUTES	24 WEEKS	INFECTION	NONE	NORMAL	>80%	POOR
25	narayanappa	40	M	240985	CLOSED	RTA	LEFT	04-01-2016	05-01-2016	60 MINUTES	18 WEEKS	NONE	NONE	NORMAL	NORMAL	EXCELLENT
26	vijay kumar	35	M	243503	CLOSED	RTA	LEFT	11-01-2016	13-01-2016	90 MINUTES	20 WEEKS	PROXIMAL SCREW BREAKAGE	DYNAMIZATION AND FIBULAR PLATING	NORMAL	NORMAL	POOR
27	Muniswamy	52	M	255834	CLOSED	RTA	LEFT	13-02-2016	14-02-2016	100 MINUTES	18 WEEKS	NONE	NONE	NORMAL	NORMAL	EXCELLENT
28	Govindappa	60	M	256894	CLOSED	RTA	RIGHT	17-02-2016	18-02-2016	90 MINUTES	18 WEEKS	NONE	NONE	NORMAL	NORMAL	EXCELLENT
29	ramachandrappa	45	M	255516	OPEN TYPE II	RTA	RIGHT	14-02-2016	15-02-2016	110 MINUTES	20 WEEKS	NON UNION	NONE	NORMAL	NORMAL	EXCELLENT
30	salma taj	25	F	263491	CLOSED	FALL	LEFT	07-03-2016	08-03-2016	110 MINUTES	14 WEEKS	NONE	NONE	NORMAL	NORMAL	EXCELLENT