RETROSPECTIVE AND PROSPECTIVE OUTCOME ANALYSIS OF SEGMENTAL FRACTURES OF TIBIA

Dissertation submitted to

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INSTITUTE OF ORTHOPAEDICS AND TRAUMATOLOGY
RAJIV GANDHI GOVERNMENT GENERAL HOSPITAL,
CHENNAI-3.

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CERTIFICATE

This is to certify that this dissertation titled **"Retrospective and Prospective Outcome Analysis of Segmental Fractures of Tibia"** is a bonafide record of work done by **DR.A.ARUL MURUGAN,** during the period of his Post graduate study from June 2015 to September 2017 under guidance and supervision in the Institute of Orthopaedics and Traumatology, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai-600003, in partial fulfilment of the requirement for **M.S.ORTHOPAEDIC SURGERY** degree Examination of The Tamilnadu Dr. M.G.R. Medical University to be held in April 2018.

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DECLARATION

I declare that the dissertation entitled **"Retrospective and Prospective Outcome Analysis of Segmental Fractures of Tibia"** submitted by me for the degree of M.S.Orthopaedics is the record work carried out by me during the period of **June 2015 to September 2017** under the guidance of **PROF.N.DEEN MUHAMMAD ISMAIL., M.S.Ortho., D.Ortho.,** Director and Professor of Orthopaedics, Institute of Orthopaedics and Traumatology, Madras Medical College, Chennai.

This dissertation is submitted to the Tamilnadu Dr.M.G.R. Medical University, Chennai, in partial fulfillment of the University regulations for the award of degree of M.S.ORTHOPAEDICS (BRANCH-II) examination to be held in April 2018.

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CONTENTS

INTRODUCTION

Segmental tibia fractures is defined as a unique fracture type characterized by least two different fracture lines with a completely isolated intercalary osseous fragment. Segmental fractures of tibia are uncommon and are usually caused by a high-energy trauma. They have a high complication rate.

Incidence is about 12.8 % of all tibia fractures. Modes of injury commonly are road traffic accidents, falls from height, industrial and train accidents. Almost 37.5 % to 83.8 % of these fractures are open and they often sustain injury to the others parts of body. Since it is caused by high energy trauma there is severe soft tissue injury and periosteal stripping due to which the central fragment is devoid of blood supply. Segmental tibia fracture is considered as separate clinical entity compared to the normal tibia fractures for the following reasons like, they are almost always caused by high-energy injuries, approximately 50% are compound, they are often part of multiple injuries, they are frequently associated with sever soft tissue injuries, they have high complication rates, also their prognosis is often poor. Treatment goal for this type of fracture is clinical and radiological union maintaining normal length, normal alignment, no rotational deformity, normal adjacent joint movements and reduced morbidity. Current treatment options are locked intramedullary nailing, external fixators and plaster of paris cast immobilization. Delayed unions and nonunion are commonly seen with segmental tibia fractures when compared to non-segmental tibia fractures.

AIM OF THE STUDY

To evaluate the Functional and Radiological outcome following open / closed reamed interlocking intramedullary nailing for segmental fractures of tibia

REVIEW OF LITERATURE

The history of intramedullary nailing for the treatment of long bone fractures and nonunion has begun long ago in 16^{th} century.

Bernardino de Sahagun, a 16th century Anthropologist in Mexico with Hernando Cortes, recorded the first use of an intramedullary device, who witnessed Aztec physicians placing wooden sticks into the medullary canals of patients with long bone nonunion.

During the middle 1800 and up to the first decade of the 1900, most of the work in intramedullary nailing of nonunion appear to use of ivory pegs. The majority of this work was reported at the time in the German literature.

Gluck, during 1890s recorded the first description of an interlocked intramedullary device made up of ivory with holes at both ends where ivory interlocking pins could be passed.

Nicolaysen of Norway, around the same time period, described the biomechanical principles of intramedullary devices in the treatment of proximal femur fractures where he proposed that the length of intramedullary implants can be maximized to provide for the best biomechanical advantage.

Hoglund of the United States at 1917 reported the use of autogenous bone as an intramedullary implant in which a span of the cortex was cut out and then passed up the medullary cavity across the fracture site.

Hey Groves of England, during World War I, reported the first use of metallic rods for the treatment of gunshot wounds where these rods were passed into the medullary cavity through an incision made over the fracture site. This technique appeared to have a high infection rate and was not universally accepted.

After Smith-Petersen's 1931 report of the successful use of stainless steel nails for the treatment of femoral neck fractures, that the application of metallic intramedullary implants began to expand rapidly.

Gerhard Kuntscher first reported use of the V-shaped stainless steel nail in 1940 which he recommended inserting the nail into the bone away from the fracture site, thus, avoiding any disturbance of the zone of injury and preventing infection. But his work was not well appreciated in Germany. Later he collaborated with Finnish surgeons and reported in 1947, of 105 cases using the V-shaped nail. By the late 1940s, Kuntscher had begun to abandon use of the V-shaped nail design in favor of another Kuntscher design, the cloverleaf nail for torsional stability.

In 1946, Soeur reported on his use of a U-shaped nail in the femur, tibia and humerus.

In the US, the Hansen-Street nail was introduced in 1947. This was a solid diamond-shaped nail, designed to resist fracture rotation via its compressive fit within the cancellous bone. These nails were originally inserted using a closed method in order to avoid the high infection rate reported earlier by Hey Groves.

In 1942, Fischer had reported the use of intramedullary reamers to increase the contact area between the nail and host bone. However, it took another decade with Kuntscher's introduction of flexible reamers.

In 1950 Herzog modified the Kuntscher nail, by adding a proximal Bend for easy insertion

Modny and Bambara introduced the transfixion intramedullary nail in 1953 which was cruciate-shaped, with multiple holes the length of the nail to allow for placement of screws at 90° angles from each other. Also during this time, a rapid gain in experience occurred using reamed nails for treating tibia shaft fractures. The dominant design during this time period was the slotted cloverleaf-shaped interlocked nail, e.g., the AO and Grosse-Kempf nails.

Design achievements of the 1990s included the introduction of new titanium nails, cephalomedullary devices such as the Gamma nail, and retrograde supracondylar intramedullary nails such as the GSH (Green-Seligson-Henry) nail.

Most commonly performed surgery for segmental tibia fracture is interlocking intramedullary nailing in spite of significant difficulty and complications rates of other currently available treatment modalities.

Duan et al, in a Cochrane Review on intramedullary nailing was unable to come to a definitive conclusion whether reamed or undreamed nail for segmental tibia fracture. They also noted that reamed nail for closed segmental tibia fracture demonstrated a decreased incidence of implant failure, less re-operation related to nonunion.

Mundi et al In a review of open tibial diaphyseal fractures treated by reamed and undreamed nailing echoed that superiority of reamed nailing in closed tibia fractures, but no significant difference detected in open fractures.

In 1969 Zucman and Maurer published their treatment of 36 segmental tibia fractures with un-reamed Kuntscher-type nails in their 36 patients, 92% went on to union, but with 16% rate of septic union in patients with compound injury.

In 1972 Pantazopoulos et al reported on their results of unreamed Kuntscher nailing of 13 segmental tibia fractures with one nonunion, no cases of infection, and no cases of malunion.

In 1981, Melis et al detailed their treatment of 38 segmental tibia fractures with reamed Kuntscher-Herzog intramedullary nails and supplementation with immobilization in 22 closed and 16 open fractures, they reported one malunion, one non-union, and one infection.

Woll and Duwelius reported on their treatment of 31 segmental tibia fractures with seven fractures treated with unreamed Lottes’ nails and the remaining fractures were treated with External fixation, plate osteosynthesis, and nonoperative treatment. Of the four treatment modalities unreamed unlocked Lottes’ nails demonstrated the lowest complication rate. He also convinced that the high rate of nonunion and malunion was due to the lack of distal rotational control and distally locked intramedullary nails would provide a much lower rate of malunion.

In 1985 Klemm and Birner has done a review of early reports on tibia fractures treated between 1976 and 1983 with reamed locked intramedullary nailing. Of the 401 tibia fractures 41 were segmental with an overall delayed union of 0.8%, infection rate of 2.2%, and an excellent or good outcome in 94% of patients.

Wu and Shih treated 38 segmental tibia shaft fractures with reamed interlocking intramedullary tibia nailing with the results of Klemm and Birner in mind, and reported a union rate of 97% without any deep infections, clinically significant malalignment, or implant failures.

With the positive results of reamed locked intramedullary nailing of segment tibia fractures, Huang et al treated 33 segmental tibia fractures with this technique and reported 3% malunion, 9% delayed unions, no cases of nonunion, and 6% deep infection rate which is in compound fractures.

With the use of reamed intramedullary nail it was suggested to reduce and stabilize the fracture with a pointed reduction clamp or schanz pin or drill bit to avoid rotation of the fragment and potential stripping of soft tissues from the fracture fragment. With these principals in mind, Kakar and Tornetta followed 51 patients to union with segmental tibia fractures treated with unreamed locked intramedullary nail placement with only a 9% revision rate.

Most recently Terra et al compared healing in matched controls of 30 segmental and non-segmental tibia fractures treated with 18 unreamed locked intramedullary nails, 4 reamed locked intramedullary nails, 3 plate osteosynthesis, and 5 external fixation. The preferred treatment was unreamed locked intramedullary nailing, but the authors report a greater than 55% rate of reoperation to obtain union.

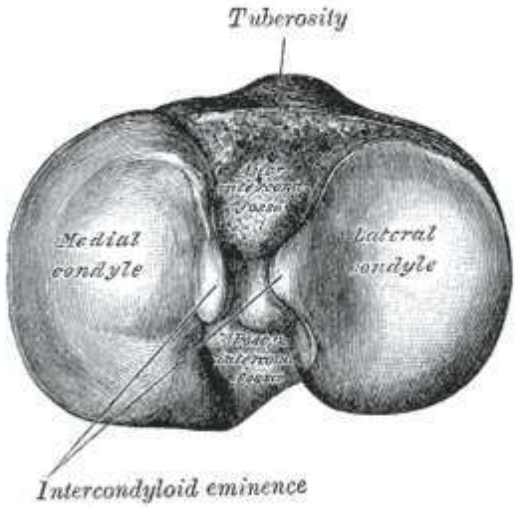
The preferred treatment of closed segmental tibia shaft fractures is reamed locked intramedullary nailing to maximize biomechanical stability of the construct. The preferred treatment of open segmental tibia shaft fractures is undreamed locked intramedullary nailing to maximize fracture biology and to minimize the risk of devascularization of the intercalary segment.

SURGICAL ANATOMY OF LEG

The bony framework of the leg consists of two bones, the tibia and fibula. Tibia is the strongest and largest of two bones in leg which is also known as shinbone or shank bone. The tibia is medial to the fibula and it closer to the median plane. The tibia is connected to the fibula by syndesmotic joint which is called as interosseous membrane of the leg. It is the second largest bone in the human body next to the femur. The leg bones are the strongest long bones as they support the rest of the body. The tibia is called as a long bone as it is composed of a diaphysis and two epiphyses.

PROXIMAL TIBIA

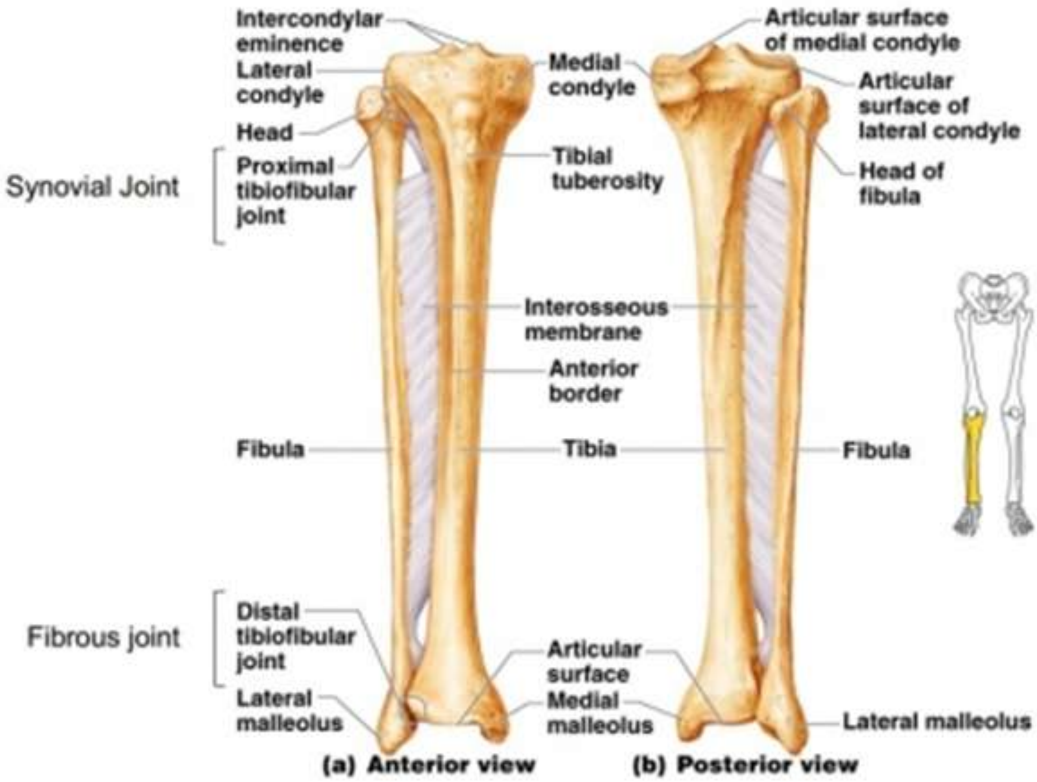
The proximal tibia is expanded in the transverse plane with a medial and lateral condyle, which are both flattened in the horizontal plane. The medial condyle is the largest and is better supported over the shaft. The upper surfaces of the condyles articulates with the femur to form the knee joint. The weight bearing part of the knee joint is medial tibiofemoral joint. The two condyle are separated by the intercondylar area. In front and behind the intercondylar eminence there rough depressions for the attachment of the anterior and posterior cruciate ligaments and the menisci. Together with the medial and lateral condyle the intercondylar region forms the tibial plateau, which both articulates with and is anchored to the distal femur. The articular surfaces of both condyles are concave, particularly centrally. The flatter outer margins are in contact with the menisci. The posterior surface of the medial condyle have a horizontal groove for attachment of the semimembranosus muscle, whereas the lateral condyle has a circular facet for articulation with the head of fibula. Below the condyles anteriorly is the tibial tuberosity which serves for attachment of the patellar ligament.



MID THIRD TIBIA

The shaft of the tibia is triangular in cross-section and forms three borders: An anterior, medial and lateral also called as interosseous border. All the three borders form three surfaces; the medial, lateral and posterior.

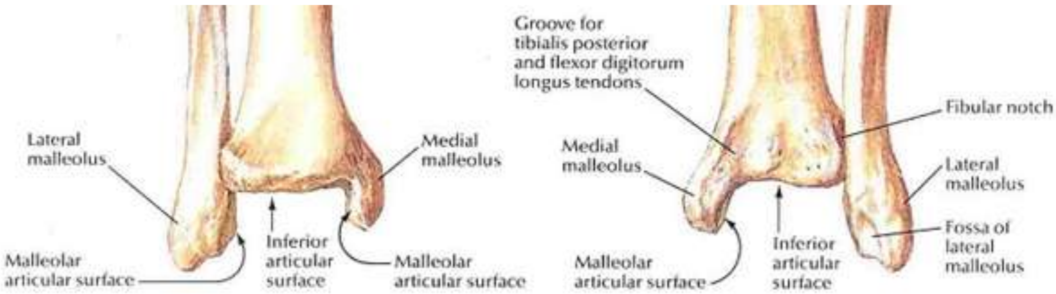
Anterior border is the most prominent. It commences above at the tuberosity, and ends below at the anterior margin of the medial malleolus. It gives attachment to the deep fascia of the leg. The medial border begins at the back part of the medial condyle, and ends at the posterior border of the medial malleolus; its upper part gives attachment to the tibial collateral ligament of the knee-joint to the extent of about 5 cm., and insertion to some fibers of the popliteus muscle; from its middle third some fibers of the soleus and flexor digitorum longus muscles take origin. The interosseous crest or lateral border gives attachment to the interosseous membrane; it commences above in front of the fibular articular facet, and bifurcates below, to form the boundaries of a triangular rough surface, for the attachment of the interosseous ligament which connect the tibia and fibula.



The medial surface is covered by the aponeurosis derived from the tendon of the sartorius, and by the tendons of the gracilis and semitendinosus, rest of its extent it is subcutaneous. The lateral surface is a shallow groove for the origin of the tibialis anterior; its lower third is smooth, and is covered by the tendons of the tibialis anterior, extensor hallucis longus, and extensor digitorum longus, arranged in this order from the medial to lateral The posterior surface presents, at its upper part, a prominent ridge, the popliteal line which marks the lower limit of the insertion of the popliteus and serves for the attachment of the fascia covering this muscle, and gives origin to part of the soleus, flexor digitorum longus, and tibialis posterior. The middle third of the posterior surface is divided by a vertical ridge into two parts; the ridge begins at the popliteal line and is well-marked above, but indistinct below; the medial and broader portion gives origin to the flexor digitorum longus, the lateral and narrower to part of the tibialis posterior. The remaining part of the posterior surface is smooth and covered by the tibialis posterior, flexor digitorum longus, and flexor hallucis longus. Immediately below the popliteal line is the nutrient foramen, which is large and directed obliquely downward.

LOWER THIRD TIBIA

The lower extremity of the tibia is much smaller than the upper extremity and presents five surfaces; it is prolonged downward on its medial side as a strong pyramidal process, the medial malleolus. The lower extremity of the tibia together with the fibula and talus forms the ankle joint. The inferior articular surface is quadrilateral, and smooth for articulation with the talus. It is concave from before backward, broader in front than behind and it is continuous with that on the medial malleolus. The anterior surface of the lower extremity is smooth and rounded above, and covered by the tendons of the extensor muscles; its lower margin presents a rough transverse depression for the attachment of the articular capsule of the ankle-joint. The posterior surface is traversed by a shallow groove directed obliquely downward and medial ward, continuous with a similar groove on the posterior surface of the talus and serving for the passage of the tendon of the flexor hallucis longus. The lateral surface presents a triangular rough depression for the attachment of the inferior interosseous ligament connecting it with the fibula; the lower part of this depression is smooth, covered with cartilage in the fresh state, and articulates with the fibula. The surface is bounded by two prominent borders (the anterior and posterior colliculi), continuous above with the interosseous crest; they afford attachment to the anterior and posterior ligaments of the lateral malleolus. The medial surface is formed by medial malleolus.



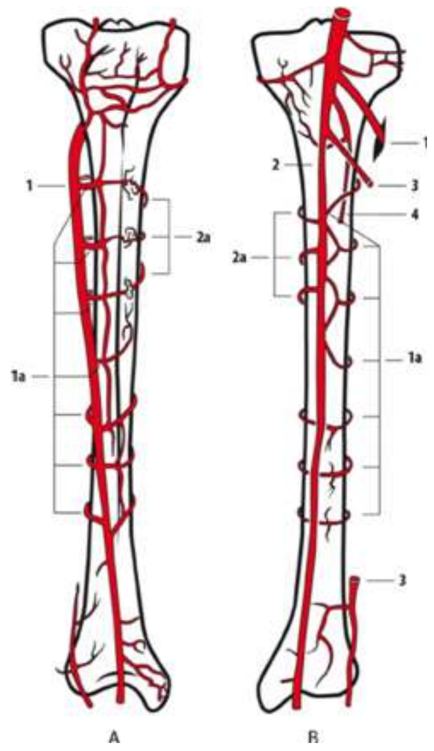
JOINTS FORMED WITH TIBIA

The tibia is a part of four joints in leg; the knee, ankle, superior and inferior tibiofibular joint

BLOOD SUPPLY OF TIBIA

Nutrient artery arises from posterior tibial artery and it enters posterolateral cortex of the tibial at the origin of the soleus muscle and it divides into three ascending branches & a single descending branch, which gives off smaller branches to the endosteal surface. It may be damaged in segmental fractures of tibia

Periosteal blood supply may be vulnerable to injury after its division from popliteal artery, where it passes thru hiatus in upper interosseous membrane, periosteum has abundant blood supply from anterior tibial artery branches as it courses down interosseous membrane



OSSIFICATION OF TIBIA

It is ossified from three centers; a primary center for the diaphysis and two secondary center for both epiphysis. Ossification begins in the center of the body at seventh week of fetal life, and gradually extends toward the extremities. The center for the upper epiphysis appears before or shortly after birth at close to 34 weeks gestation; it is flattened in form, and has a thin tongue-shaped process in front, which forms the tibial tuberosity (traction apophysis); that for the lower epiphysis appears in the second year. The lower epiphysis fuses with tibial shaft at eighteen years, and the upper one fuses about the twenty years. Two additional centers occasionally exist, one for the tongue-shaped process of the upper epiphysis, which forms the tuberosity, and one for the medial malleolus.

FIBULA

The fibula or calf bone is located on the lateral side of the tibia, to which it is connected above by arthroidal joint and below by syndesmotic joint. It is the smaller of the two bones. Its upper extremity is small, placed toward the back of the condyle of tibia, below the level of the knee joint, it does not contribute in formation of knee joint. Its lower extremity inclines a little forward, so as to be on a plane anterior to that of the upper end; it projects below the tibia, and it helps in formation of the lateral part of the ankle-joint. Head of the fibula is of an irregular quadrangular in shape with medial articulating surface for tibia. On the lateral side is a thick and rough surface gives attachment to the tendon of the biceps femoris and to the fibular collateral ligament of the knee-joint, the ligament dividing the tendon into two parts.

The body of the fibula presents four borders - the antero-lateral, the antero-medial, the postero-lateral, and the postero-medial; and four surfaces - anterior, posterior, medial, and lateral.

BORDERS

The antero-lateral border gives attachment to an intermuscular septum, which separates the extensor muscles on the anterior surface of the leg from the peronaei longus and brevis on the lateral surface. The antero-medial border, or interosseous crest serves for the attachment of the interosseous membrane, which separates the extensor muscles in front from the flexor muscles behind. The postero-lateral border gives attachment to an aponeurosis which separates the peronaei on the lateral surface from the flexor muscles on the posterior surface. The postero-medial border gives attachment to an aponeurosis which separates the tibialis posterior from the soleus and flexor hallucis longus.

BLOOD SUPPLY

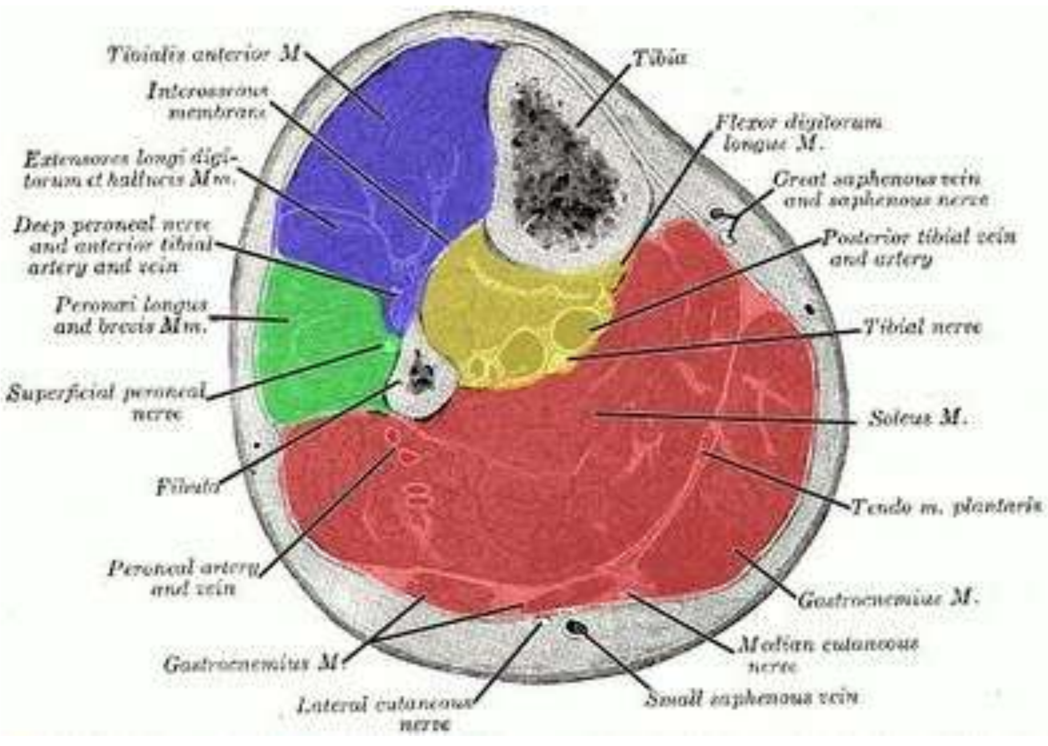
The shaft is supplied in its middle third by a large nutrient vessel from the fibular artery. It is also perfused from its periosteum which receives many small branches from the fibular artery. The proximal head and the epiphysis are supplied by a branch of the anterior tibial artery.

DEVELOPMENT

The fibula is ossified from *three* centers, one for the shaft, and one for either end. Ossification begins in the body about the eighth week of fetal life. Ossification commences in the lower end in the second year, and in the upper about the fourth year. The lower epiphysis, the first to ossify, unites with the body about the twentieth year; the upper epiphysis joins about the twenty-fifth year

INTEROSSEOUS MEMBRANE OF LEG

The interosseous membrane of leg is a tough fibrous sheet of connective tissue that spans the distance between facing interosseous borders of the tibial and fibular shafts. The collagen fibers descend shaft obliquely from the interosseous border of the tibia to the interosseous border of the fibula, except superiorly where there is a ligamentous band, which ascends from the tibia to fibula. There are two apertures in the interosseous membrane, one at the top and the other at the bottom, for vessels to pass between the anterior and posterior compartments of leg. The interosseous membrane not only links the tibia and fibula together, but also provides an increased surface area for muscle attachment.



CLASSIFICATION

AO/OTA Classification of tibial shaft fracture

Simple fractures: 42-A1: Spiral

42-A2: Oblique >30 degree

42-A3: Transverse <30 degree

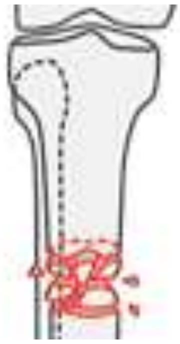
Wedge fractures: 42-B1: Spiral wedge

42-B2: Bending Fragmented wedge

Complex fractures: 42-C1: Spiral

42-c2: Segmental

42-C3: Irregular



GUSTILO ANDERSON CLASSIFICATION

Type	I	II	IIIA	IIIB	IIIC
Energy of injury	Low energy	Moderate	High	High	High
Size of wound	< 1 cm	> 1cm	>10cm	>10cm	>10cm
Soft tissue contamination	Clean	Moderate contamination	Extensive	Extensive	Extensive
Fracture Pattern	Simple fracture pattern with minimal comminution	Moderate comminution	Severe comminution or segmental fractures	Severe comminution or segmental fractures	Severe comminution or segmental fractures
Periosteal Stripping	No	No	Yes	Yes	Yes
Skin Coverage	Local coverage	Local coverage	Local coverage including	Soft tissue loss which require plastic surgeon intervention	Soft tissue loss which require plastic surgeon intervention
Neurovascular Injury	Normal	Normal	Normal	Normal	Neurovascular injury present which require vascular surgeon intervention

CLASSIFICATION PROPOSED BY MELIS *ET AL* IN 1981

They divided segmental tibia fractures into four distinct categories based on fragment fixation with an intramedullary tibial nail construct.

Type I: Defines a segmental fragment between the proximal and middle third of diaphysis of tibia

Type II: Defines a segmental fragment between the middle and distal third of tibial diaphysis.

Type III: Defines a long segmental fragment between the proximal and distal third of tibial diaphysis

Type IV: defines a segmental fragment which is entirely contained in the middle third of the tibial diaphysis.

EVALUATION

- History and physical examination
- Trauma series X ray
- Anteroposterior and lateral view of leg with knee with ankle
- Computed tomography (CT) to rule out intra-articular extension both in knee and ankle joint

TREATMENT OPTIONS AVAILABLE FOR SEGMENTAL FRACTURES OF TIBIA ARE

Intramedullary interlocking nailing:

Intramedullary nailing is the commonly performed surgery for segmental tibia fracture. Inspite of its popularity, it has many potential pitfalls when done for displaced segmental tibia fracture. An interlocking Nail can overcome the disadvantages of plating and conventional Kuntscher nailing wherein the fractures can be stabilized immediately, and early ambulation becomes possible. Intramedullary nailing has the advantage of controlling the length, rotation, alignment, dissection of the fracture site, disruption of the fracture vascularity, early weight-bearing, and incision site away from traumatic open wounds. Duan et al, in a Review on intramedullary nailing for adult diaphyseal tibial fractures, was unable to come to a definitive conclusion between reamed and unreamed nailing. They also noted that reamed nailing demonstrated a decreased incidence of implant failure, less re-operation related to nonunion for closed tibia fractures. In a review of open tibial diaphyseal fractures Mundi et al found that superiority of reamed nailing in closed tibia fractures, but no significant advantage in open fractures. The decision of unreamed versus reamed tibial nails is much less certain in segmental tibia fractures as reports in the literature are much less common than non-segmental fractures of the tibial diaphysis. One of the main advantages of treatment with an intramedullary nail is that we can preserve the blood supply to the middle fragment from surround soft tissue but while reaming the middle fragment will go for rotational deformity which will strip the periosteum and lead on to avascular necrosis. To minimize this complication the middle fragment is reduced and stabilized with a pointed reduction clamp to avoid stripping of soft tissues from the fracture. So the preferred treatment of closed segmental tibial shaft fractures is reamed locked intramedullary nailing to maximize biomechanical stability of the construct and for open segmental tibial shaft fractures, unreamed locked intramedullary nailing to maximize fracture biology and to minimize the risk of devascularization of the middle segment.

Plate osteosynthesis

The main principles in treatment of segmental tibia fractures is to preserve the soft tissue around the bone, minimize interventions at the site of fracture, reproduce anatomic leg length, alignment and rotation which will provide a suitable environment for fracture healing . Segmental fractures of the tibia treated by plate osteosynthesis failed to challenge these above mentioned principals. Rommens *et al* In a series of 22 patients treated with plate osteosynthesis published in 1989, found a 60% complication rate with greater than 25% chance of wound complication and infection. Not surprisingly, approximately 20% of tibias went on to develop pseudarthrosis with some progressing to implant failure. With the greater understanding of fracture biology and healing has developed the use of plate osteosynthesis decreased.

External fixator

External fixation provides a viable option segmental tibia fractures as it provides immediate stability to a grossly unstable injury. Unilateral placement of AO tubular external fixator with convergent pin orientation provides necessary stability of the fracture and support. It was thought to leave a small footprint and maintain the biology of the fracture in a comparable manner to conservative treatment. Management by external fixator has proven to provide immediate skeletal stabilization, decreased operative time, reduced blood loss, and improved blood supply at fracture sites in segmental tibia fractures. Unfortunately, the frequency of pin tract infection, delayed union, nonunion and malunion lead to removal and conversion to alternate methods of definitive fixation. External fixator with extensive soft tissue compromise provides a viable option for the treating surgeon for easy access to the injured tissue and provides initial stability. Rommens et al reported 50% were complicated by “bone-healing disturbances” which include pseudarthrosis, refracture, delayed union, and malunion. This complications was thought to be related to the lack of stability in bi-dimensional planes.

Ilizarov ring fixator

Ilizarov external fixation has the capacity to provide multilevel stabilization of the fracture with minimal disturbance to the soft-tissue envelope. It gives multiplanar control which is absent from monolateral designs. It leaves a very small ‘footprint’ on the biology of the fracture and is almost equivalent to conservative methods if fixation pins are kept away from the fracture zones except from the patient can able to weight bear immediately after surgery and this produces a micro movement at fracture site and this serves as a stimulus for callus formation. Ilizarov external fixators were commonly used for grade III compound segmental tibia fractures. It has the advantage of circumferential 360 degree control, post-surgical deformity correction outside of the operating room, capture all fracture segments, provides minimal disruption of fracture biology, and possibly allows almost immediate partial weight-bearing. Most common complication is patient intolerance and pin tract infection. But this can be managed with a short course of antibiotics. Ozturkmen et al demonstrated successful treatment of 24 adult patients all of whom went on to union with good to excellent function results. Giotakis et al used circular external fixation to include Ilizarov and Taylor Spatial Frame in the treatment of 20 segmental tibia fractures. Of which there were 2 nonunion treated with either continued external fixation or revision with bone grafting.

Conservative treatment with casting and bracing

Charnley noted that a double fracture of the tibia (segmental fracture) should never be initially treated with an open operation as the danger of converting the central fragment into a tubular sequestrum due to stripping of periosteum leading to avasularity. Langard and Bo stated that initial "non-operative treatment was considered essential" in many patients with segmental tibia fractures which is mostly caused by high energy trauma due to the high incidence of concomitant injuries. The advantages of conservative treatment is intraosseous and extraosseous blood supply is maintained in this method of treatment but the main disadvantage is prolonged immobilization of ankle and knee joint which leading on to knee stiffness and morbidity and malunion. The desire for a more rigid construct to add stability to the segmental fracture and the increasingly frequent use of intramedullary nails led to the decrease in conservative management. Conservative management should be reserved for low risk patients with a closed fracture, minimal shortening, and minimal angulation after a thorough discussion of risks and complications. Overall, surgery is the preferred treatment for segmental tibia fractures given the difficulty in maintaining an acceptable reduction in a functional brace or cast.

INTERLOCKING NAILING IN SEGMENTAL TIBIA FRACTURE

Accurate starting point for tibia nailing continues to play a crucial role in this procedure. Ideal starting point for Intramedullary nailing of tibia lies at the anterior edge of the tibial plateau and just medial to the lateral tibial spine. Usually the proximal fragment will go for varus angulation and extension. To counter act this deformity lateral entry point may be taken. Most commonly used approach for the starting point for intramedullary nailing of tibial shaft fractures is through an infrapatellar approach either by splitting the patellar tendon (transtendinous approach) or alternatively by dissecting just adjacent to the patellar tendon (paratendinous approach). The knee is rested over the radiolucent triangle in a flexed or hyperflexed position or made to hang over the edge of the table. The radiolucent triangle will serve as counter traction while reducing the fracture.

Nailing in the semi extended position has recently gained popularity in the orthopedic literature. It has been suggested by Tornetta and Collins as a method to avoid apex anterior deformities. Recent reports have modified this concept suggesting tibial nailing in the semi extended position using a suprapatellar approach and nail insertion through the patellofemoral joint. For the past few years, surgical instrumentation has been developed for performing the surgery safely without damaging the articular cartilage. It is performed with the knee flexed approximately 15–20 degrees with 3 cm longitudinal incision above one to two fingerbreadths of the patella. Blunt dissection of the quadriceps tendon performed and patellofemoral joint entered. The starting point is established under fluoroscopic guidance using a 3.2-mm guide pin strictly adhering to the fluoroscopic landmarks described above. The remaining surgical procedure including reaming of the canal and tibial nail insertion is performed through the cannula system which allows for safe protection of the surrounding soft tissues and articular structures. Suprapatellar nailing in the semiextended position may also represent a feasible alternative to the traditional infrapatellar approach when soft tissue injuries around the infrapatellar area make the placement of surgical incisions undesirable.

REDUCTION TECHNIQUES

During tibia nailing fracture reduction should be attained and maintained throughout the nailing processes. Placement of the tibial nail alone does not result in adequate fracture reduction. While application of simple longitudinal traction results in improved fracture alignment through ligamentotaxis principle, but that is not adequate to achieve an anatomic fracture reduction. There are various closed, minimal invasive, and open reduction maneuvers have been described and should be in the surgeons armamentarium while doing nailing.

The universal distractor can be used as a reduction tool if the fracture is old by assisting in maintaining length and alignment. Schanz pins are place carefully in medial side away from the planned position of the tibial nail or at the proximal and distal locking site. Alternatively two-pin external fixation can be used to obtain and maintain length and alignment during intramedullary nailing of tibial shaft fractures with pin placed following previous principle.

Closed reduction can also be achieved by F-tool. It is an F-shaped radiolucent reduction device that will allow for correction of varus/valgus angulation as well as correction of medial/lateral translation. But due to significant pressure on the tissues prolonged application should be avoided.

Certain fractures can also be reduced by placement of percutaneously placed reduction clamps. Particularly, spiral and oblique fractures reduces readily on application of percutaneous clamps. These clamps can be applied in a soft tissue through small stab incisions. The type of the clamp and the location of the surgical incisions should be chosen accordingly in order to minimize any prolonged soft tissue compromise from clamp placement.

Open reduction maneuvers with respectful handling of the surrounding soft tissues can be performed if failed by closed reduction. It not only allows for applying reduction clamp directly over bone but also mini plates can be fixed to maintain reduction during entire procedure and also provide additional stability. The plates are secured to the proximal and distal fracture fragments using unicortical screws. If planned to leave the plate insitu, the unicortical screws should be exchanged against bicortical screws. Unicortical plating or "reduction plating" has been suggested as a safe and effective technique and should be considered for select cases of tibial shaft that require an open approach to achieve an acceptable fracture reduction.

Blocking screws (poller screws) is used in the metaphyseal area to attain reduction and to substitute a deficient cortex. The blocking screws are placed prior to the reaming process and nail placement. Blocking screws are typically placed on the concave side of the deformity. For instance, the typical deformity of a proximal third tibia fracture is characterized by a valgus- and apex anterior deformity a blocking screw can be placed in an anterior to posterior direction into the lateral portion of the proximal fracture fragment. Similarly, the apex anterior deformity can be overcome by a blocking screw that is placed in a medial to lateral direction in the posterior portion of the proximal fragment.

Fibula fixation for distal tibia fracture is an accepted treatment for attaining good reduction of tibia. Prasad et al. compared intramedullary tibial nail fixation with fibula fixation versus intramedullary tibial nail fixation without fibula fixation in 60 distal third tibia-fibula fractures. The authors reported improved rotational and varus / valgus alignment in patients undergoing fibula fixation in conjunction with tibial nailing. However, the authors also reported a wound complication rate of 10 % in the fibula fixation group. Author concluded that in distal third tibial shaft fractures undergoing intramedullary nail fixation, adjunct fibula fixation may allow for achieving and maintaining fracture reduction of the tibia. However, there remains the concern of wound complications from the additional incision in the area of traumatized tissue. They therefore suggest using adjunct fibula fixation cautiously.

PATHOPHYSIOLOGY OF INTRAMEDULLARY NAILING

Nailing without reaming

Smaller diameter implants are used in nail insertion without reaming. The advantages are less heat production and less disturbances of the endosteal blood supply resulting in considerable less bone necrosis, which appears to be one of the risk factors for the development of post-operative infection. The influence of nail diameter on blood perfusion and mechanical parameters studied in dog models by Hupel TM et al. Following segmental osteotomy of the tibia, it was shown that a loose fitting nail did not affect cortical perfusion as much as right fitting nail and it allowed more complete cortical revascularization at 11 weeks post nailing.

Nailing with reaming

Nailing with reaming produces various local and general changes in the body.

Local Changes

“Tibial reaming enhances periosteal blood flow and increases muscle perfusion. It reduces endosteal blood flow for a period but this seems to have little clinical effect. Unlike femoral reaming, it seems to have little coagulative effect and does not cause adult respiratory distress syndrome (ARDS). Reamed nailing of closed tibial diaphyseal fractures gives better clinical results than unreamed nailing. This is not true of severe open tibial fractures, where the results of reamed and un-reamed nailing appear to be very similar.

General Changes

These include pulmonary embolism, temperature related changes of the coagulation system and humoral, neural and inflammatory reaction. The development of post traumatic pulmonary failure following early femoral nailing in the multiple injured patients is associated with the reaming procedure. Wenda et al measuring intramedullary pressure intra operatively, found values between 420 – 1510 mm Hg with reaming procedures, as compared with 40 – 70 mm Hg in cases where used without reaming.

COMPLICATIONS

ANTERIOR KNEE PAIN

It is a commonly reported complication after intramedullary nailing of tibia. A comprehensive review with pooled data from publications including the years 1990 until 2005 suggested that postoperative knee pain may occur in approximately 47 % of patients following intramedullary nailing. The exact cause for anterior knee pain following tibial nailing is not fully understood. By serial observation the probable cause may include traumatic and iatrogenic damage to intraarticular structures, injuries to the infrapatellar branch of the saphenous nerve, thigh muscle weakness secondary to pain-related neuromuscular reflex inhibition, impingement due to fat pad fibrosis, reactive patellar tendonitis, bending strain exerted by the nail on the proximal part of the tibial bone, and proximal protrusion of the nail. As of now, it is assumed that the reason for postoperative knee pain is multifactorial and the above mentioned factors may be contributing to this problem at varying degrees. In order to find the cause of anterior knee pain after intramedullary nailing, transtendinous approaches and paratendinous approaches were compared. Prospective randomized clinical data has not shown any significant difference between the transtendinous and paratendinous approach. In a prospective randomized clinical trial including fifty patients undergoing intramedullary tibial nailing, Toivanen et al. at an average follow-up of 3.2 years did not find any significant differences in the functional outcomes of the transtendinous versus paratendinous approach. In a subsequent follow-up study using the same patient population with eight year follow-up, they reported there were no significant differences between the two approaches.

The treatment of elective hardware removal following intramedullary tibial nailing remains uncertain. Court-Brown et al. reported marked or complete relief of anterior knee pain in 60 out of 62 patients who underwent elective nail removal. In contrast, Keating et al. reported on 49 patients undergoing tibial nail removal due to persistent anterior knee pain, approximately 45 %, partial relief in approximately 35 %, and no improvement in approximately 20 % of patients. We recommend considering nail removal only in patients with persistent anterior knee pain if a mechanical etiology, such as nail protrusion or prominent interlocking screws, can be identified. However, in symptomatic patients with correctly placed hardware, the benefit of a tibial nail removal remains uncertain.

With regards to postoperative anterior knee pain, good results have been reported in preliminary clinical investigations of suprapatellar tibial nailing. Jones et al. reported no differences with anterior knee pain between patients undergoing suprapatellar versus infrapatellar nailing.

However, the authors reported that there was trend toward greater symptomatic knee pain in the infrapatellar group. Furthermore, Sanders et al. reported on 56 consecutive patients undergoing suprapatellar nailing in the semi extended position. These authors did not identify any patients with postoperative anterior knee pain at 12 months follow-up except one patient who presented with peri-incisional pain around the knee.

INFECTION

The combination of open operation and instrumentation of the whole diaphysis raises concern about the risk and consequences of infection. Infections were classified into three stages.

The first stage (early) is a stage of bacterial cellulitis occurring in the immediate postoperative period usually within 2-6 weeks. It is usually treatable with high doses of intravenous antibiotics and, as long as stability of the fracture is retained. There is no need for wound exploration or implant removal. If there is an underlying collection then incision and drainage is mandatory.

The second stage (Intermediate) defined between 2 to 9 months post-operatively, is associated with delayed wound healing, wound necrosis or discharge from the operative site. Impaired fracture healing response may be present. At this stage bone infection will be present and nail removal, followed by re-stabilization of the fracture could be necessary. However, assuming that the implant (nail) still provides a stable mechanical environment, revision of fixation may not be necessary and local soft tissue treatment should be combined with the appropriate administration of antibiotics for suppression of the infection until union is established.

The third stage (late) represents established intramedullary osteomyelitis. In this case, principles of management include establishing the extent of non-viable hard and soft tissue (the zone of necrosis) and the extent of infection (the zone of disease). After debridement and irrigation, the most appropriate method of fracture stabilization is carried out if the fracture is still un-united and for any bone loss restoration is performed when an aseptic environment has been achieved with the most appropriate option (i.e.: bone grafting, bone transport, etc.). If the fracture has united usually implant removal with debridement and irrigation of the intramedullary canal is recommended.

VASCULAR DAMAGE

The most feared vascular complication of tibial nailing is drill damage to the popliteal artery in the area of the arterial trifurcation. Avoidance of the complication is achieved by meticulous attention to surgical detail. If an anteroposterior cross screw is used, it is important to pass the drill slowly through the nail and to feel for the posterior tibial cortex, which may well provide little resistance in osteoporotic bone. Damage to the medial inferior genicular artery has also been noted, and there is a report of distal cross screw occlusion of the posterior tibial and peroneal arteries. It should be emphasized that severe vascular complications of intramedullary nailing are rare and should be avoidable by using correct nailing techniques.

HARDWARE BREAKAGE

Nail and screw breakage rates depend on the size of the nail that is used and the type of metal from which it is made. Larger reamed nails have larger cross screws, and the incidence of nail and screw breakage is greater with unreamed nails that utilize smaller screws. “Screw breakage associated with the use of unreamed nails has been quoted as being as high as 52%, with most series experiencing 10% to 20% screw breakage. With reamed nails, the incidence is between 0% and 2.9%. Titanium nails are associated with lower screw breakage rates. Riemer et al quoted a 2% breakage rate for titanium screws and a 25% breakage rate for stainless steel screws used in unreamed nails. Gaebler et al showed that with unreamed nails, the odds of fatigue failure of locking screws were three times higher in Gustilo III fractures compared with closed fractures. Whittle et al have studied the fatigue failure of tibial nails and screws in detail. Screw breakage is rarely problematic and not infrequently, it serves to reduce a slightly distracted fracture and facilitate union. Removal of broken cross screws is usually straightforward but necessitates an incision on the opposite side of the leg. The two halves have to be removed through separate incisions in a conventional manner or, if the distal end of the cross screw does not protrude sufficiently through the cortex, a trephine can be used to remove the distal fragment. An easy alternative is to retract the nail sufficiently to align the two parts of the screw, remove the proximal piece of the screw, and hammer the distal piece through the distal cortex using a thin metal punch. The distal screw fragment can then be removed from the soft tissues or can be left if it is asymptomatic.

Broken nails tend to be associated with untreated nonunion, and it is wise to treat a suspected nonunion by exchange nailing before the nail breaks. Few nails break these days, and the highest incidence is 6%. Broken cannulated nails are usually easily removed using a long hook, but solid nail fragments can be difficult to remove and may even require bone fenestration to aid removal.

THERMAL NECROSIS

Thermal necrosis of the tibial diaphysis following reaming is an unusual, but serious, complication. Its true incidence is unknown, but there are occasional references in the literature. Danckwardt-Lillestrom stated that intermittent reaming without appreciable pressure should not cause bone damage, and it is likely that applying excessive force causes thermal damage, particularly to blunt reamers. Some force must be applied to the reamer to facilitate its passage down the intramedullary canal, but there are no guidelines as to what degree of force should be applied. Eriksson and Albrektsson showed that temperatures above 47°C may be deleterious to bone, and Leunig and Hertel emphasized that a tourniquet should not be used for tibial nailing, as it eliminates heat convective transfer by shutting down the global blood flow to the whole limb. It is obviously important to keep the reamer bits sharp and to take care when reaming. Thermal necrosis has been reported to present with a cutaneous blister soon after surgery, which is followed by soft tissue and bone death and osteomyelitis. It is reasonable to suppose that less severe cases of thermal necrosis exist, and it is probable that a number of cases of tibial osteomyelitis have been caused by thermal necrosis that has not been severe enough to cause skin damage. This would seem to be the logical explanation for the unexplained dropped hallux noted by Robinson et al after reamed tibial nailing. All of their patients recovered muscle function within 4 months. The condition was attributed to peroneal nerve dysfunction but probably represented thermal necrosis of a lesser degree than that recognized by Leunig and Hertel. Giannoudis et al have shown that the generation of heat during reaming is greater with narrow intramedullary canals, and they suggest that excessive reaming should not be used if the canal is narrow. If this is the case, an 8- or 9-mm nail should be used. If thermal necrosis occurs, the treatment is the same as for osteomyelitis.

BONE DAMAGE

Intramedullary nailing can cause perioperative propagation of the fracture. This is rarely a problem, as the use of a statically locked nail stabilizes the fracture. An incorrect starting point or failure to aim the nail correctly down the intramedullary canal may well result in bone damage, however. It has been estimated that this complication occurs in up to 8% of cases. Georgiadis et al have drawn attention to the specific problem of the displacement of an occult posterior malleolar fragment during nailing. As about 2.3% of patients with tibial fractures have coexisting ankle fractures, it is obvious that surgeons will encounter posterior malleolar displacement from time to time. Diagnosis is made at the time of screening the ankle to insert the distal cross screw. Treatment is carried out by the use of percutaneously inserted leg screws to stabilize the ankle fracture"

DROPPED HALLUX DEFORMITY

Dysfunction of the peroneal nerve is known to be an uncommon complication of the nailing of tibia. It is often transient because of which it is under reported in long term studies. The probable causes include use of the '90/90' position with calcaneal traction, the reaming of the medullary canal, and a subclinical compartment syndrome. There is usually complete recovery of function within six months. Robinson CM, et al. authors performed a prospective study of 208 patients with tibial fractures treated by reamed intramedullary nailing, 11 (5.3%)

developed dysfunction of peroneal nerve, 8/11 showed a 'dropped hallux' syndrome, with weakness of EHL and numbness in first web space, with no clinical involvement of extensor digitorum longus or tibialis anterior; there was good recovery of muscle function within 3-4 months in all cases, but after one year 3 patients still had some residual tightness of EHL, and two some numbness in the first web space

SCORING SYSTEM

MODIFIED KNEE SOCIETY SCORE

Objective Scoring

1) Pain	**Points**
None	50
Mild or occasional	45
Stairs only	40
Walking and stairs	30
Moderate occasional	20
Moderate continual	10
Severe	0

2) Range of motion	**Points**
5 degree = 1 point	Total 25

Stability (maximum movement in any position)

3a) Anteroposterior	**Points**
<5 mm	10
5-10 mm	5
10 mm	0

3b) Mediolateral	**Points**
<5 degree	15
6-9 degree	10
10-14 degree	5
15 degree	0

4) Flexion contracture	Points
5-10 degree	-2
10-15 degree	-5
16-20 degree	-10
>20 degree	-15

5) Extension lag	Points
<10 degree	-5
10-20 degree	-10
>20 degree	-15

6) Alignment	Points
5-10 degree	0
0-4 degree	3 points for each degree
11-15 degree	3 points for each degree

Functional scoring

7) Walking	50 points
Unlimited	40
>10 blocks	30
5-10 blocks	20
<5 blocks	10
Housebound	0

8) Stairs climbing	Points
Normal up & down	50
Normal up, down with rail	40
Up & down with rail	30
Up with rail; unable down	15
Unable	0

9) Functional Deductions	Points
Cane	-5
Two cane	-10
Crutches and walker	-20
Others	20

Points	Grading
80-100	Excellent
70-79	Good
60-69	Fair
<60	Poor

JOHNER AND WRUCHS CRITERIA

	Excellent	Good	Fair	Poor
Nonunion	None	None	None	Yes
Deformity (varus/valgus)	None	2-5 o	6-10 o	>10 o
Mobility at Ankle (%)	Normal	>75 %	50 – 75%	< 50%
Gait	Normal	Normal	Insignificant limp	Significant limp

MATERIALS AND METHODS

This study was conducted between June 2015 to September 2017 in the Institute of Orthopaedics, Madras Medical College (MMC) and Rajiv Gandhi Government General Hospital, Chennai with approval from IOT Ethical Committee and MMC Ethical Committee and all participants signed an approved informed-consent form. The retrospective cases are taken from our IOTRA (Institute of Orthopaedics and Traumatology Research Analysis) and prospective cases are followed up using IOTRA and all the details are entered in the software. Twenty one patients were admitted in our Institute of Orthopaedics and Traumatology with segmental tibia fractures during the described period prospectively and retrospectively with either open or closed segmental tibia fractures with compromised soft tissue and treated with interlocking nail. All patients were subjected to a detailed history and clinical examination. Clinical examination was performed including general, systemic, neurovascular and local examination of injured part. Depending on nature of injury relevant radiological examination was done. If clinical examination indicates diminished distal pulses, further workup for vascular consultation was done. Anteroposterior and lateral radiograph of knee with leg with ankle were done to diagnose fracture type. Routine preoperative investigation was followed. Open fractures were immediately irrigated, washed and temporarily immobilized with posterior POP above knee slab. Plastic surgeon opinion was obtained for grade 2 and grade 3 compound cases. Patients were operated within 3 weeks of hospital admission.

INCLUSION CRITERIA

- All segmental tibia fracture.
- Age >18 years and <65 years

EXCLUSION CRITERIA

- Associated vascular injury
- Associated neurological injury
- Pathological fracture
- Severe systemic illness like active cancer elsewhere in body, chemotherapy, insulin dependent diabetes mellitus, renal failure and other medical contraindication for surgery

OPERATIVE PROTOCOL

Pre-operative Planning

X ray of the injured leg in AP & Lateral views taken. Fracture angulation is noted in all planes and reduction method was planned. Tibia and fibula fracture location from the proximal and distal articular surface was noted. If the fracture is within proximal 1/3 of tibia then lateral and high entry point was planned. If it was in the diaphysis of tibia then central entry point was planned. If there is fibula fracture within 8 cm from distal articular surface is noted then planned for fixation.

Planning for pollar screw is made if there the fracture is within the metaphyseal region to narrow the medullary canal and to correct the deformity while nailing.

Any intra articular extension was clearly noted, if there is doubt then CT scan is taken. The length of intermediate fragment was also measured.

Approximate length of the nail was measured in the contralateral leg from the tibial tuberosity to most prominent point of medial malleolus. The diameters of medullary canal at isthumus was measured.

Operative Protocol

The nails used were cannulated stainless steel nail, with 2 proximal (mediolateral) and 3 distal (2 mediolateral and 1 anteroposterior) locking options, of diameter 8, 9 or 10 mm.

Then through a patellar tendon splitting approach, entry point made as planned previously Progressive reaming done in proximal fragment and guide wire was passed under image intensifier control, reduction verified, if not satisfactory then fracture site opened tibia reduced then serial reaming has been done while the intermediate fragment is controlled with reduction clamp or unicortical schanz pin or drill bit depending upon the availability in our theatre in all cases. Intramedullary nail introduced and locked with two proximal screws and two or three distal screws (if distal fragment was within 4-5 cm).

Closed reduction was done in thirteen cases. In the remaining eight cases, closed reduction was attempted and we had to do open reduction as there was a marked overriding of the fragments or delay in taking up the case due to some reasons. Achieving the alignment was confirmed in both coronal and sagittal plane with image intensifier.

For one cases supplementary fibular plating, through posterolateral incision has been done. Skin, subcutaneous tissue and fascia incised. The peroneal muscles are retracted anteriorly. The interosseous membrane is stripped from the anterior border of the fibula from proximal to distal direction. Fibular fracture site exposed, freshened and reduced. After achieving the proper alignment and reduction, fibular plating done with appropriate one third tubular plate (seven holed plate) and cortical and cancellous screws of different sizes. Once proper length and rotation of fibula is achieved, in fresh cases the tibia aligns itself and malalignment in both sagittal and coronal planes could be avoided. In those delayed cases where alignment of fibula does not result delayed in alignment of tibia, Open reduction and internal fixation with intramedullary nail is done. In our case it was a two weeks old so reduction was not achieved with fibula plating but we could able to negotiate the guide wire through the segment and reaming was done by controlling the intermediate fragment with reduction clamp. Tourniquet was not used in any cases. All cases were done under spinal anesthesia.

Postoperative Management

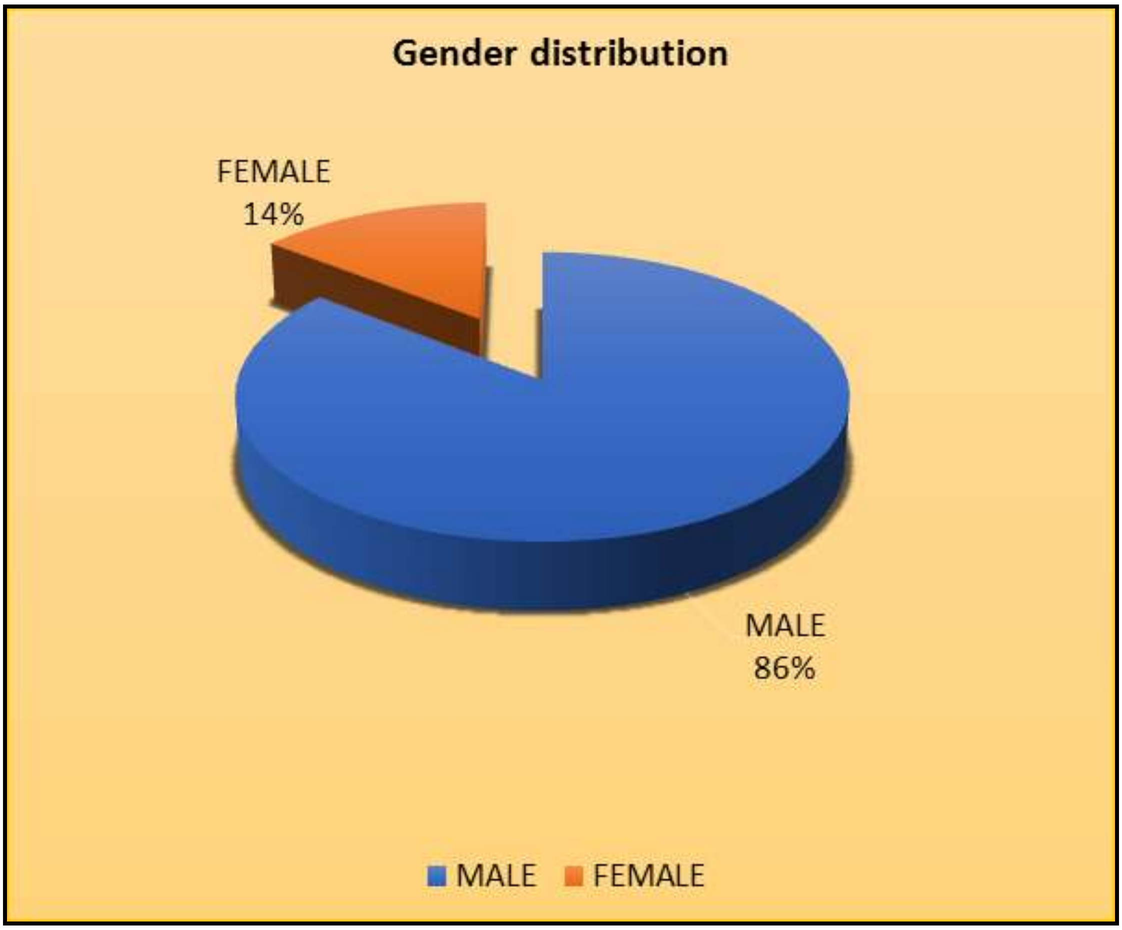
Operated limb is elevated in the immediate post-operative period and maintained for 48 hrs. Isometric quadriceps exercise and toes mobilization was started from first postoperative day. Drain removed on second postoperative day or when amount decreases to less than 30 ml per day. Active range of motion (ROM) exercise for knee and ankle was started after two days postoperatively in all patients. Patient is mobilized with walker with non-weight bearing walking after two days if other injury elsewhere in the body permits. Serial radiographs were taken at 4 weeks interval. Partial weight bearing was started at 6wks when there is radiological evidence of callus formation. Then allowed for full weight bearing after clinical and radiological union

Follow up

All the fractures were followed through till union of fracture with clinical and radiological examination at intervals of 4 to 6 weeks. The maximum follow up was 18 months. On follow up axial alignment was assessed and functional analysis was quantified using Modified Knee Society Scoring and Johner and Wruchs criteria. Radiographs were analyzed for correction, maintenance of position or loss of reduction. Fracture was defined as united when patient was able to bear full weight on the injured limb without pain and without support and when radiographs showed bridging callus in at least 3 cortices.

RESULTS

GENDER DISTRIBUTION

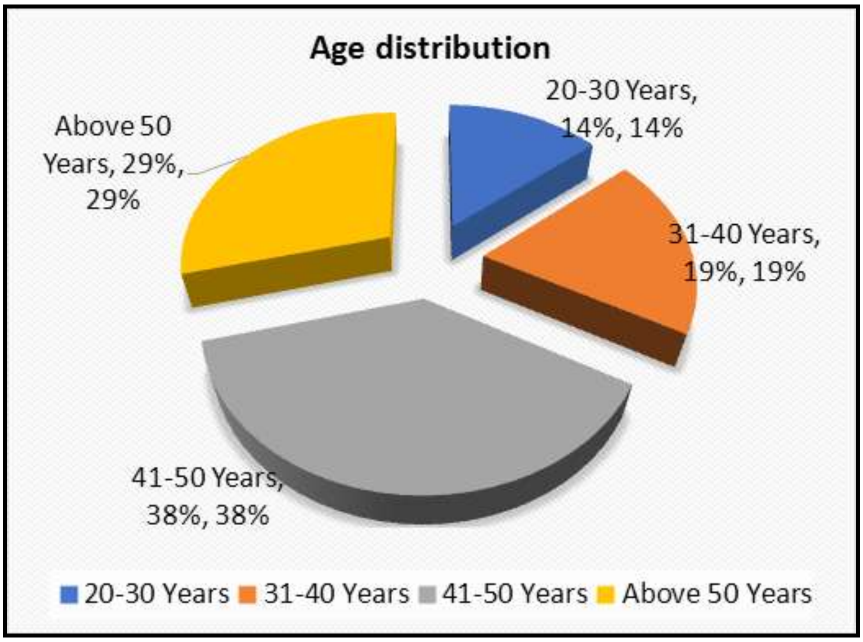


Sex ratio in this study is 4:1. Men are most commonly affected than females.

SIDE AFFECTED

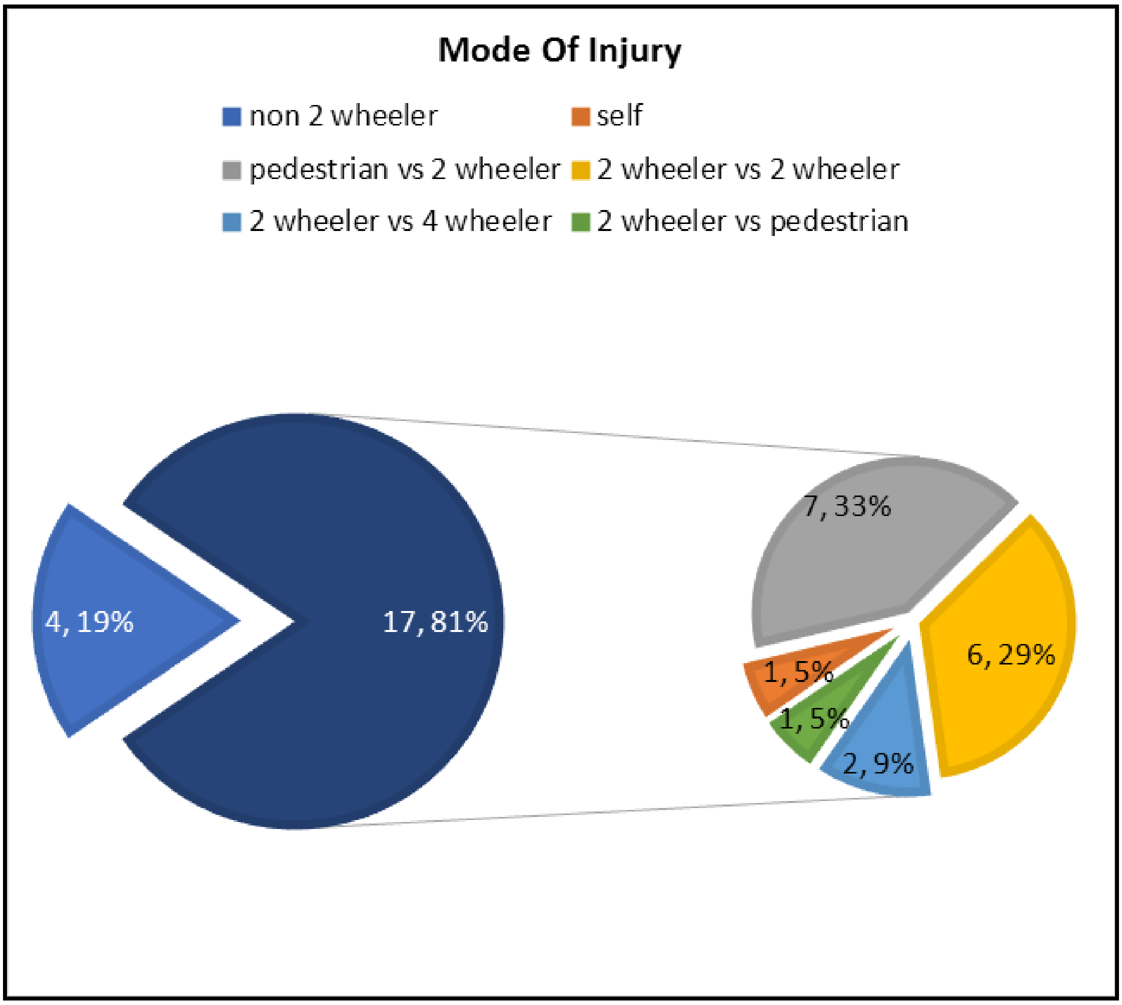
Right side is most commonly affected than left side in ratio of 4:1 in this study

AGE DISTRIBUTION



Young active adults in the age group of 41-50 years are most commonly affected in this study and the mean age affected is 44.15 years.

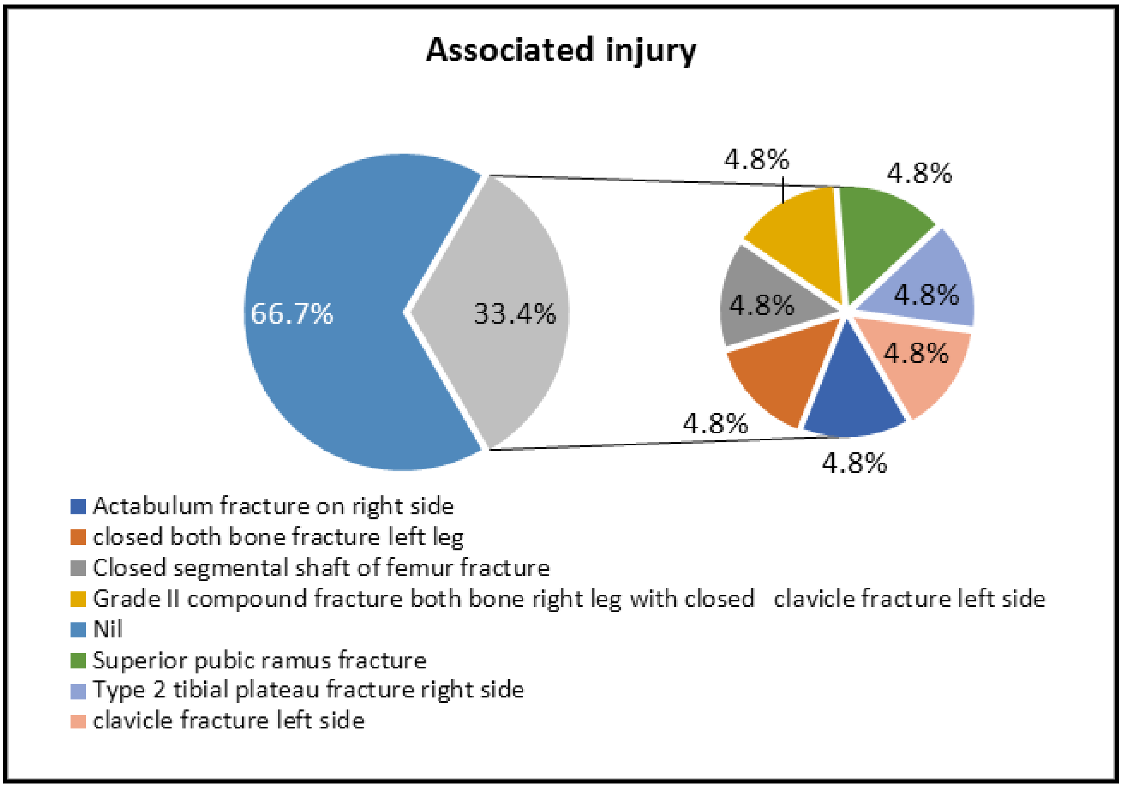
MODE OF INJURY



Two wheeler injury is most common mode of injury which contributes to 81% of patients. Among which pedestrian vs 2 wheeler is most common mode of injury which contributes to 33% of patients.

ASSOCIATED INJURY

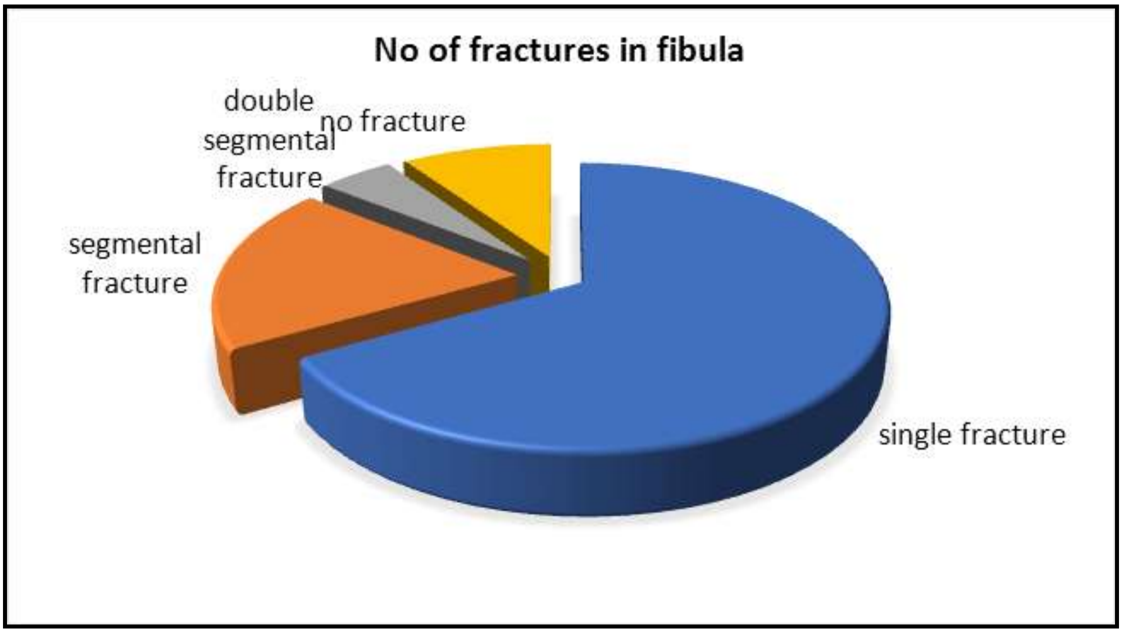
Associated injury	No of patients	Percent
Acetabulum fracture on right side	1	4.8
closed both bone fracture left leg	1	4.8
Closed segmental shaft of femur fracture	1	4.8
Grade II compound fracture both bone right leg with closed clavicle fracture left side	1	4.8
Superior pubic ramus fracture	1	4.8
Type 2 tibial plateau fracture right side	1	4.8
Left clavicle fracture	1	4.8
Nil	15	66
Total	21	100.0



Since this injury is caused by high energy trauma 30 % of people who sustain segmental tibia fracture had associated other bony injury.

FIBULA FRACTURE

No of fracture line	No of patients	percent
single facture	14	66.6%
segmental fracture	4	19%
double segmental fracture	1	4.8%
No fracture	2	9%
Total	21	100%

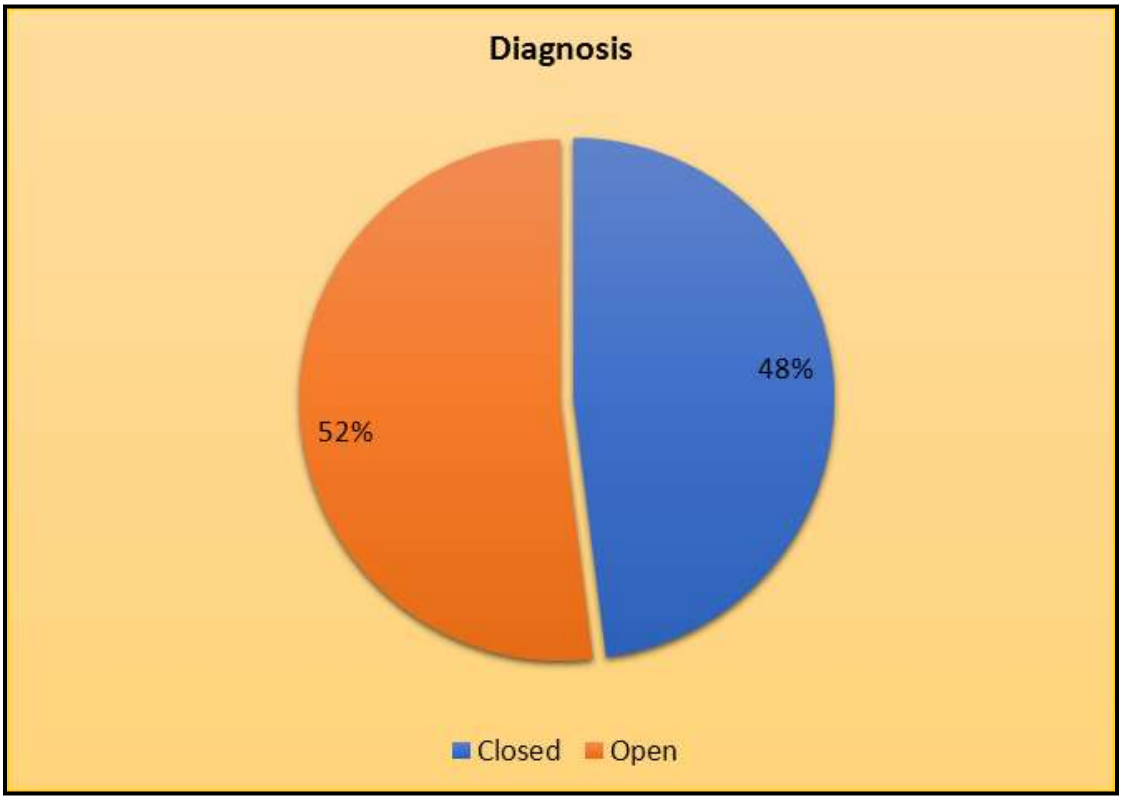


In our study 14 patients had associated fibula fracture at single level, 4 patients had segmental fibula fracture, 1 patient had double segmental fibula fracture and 1 patient had isolated tibia fracture.

Except one patient all patient had fibula fracture above the level of syndesmosis.

DIAGNOSIS

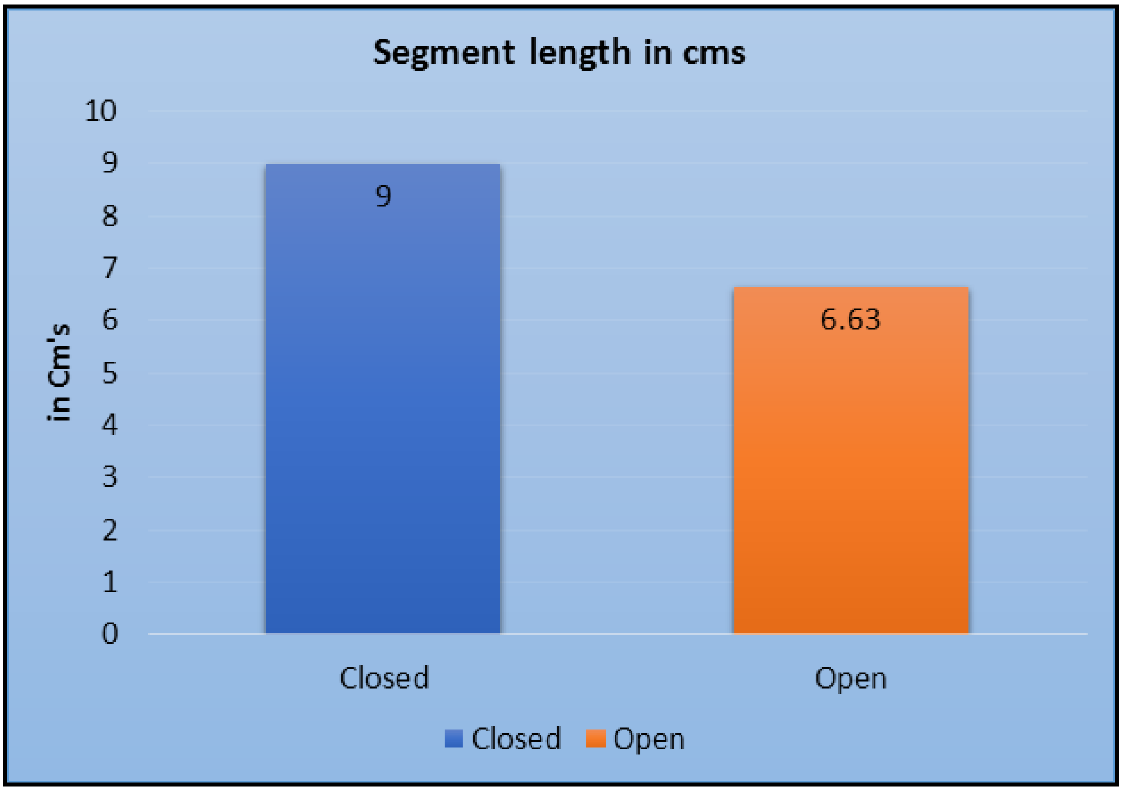
Diagnosis	No of patients	Percent
Closed segmental both bone fracture	10	47.6%
Compound segmental both bone fracture	11	52.4%
Total	21	100.0



52 Percent people in our study sustained compound fracture which is due to high energy trauma.

SEGMENT LENGTH IN CMS

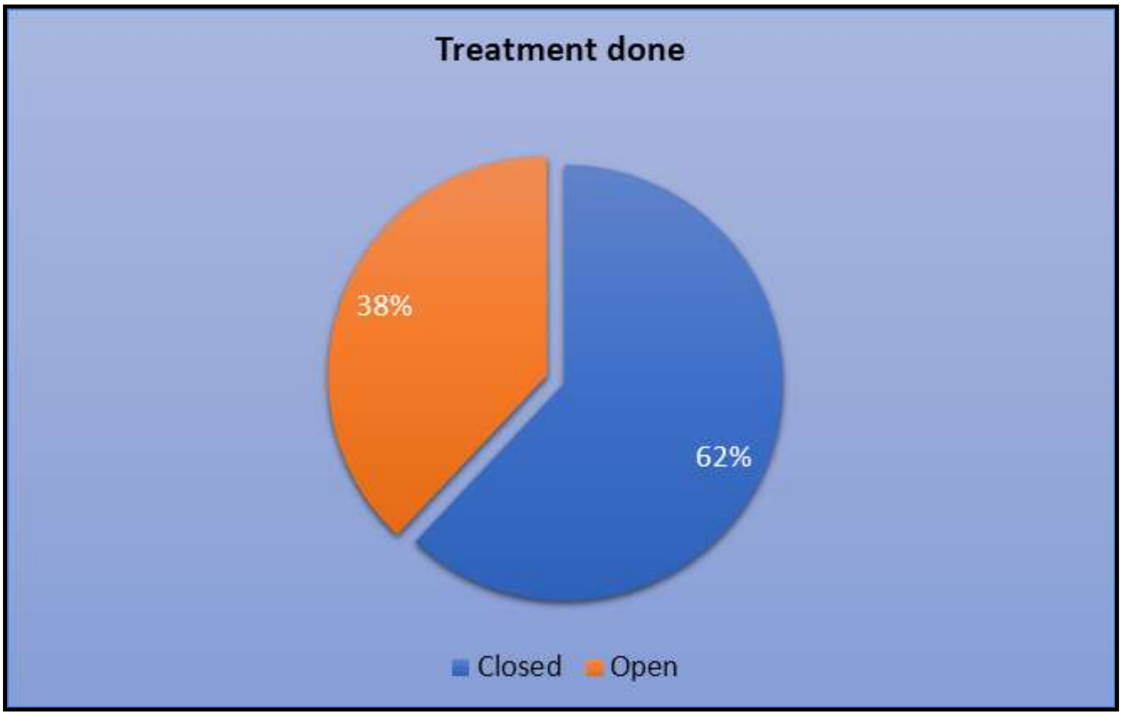
		N	Mean	Std. Deviation	Std. Error Mean	t value	p value
segment length in cms	Closed	13	9.00	3.85	1.07	1.446	0.165
	Open	8	6.63	3.29	1.16		



New observation that mean segment length in compound fracture is less when compared to closed fracture. This will affect the result of the study.

TREATMENT DONE

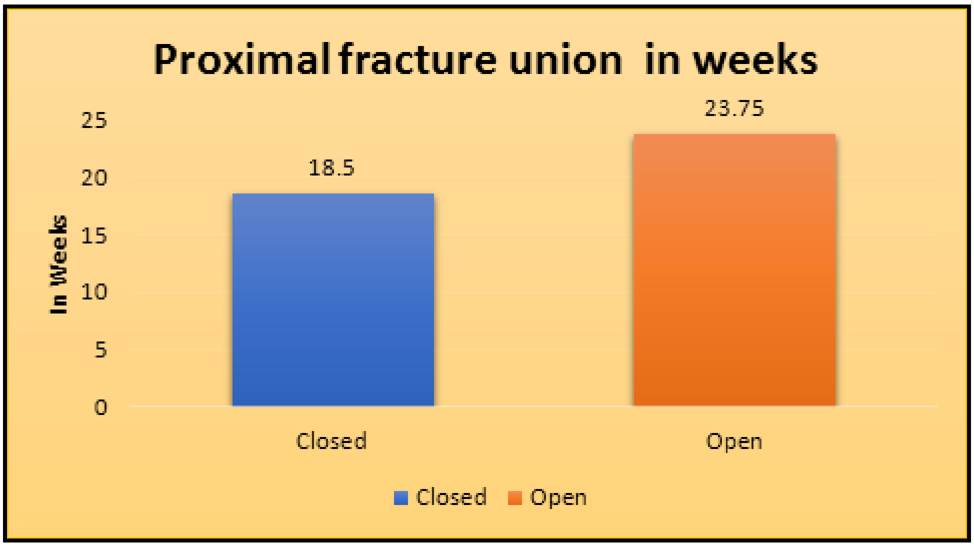
Treatment done	No of patients	Percent
Closed interlocking nailing	13	61.9
Open interlocking nailing	8	38.1
Total	21	100.0

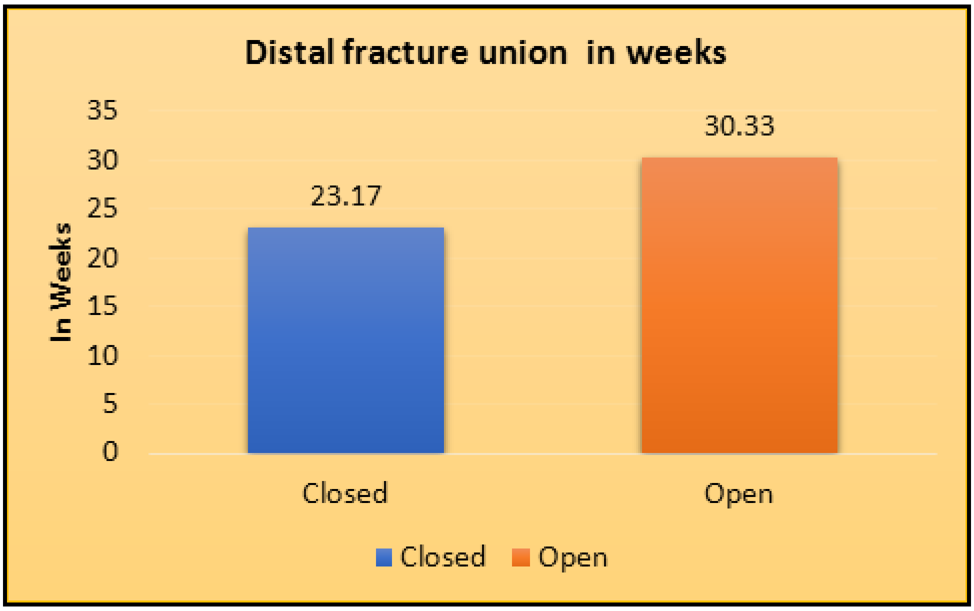


62 percent of the people underwent closed nailing while 38 percent underwent open nailing of both fracture site.

FRACTURE UNION IN WEEKS

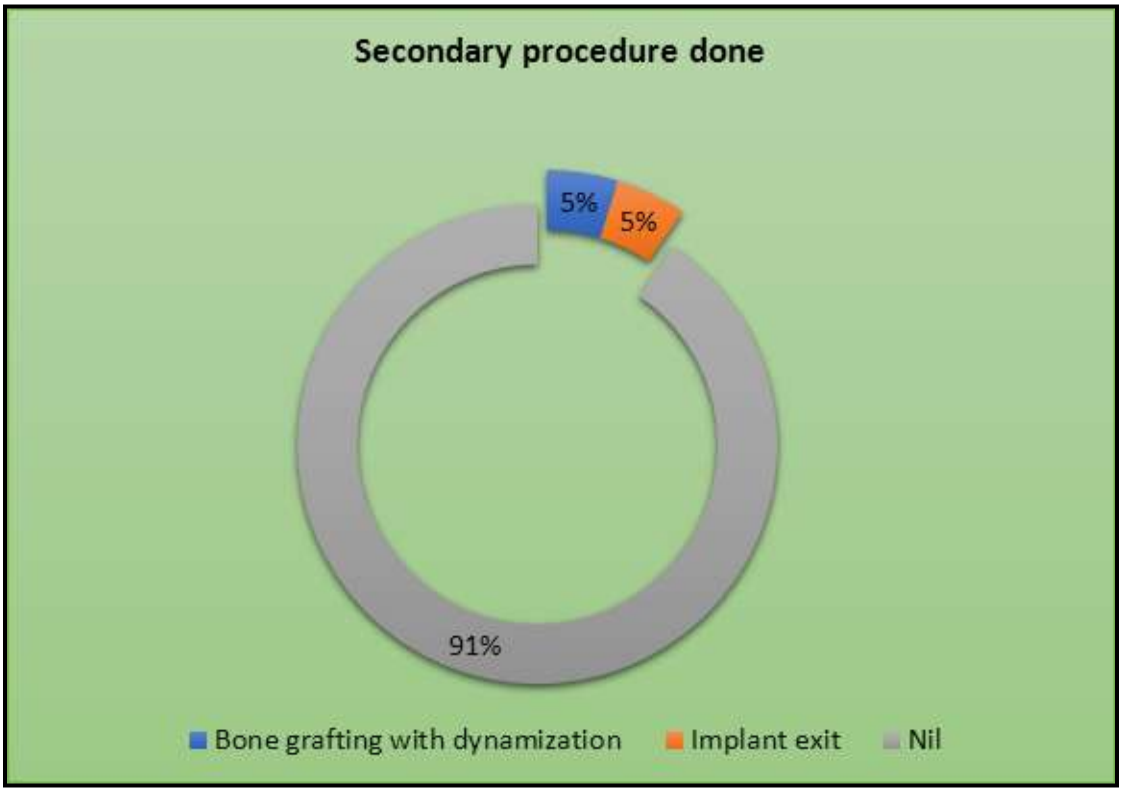
Treatment done group		N	Mean	Std. Deviation	Std. Error Mean	t value	p value
Proximal fracture union in weeks	Closed	12	18.50	4.60	1.33	2.274*	0.035
	Open	8	23.75	5.70	2.02		
Distal fracture union in weeks	Closed	12	23.17	2.48	0.72	4.794**	p<0.0001
	Open	6	30.33	3.88	1.58		





SECONDARY PROCEDURE

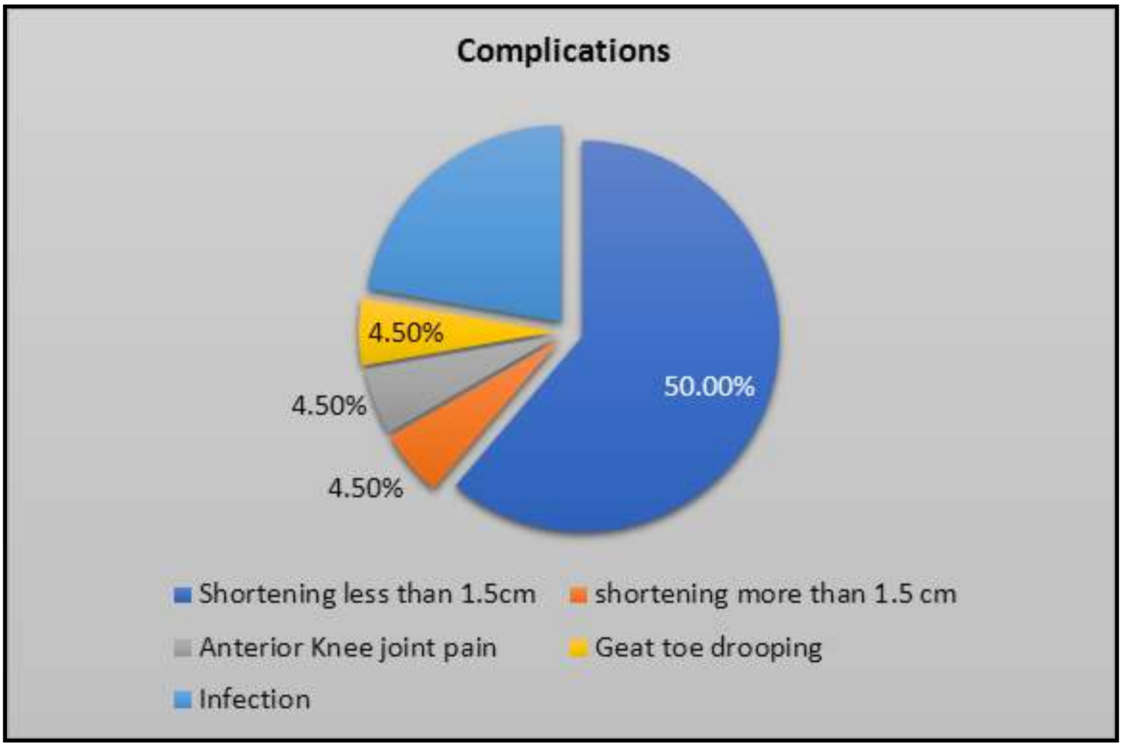
Secondary procedure done	No of patients	Percent
Bone grafting with dynamization	1.0	4.8%
Implant exit	1.0	4.8%
Nil	19.0	90.5%
Total	21	100.0



Only one patient underwent bone grating with dynamization while one patient underwent implant exit after union due to infection.

COMPLICATIONS

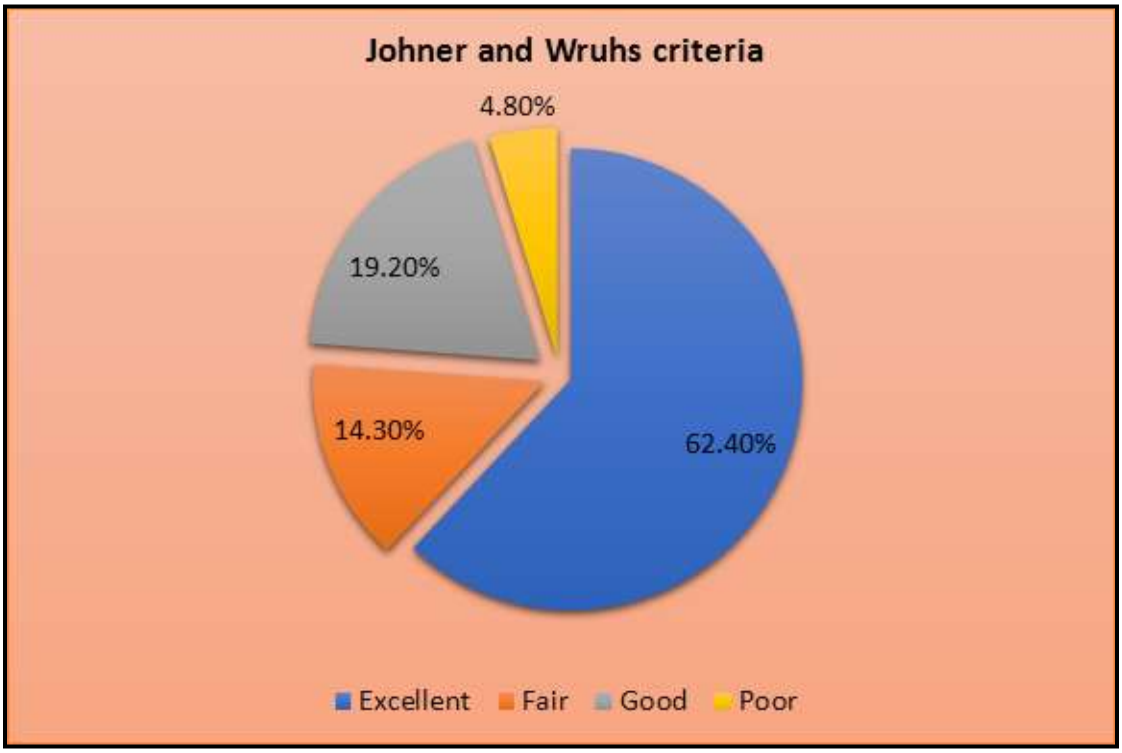
Complications	Frequency	Percent
Shortening less than 1.5 cm	10	50.0%
Shortening more than 1.5 cm	1	4.5%
Anterior Knee joint pain	1	4.5%
Great toe drooping	1	4.5%
Infection	4	18.2%
Nil	5	22.7%



Most common complication encountered in this study is limb shortening which is less than 1.5 cm which is insignificant. Followed by infection.

JOHNER AND WRUCHS CRITERIA

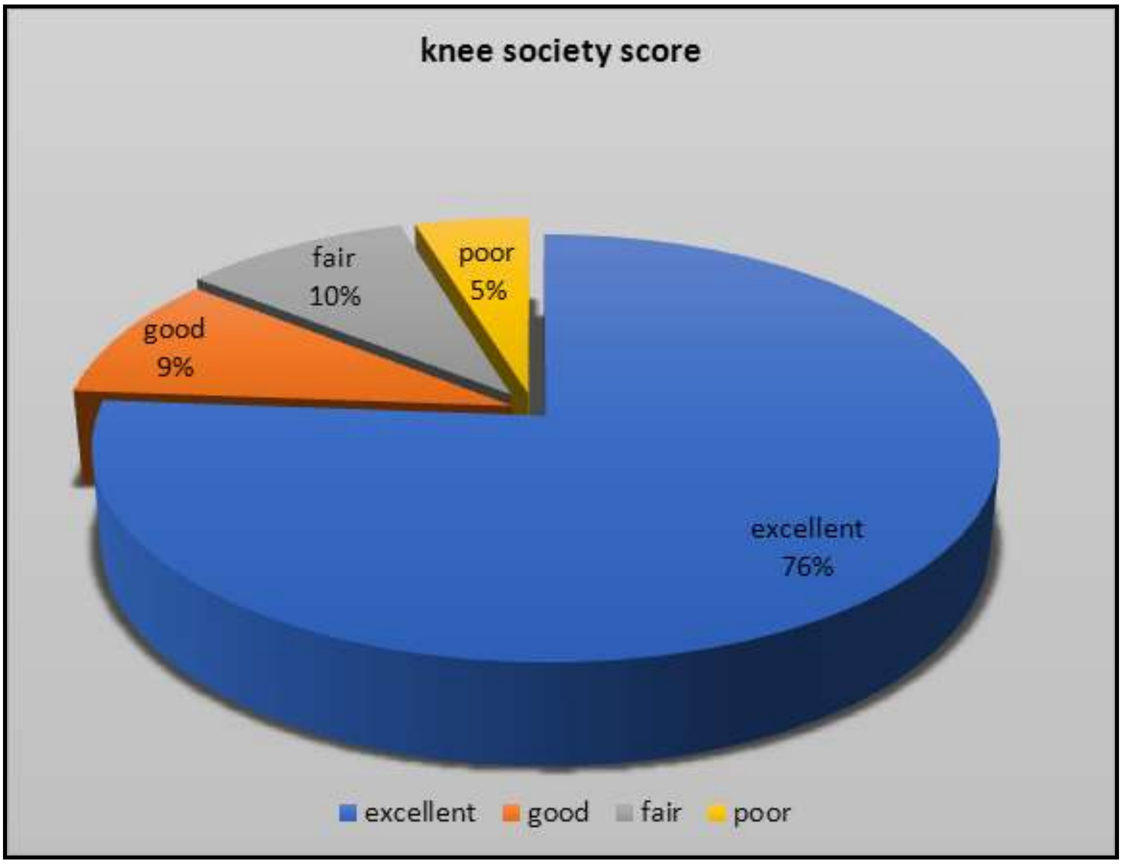
Johner and Wruchs criteria	No of patients	Percent
Excellent	13	62.4%
Fair	3	14.3%
Good	4	19.2%
Poor	1	4.8%
Total	21	100.0%



According to this criteria we got acceptable functional outcome in 81.6% of patients and unacceptable outcome in 18.4% of patients.

KNEE SOCIETY SCORE

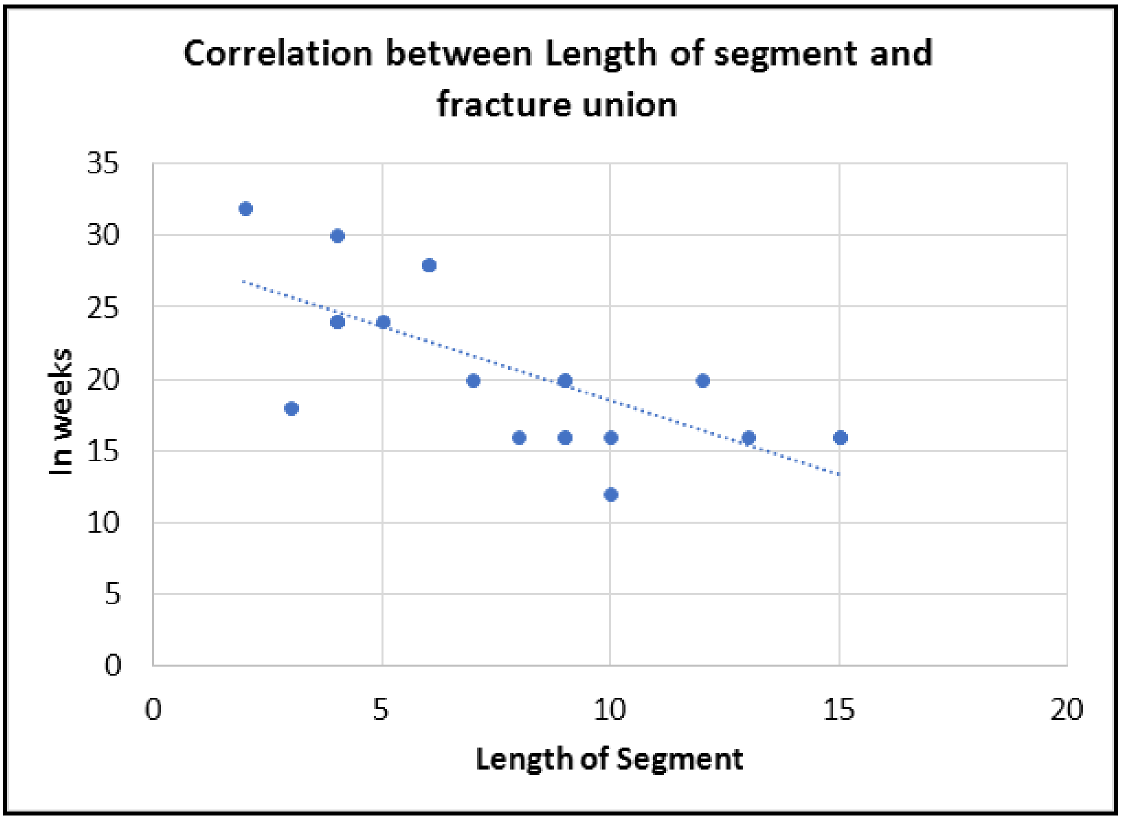
Knee Society Score	No of cases	Percent
Excellent	16	76.8%
Fair	2	9.6%
Good	2	9.6%
Poor	1	4.8%
Total	21	100.0%



According to this score we got acceptable knee functional outcome in 85% of patient and unacceptable outcome in 15% of patients.

CORRELATION BETWEEN LENGTH OF SEGMENT AND FRACTURE UNION

Correlations		
		Union
length	Pearson Correlation	-.705**
	Sig. (2-tailed)	.001
	N	21
**. Correlation is significant at the 0.01 level (2-tailed).		



DISCUSSION

The aim of the study is to evaluate the functional and radiological outcome of interlocking nailing in closed and compound segmental tibial fractures.

The injuries in our study are encountered mainly in young males of 21 to 50 years with highest at 41-50 years of age which is 40% of affected population. The mean age of affected people is 44.15 who are the bread winner of the family. A study done by Dr.Vivek P Nikumbha et al. (10) shows the mean age of patients in their study was 40.6 years which is consistent with our study.

Males (18 patients) are more commonly affected than female (3 patients) with the ratio of 5:1 in our series. A study conducted by Ramji Lal Sahu et al. (43) shows male female ratio was 4.8:1 which is same result as in our study.

Right leg (17 patients) was most commonly affected than left leg (4 patients) in the ratio of 4:1. A study done by Ching-Kuei Huang et al. (13) shows right leg was involved in 20 cases, left leg in 13 cases in the ratio of 2.5:1.

Tibia fracture are the commonest among the major long bones fractures. The commonest cause of the fracture being road traffic accidents. In our study 100% of the segmental tibia fractures groups were due to road traffic accidents. A study done by Dr.Vivek P Nikumbha et al. (10) shows road traffic accident was the most common mode of injury accounting for 86.27 % of the cases; assault was the cause of injury in only 3.93 % of the cases which is consistent with our result.

Segmental fracture is considered by many to be a distinctive type of injury having increased severity of soft tissue injury. In our study 11 (54%) patients had open injury which is due to subcutaneous location of entire length of tibia shin and high energy trauma and 10 (46%) patients had closed injury. A study conducted by Ramji Lal Sahu et al. (43) shows that 44.5% of patients sustained compound injuries which is also consistent with our result.

In our series 18 fibula fracture was above the level of syndesmosis and only one patient had at the level of syndesmosis for which fibula plating has been done. Other finding is that two patients had isolated segmental tibia fracture, 14 patients had single fracture of fibula (1 patient above the fracture site of tibia and 13 patients at the level of fracture site of tibia), 4 patients had double segmental fibula fracture (at the level of fracture site of tibia) and 1 patient had double segmental fibula fracture (at the level of fracture site of tibia). Andreas H. Ruecker et al. (44) in his study concluded that fibular plating may be helpful to restore the stability of the ankle joint. It can also be performed if the surgeon needs to adjust length and angulation prior to nailing as an aid to reduction. There are several reports that recommend plating concomitant fibular fractures in distal tibial fractures in order to achieve increased stability and reduce the risk of malalignment.

Due to the availability of the new broad spectrum antibiotics, the golden period of 6 hours can now safely be extended for compound fractures after adequate wound debridement and wash for seven days (10). This gives the treating surgeon adequate time to plan the suitable treatment for the patient. This however, did not increase the infection rate after interlocking nailing. In our study we used reamed interlocking nailing in all 21 patients. Closed nailing has been done for 13 (61%) patients and open nailing has been done for 8 (39%) patients. Out of which 4 (16%) patients got infected, for all of them open nailing has been done.

Most of the patients are followed up for 18 months. In our study, average union time of proximal fracture is 19 weeks in closed fracture and 23 weeks in compound fracture. Average distal fracture union time is 23 weeks for closed and 29 weeks for compound fractures with overall average union time of 23.4 weeks. In our series one case went for nonunion at the distal fracture site the which bone grafting was done and united. As consistent with other studies proximal fracture united faster than distal fracture and closed fractures united earlier than compound fracture. The distal fractures united later than proximal fracture site as a result of direct injury to the soft tissue overlying this fracture and natural tendency to slow union in fractures at this location. John Mcmurtry et al. (14) shows that the average union times range from 15 weeks to greater than 40 weeks with fractures demonstrating more delayed unions and nonunion in open injuries which is consistent with our result. Another study done by Terra et al. (14) median time to union was longer for segmental tibial fractures 34 weeks compared with non-segmental tibial fractures which is 24 weeks respectively.

It is also observed from our study that with the increase in length of intermediate fragments fracture union has a better chance, which is due to relatively better blood supply, control of intermediate fragment while reaming and the fractures in the metaphyseal region. It is also observed that compound fractures has smaller fragment than closed fracture due to the high force of injury.

We had 7 cases of other associate injuries along with segmental tibial fractures which contributes 30% of patients which is due to high energy trauma. Most common associated injury in our series was two cases of both bone fracture of tibia. Also there was an associated one clavicle fracture, one tibial plateau fracture, one acetabulum fracture, one pubic ramus fracture and one femur. A study done by Ramji Lal

Sahu et al. (43) shows that 17% of patients have polytrauma associated with segmental tibia fracture.

Most common postoperative complication in our series was insignificant shortening of affected lower limb (50%). Infection was seen in 4 (16%) cases where open nailing has been done. One of them had a deep infection and other three had superficial infection. Intravenous antibiotics has been given and superficial infection has been controlled. Implant exit has been done after fracture union in deeply infected patient. Knee pain was seen in two patients (8%) which was constant in one (proud nail) of the patients and occasional pain in one of the patient (varus angulation). A study done by Dr.Vivek P Nikumbha et al. (10) shows superficial infection was found in 2 (5.8%) cases, deep infection in one case which is consistent with our study. Most common postoperative complication in their series was anterior knee pain in 5 (9.8%) cases. Bonnevialle et al. (43) analyzed in his study and came out with nonunion for 4 (8%) patients in distal fracture site and 2 (4%) nonunion at proximal fracture site.

In our series two patients (9%) underwent secondary procedure. One patient underwent bone grafting for nonunion at the distal fracture site and another patient went on for implant exit for infection control. Terra et al. (14) found a larger need for reoperation in segmental tibia fracture when compared to non-segmental tibia fracture which is related to increased occurrence of problems regarding bone healing and higher incidence of soft tissue complications.

In our study, we used Knee Society Scoring system for analyzing functional outcome of knee. It depends on variables like range of motion, stability and alignment, fixed flexion deformity. Results was 16 (76%) patients had excellent outcome, 2 (9%) patients had good outcome, 2 (9%) patients fair outcome and 1(4.5%) patient had poor outcome which is consistent with study done by Prashant Patel et al (17) in which excellent outcome was seen in 73% of patients treated with interlocking nailing.

Out of 21 cases in our series, 16 (78%) had acceptable Johner and Wruch's criteria for functional outcome. Excellent in 13 (62%), good in 3 (14%), fair in 4 (19%) and poor in 1 (4%) which is consistent with a study done by Ekeland and Alho et al (42) reported excellent in 29 (64%), good in 13 (29%) and fair in 2 (4.5%) and poor in one out of 45 cases.

Our study shows significant P value for the following parameter

1) Proximal fracture unites earlier than distal fracture with P value of 0.021

2) Closed proximal fracture unites earlier than compound distal fracture with a P value of 0.035.

3) Closed distal fracture unites earlier than compound distal fracture with P value of less than 0.0001.

4) Fracture with long intermediate segment unites earlier than short fragment with a P value of 0.01.

CONCLUSION

We conclude that these injuries are caused by high energy trauma involving extensive soft tissue damage hence, proper clinical assessment of soft tissue is vital and timing of the surgery is important.

Preservation of vascularity of intermediate segment and non-traumatic reduction of fracture fragments requires expert surgical skill.

Experience regarding appropriate usage of polar screw and tibial entry point makes the surgical procedure easier with excellent functional outcome.

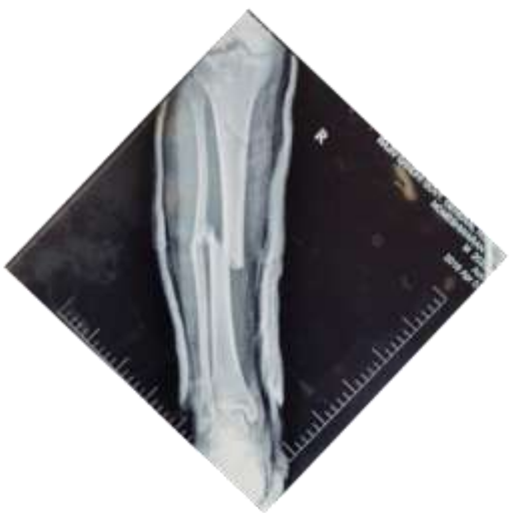
Patient counselling regarding the complex nature of injury and the possible requirement of secondary procedures should be anticipated and addressed.

CASE ILLUSTRATION

CASE-1

Name	:	Mr.Nomeshwaran
Age/Sex	:	45/M
IP No	:	33755
Address	:	No 27, Vepangadu village, Krinhnapuram Vattam, Krishnagiri.
Phone	:	9585498330
Diagnosis	:	Closed segmental fracture both bone right leg
Procedure	:	Closed interlocking nailing for tibia

Pre op x ray



Immediate Post Op X-Ray

14 weeks post op X-ray

24 weeks post op X-ray:

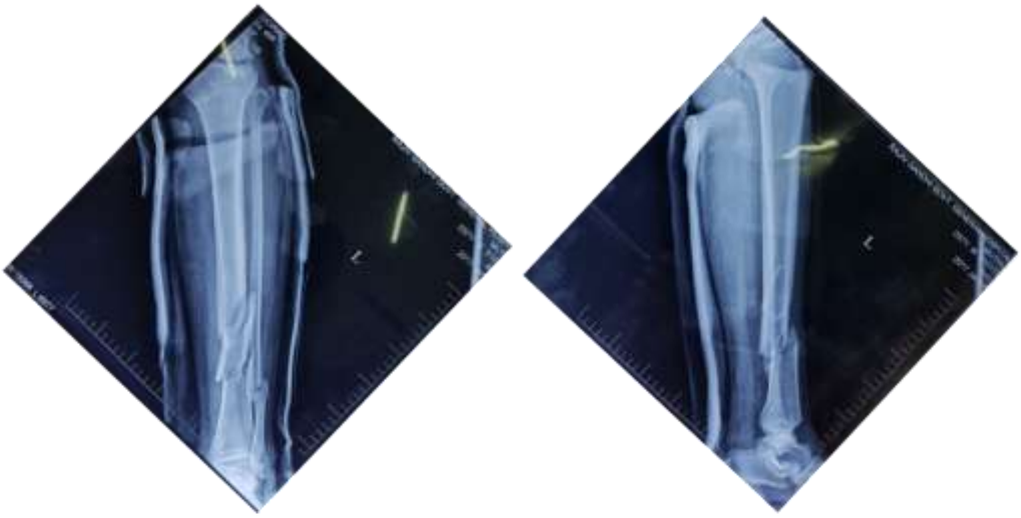
1 year 2 month post op X-ray:

Functional outcome

CASE-2

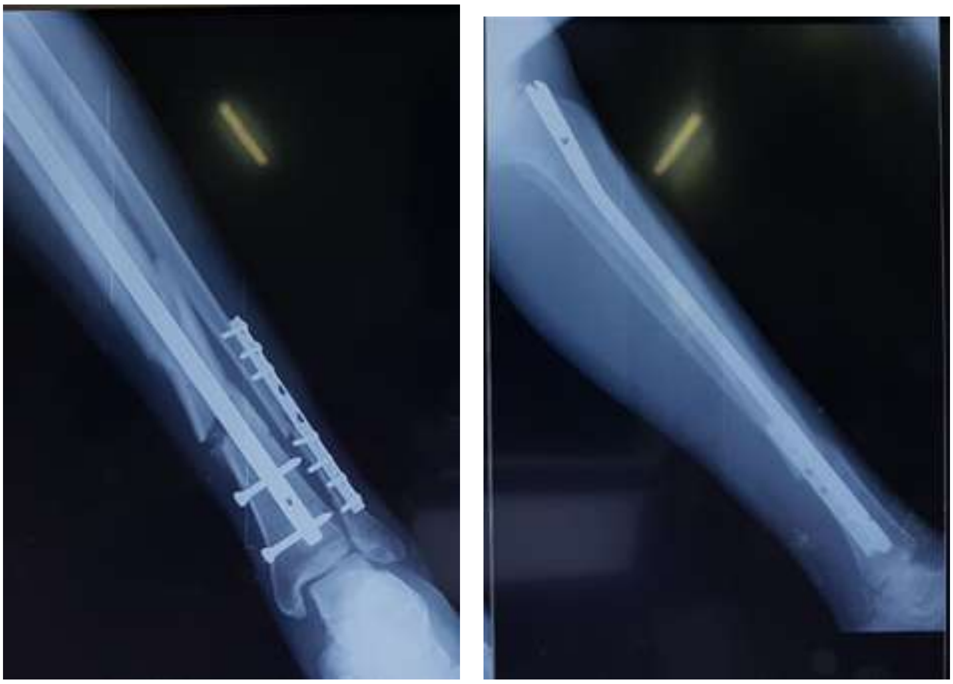
Name	:	Mr.Muthu
Age/ Sex	:	37/M
IP No	:	28780
Address	:	No 14, 1st Street Ganeshpuram, Mayor Krishnamoorthy Nagar, Chennai-114.
Phone	:	9841334655
Diagnosis	:	Grade I compound segmental fracture both bone left leg
Procedure	:	Closed interlocking nailing for tibia with fibula plating

Pre op X-Ray



Immediate post op X-ray

16 weeks post op x ray



24 weeks post op X-ray

1 year post op

Functional outcome

CASE-3

Name : Mrs.Mary

Age/ Sex : 30/f IP No: 23444

Address : No 12/135,JJ nagar,Mugappar, Chennai.

Phone : 7299619775

Diagnosis : Grade IIIA compound segmental fracture both bone right leg

Procedure : Open reduction and interlocking nailing for tibia

Pre op X-ray

Immediate post op

20 weeks post op X-ray

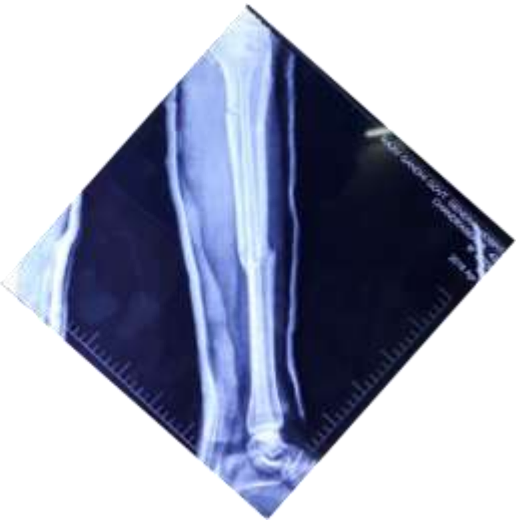
1 year 6 month post op

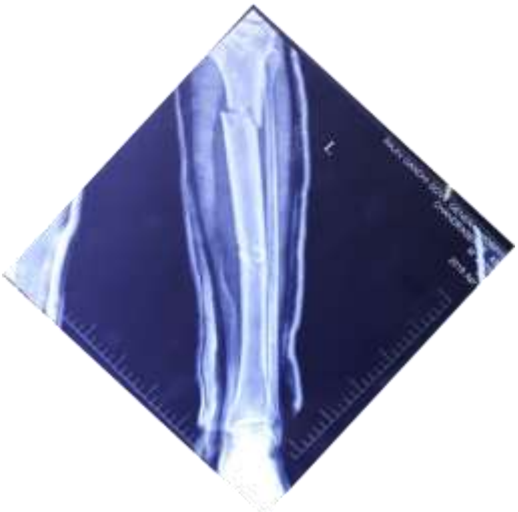
Functional outcome

CASE-4

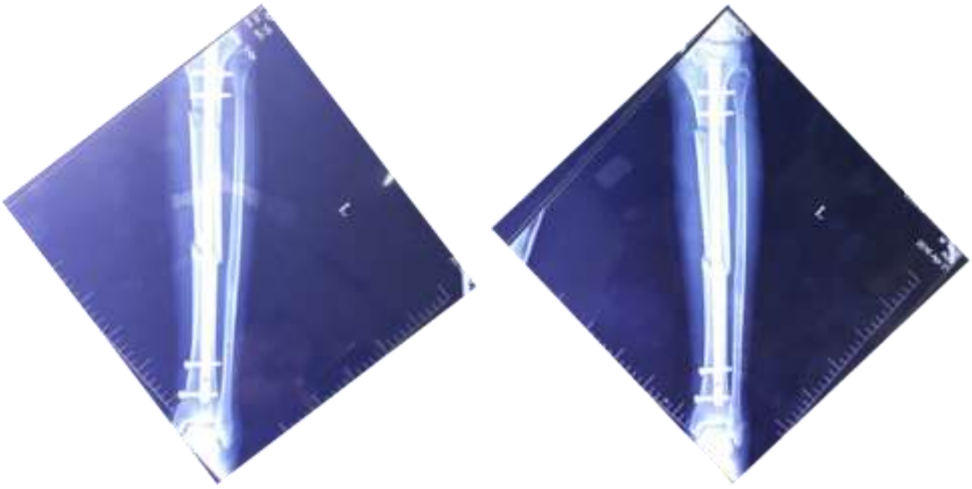
Name	:	Mr.Chandrasekar
Age/ Sex	:	45/F
IP No	:	34234
Address	:	No.23/2, First Cross, Chengal village, Thiruvannamalai district
Phone	:	9843083827
Diagnosis	:	Grade IIIA compound segmental fracture both bone left leg
Procedure	:	Closed interlocking nailing for tibia

Pre op X-Ray





Immediate post op x ray



1 year 5 month post op X-ray

Functional Outcome

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PROSPECTIVE AND RETROSPECTIVE OUTCOME ANALYSIS OF SEGMENTAL FRACTURE OF TIBIA

PROFORMA

NAME:

AGE:

SEX:

OCCUPATION:

ADDRESS:

CELL NO: Patient:

Relative:

EDUCATIONAL STATUS:

DIAGNOSIS:

NO OF SEGMENT:

LENGTH OF SEGMENTAL BONE:

LEVEL OF FRACTURE:

GRADING OF FRACTURE:

INDEX INJURY TO SURGERY:

PREOCEDURE DONE:

TIME OF UNION:

IF NON OR DELAYED UNION ANY ADDITIONAL PROCEDURE DONE:

CLINICAL PARAMETERS:

1)KNEE RANGE OF MOTION

2)CLINICAL UNION

FUNCTIONAL OUTCOME:

1)MEASURED BY MODIFIED KNEE SOCIETY SCORE

MONTHS	UNION IN X RAY	FUNCTIONAL OUTCOME	COMPLICATION IF ANY
0 day			
1			
3			
6			
9			
12			

Clinical and radiological outcome grade:

INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE, CHENNAI 600 003

EC Reg.No.ECR/270/Inst./TN/2013
Telephone No.044 25305301
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CERTIFICATE OF APPROVAL

To
Dr.A.Arul Murugan
Post Graduate in M.S.Orthopaedics
Institute of Orthopaedics & Traumatology
Madras Medical College
Chennai 600 003

Dear Dr.A.Arul Murugan,

The Institutional Ethics Committee has considered your request and approved your study titled **"PROSPECTIVE AND RETROSPECTIVE ANALYSIS OF OUTCOME IN SEGMENTAL FRACTURE OF TIBIA" - NO.08012017 (III).**

The following members of Ethics Committee were present in the meeting hold on **24.01.2017** conducted at Madras Medical College, Chennai 3

1.Dr.C.Rajendran, MD.,	:Chairperson
2.Dr.M.K.Muralidharan,MS.,M.Ch.,Dean, MMC,Ch-3	:Deputy Chairperson
3.Prof.Sudha Seshayyan,MD., Vice Principal,MMC,Ch-3	: Member Secretary
4.Prof.B.Vasanthi,MD., Prof.of Pharmacology.,MMC,Ch-3	: Member
5.Prof.A.Rajendran,MS, Prof. of Surgery,MMC,Ch-3	: Member
6.Prof.N.Gopalakrishnan,MD,Director,Inst.of Nephrology,MMC,Ch	: Member
7.Prof.Baby Vasumathi,MD.,Director, Inst. of O & G	: Member
8.Prof.K.Ramadevi,MD.,Director,Inst.of Bio-Che,MMC,Ch-3	: Member
9.Prof.R.Padmavathy, MD, Director,Inst.of Pathology,MMC,Ch-3	: Member
10.Prof.S.Mayilvahanan,MD,Director, Inst. of Int.Med,MMC, Ch-3	: Member
11.Tmt.J.Rajalakshmi, JAO,MMC, Ch-3	: Lay Person
12.Thiru S.Govindasamy, BA.,BL,High Court,Chennai	: Lawyer
13.Tmt.Arnold Saulina, MA.,MSW.,	:Social Scientist

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

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

Member Secretary – Ethics Committee

ஆராய்ச்சி ஒப்புதல் கடிதம்

ஆராய்ச்சி தலைப்பு : கால் எலும்பு முறிவு பல்வேறு வைத்திய ஒப்பீட்டு ஆய்வு

இராஜீவ் காந்தி அரசு பொது மருத்துவமனைக்கு வரும் நோயாளிகளிடம் கால் எலும்பு 3 துண்டுகளாக ஏற்பட்ட முறிவினை பல்வேறு வைத்திய முறைகளின் கீழ் ஒப்பீட்டு அதனை அறிவதற்கான ஆய்வு.

பெயர் : தேதி :

வயது : உள்நோயாளி எண் :

பால் : ஆராய்ச்சி சேர்க்கை எண்:

இந்த ஆராய்ச்சியின் விவரங்களும் அதன் நோக்கமும் முழுமையாக எனக்கு தெளிவாக விளக்கப்பட்டது.

எனக்கு விளக்கப்பட்ட விஷயங்களை நான் புரிந்துக் கொண்டு எனது சம்மதத்தை தெரிவிக்கிறேன்.

இந்த ஆராய்ச்சியில் பிறரின் நிர்பந்தமின்றி எந்த சொந்த விருப்பத்தின் பேரில் நான் பங்குபெற சம்மதிக்கிறேன் மற்றும் நான் இந்த ஆராய்ச்சியில் இருந்து எந்நேரமும் பின் வாங்கலாம் என்பதையும் அதனால் எந்த பாதிப்பும் ஏற்படாது என்பதையும் நான் புரிந்துக் கொண்டேன்.

இந்த ஆராய்ச்சியினால் ஏற்படும் நன்மைகளையும், சில பக்க விளைவுகளையும் பற்றி தெளிவாக மருத்துவர் மூலம் தெரிந்து கொண்டேன்.

நான் என்னுடைய சுயநினைவுடன் மற்றும் முழு சுதந்திரத்துடன் இந்த மருத்துவ ஆராய்ச்சியில் சேர்த்துக் கொள்ள சம்மதிக்கிறேன்.

ஆராய்ச்சியாளர் கையொப்பம் பங்கேற்பாளர் கையொப்பம்

நாள் :

இடம் :

ஆராய்ச்சி தகவல் தாள்

இராஜீவ் காந்தி அரசு பொது மருத்துவமனையின் வரும் கால் எலும்பு 3 துண்டுகளாக ஏற்பட்ட முறிவினை பல்வேறு வைத்திய முறைகளின் கீழ் ஒப்பீட்டு அதனை குறித்த ஒரு ஆராய்ச்சி நடைபெறுகிறது.

கால் எலும்பு 3 துண்டுகளாக ஏற்பட்ட முறிவினை பல்வேறு வைத்திய முறைகளின் கீழ் ஒப்பீட்டு அதனை அறிவதே இந்த ஆராய்ச்சியின் நோக்கமாகும்.

முடிவுகளை அல்லது கருத்துக்களை வெளியிடும் போதோ அல்லது ஆராய்ச்சியின் போதோ தங்களது பெயரையோ அல்லது அடையாளங்களையோ வெளியிடமாட்டோம் என்பதையும் தெரிவித்துக் கொள்கிறோம்.

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

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

ஆராய்ச்சியாளர் கையொப்பம் **பங்கேற்பாளர் கையொப்பம்**

நாள் :
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INTRODUCTION:

Segmental tibia fractures is defined as a unique fracture type characterized by least two different fracture lines with a completely isolated intercalary osseous fragment. Segmental fractures of tibia are uncommon and are usually caused by a high-energy trauma. They have a high complication rate. Incidence is about 12.8 % of all tibia fractures. Mode of injury commonly are road traffic accidents, falls from height, industrial and train accidents. Almost 37.5 % to 83.8 % of these fractures are open and they often sustain injury to the others parts of body. Since it is caused by high energy trauma there is severe soft tissue injury and periosteal stripping due to which the central fragment is devoid of blood supply. Segmental tibia fracture is considered as separate clinical entity compared to the normal tibia fractures for the following reasons like, they are almost always caused by high-energy injuries, approximately 50% are compound, they are often part of multiple injuries, they are frequently associated with sever soft tissue

MASTER CHART

S NO	NAME	AGE/ SEX	IP NO	Mode of injury	Associated injury	Diagnosis	Fibula fracture	AO classify cation	No of segment / length of segment	Index injury to surgery	Date of surgery	Treatment done	Proximal fracture union (wks)	Distal fracture union (wks)	Secondary procedure done	Complication	Johner and wruhs criteria	Knee society score
1	Mr.Muthu	37/M	28780	RTA Pedestrian Vs two wheeler	Nil	Grade IIIA compound segmental tibia both bone fracture left leg distal 1/3	Single, 5cm above ankle joint involving syndesmosis	42C2	One/ 3 cm	15 days	13/1/17	Closed interlocking nailing for tibia with fibula palting	18 wks	24 wks	Nil	Anterior Knee joint pain	Excellent	good
2	Mrs. Mary	30/F	13506	RTA 2 wheeler vs 2 wheeler	closed both bone fracture left leg	Grade IIIA compound segmental both bone fracture right leg	Segmental fracture, 11cm above ankle joint	42C2	One / 7 cm	14 days	18/2/16	Open interlocking nailing for both tibia	20 wks	28 wks	Nil	1 cm shortening	Good	excellent
3	Mr.Murugesan	55/M	73848	RTA 2 wheeler vs pedestrian	Nil	Grade IIIA compound segmental tibia both bone fracture left leg	Single, at the level of neck	42C2	One/ 6cm	45 Days	18/7/16	Closed interlocking nailing for tibia	28 wks	18 wks	Nil	Nil	Good	excellent
4	Mr.Nomeshwaran	45/M	33755	RTA self fall from two wheeler	Nil	Closed Segmental fracture both bone right leg	Double segmental, 10 cm from ankle joint	42C2	One / 8 cm	15 days	12/4/16	Closed interlocking nailing for tibia	16 wks	20 wks	Nil	I cm shorteing	Excellent	excellent
5	Mr.Prakasam	57/M	41455	RTA 2 wheeler vs 2 wheeler	Nil	Closed segmental fracture both bone right leg	Single, 11cm from ankle joint	42C2	One / 9 cm	14 days	8/1/17	Open interlocking nailing for tibia	16 wks		Bone grafting with dynamization	Geat toe drooping, 1 cm shortening	Good	excellent
6	Mr.Prakash	45/M	15698	RTA Pedestrian vs 2 wheeler	Actabulum fracture on right side	Closed segmental fracture both bone right leg	Single, 15cm from ankle joint	42C2	One / 4 cm	18 days	27/2/16	Closed interlocking nailing for tibia	24 wks	24 wks	Nil	1.5 cm shortening	Good	excellent
7	Mr.Rajendiran	57/M	94924	RTA pedestrian Vs 4 wheeler	Nil	Grade IIIA compound both bone fracture right leg	Single, 15cm from ankle joint	42C2	One / 4 cm	20 days	24/9/15	Open interlocking nailing for tibia	24 wks	28 wks	Nil	2 cm shortening	Fair	Excellent

S NO	NAME	AGE/ SEX	IP NO	Mode of injury	Associated injury	Diagnosis	Fibula fracture	AO classify cation	No of segment / length of segment	Index injury to surgery	Date of surgery	Treatment done	Proximal fracture union (wks)	Distal fracture union (wks)	Secondary procedure done	Complication	Johner and wruhs criteria	Knee society score
8	Mr.Subramani	45/M	25661	RTA pedestrian Vs 4 wheeler	Congenital lymphoedema	Closed fracture both bone right leg	Single, 9 cm from ankle joint	42C2	One / 2 cm	30 days	17/1/17	Open interlocking nailing for tibia	32 wks		Nil	Nil	Excellent	excellent
9	Mr.Iyappan	35/ M	26136	RTA 2 wheeler vs 2 wheeler	Type 2 tibial plateau fracture right side	Grade III A compound fracture both bone right leg	Single, 20 cm from ankle joint	42C2	One / 12 cm	50 days	27/5/2016	Open interlocking nailing for tibia	20 wks	38 wks	Implant exit	Infection	Excellent	Excellent
10	Mr.Chandrasekar	43/M	34234	RTA 2 wheeler vs 2 wheeler	Grade II compound fracture both bone right leg with closed clavicle fracture left side	Grade IIIA compound segmental fracture Both bone left leg	No fibula fracture	42C2	One / 10 cm	22 days	20/4/16	Closed interlocking nailing for tibia bilaterally and ORIF for clavicle	16 wks	24 wks	nil	0.5 cm shortening	Excellent	Excellent
11	Mr.David	45/M	7229	RTA 2 Wheeler vs 4 wheele	Nil	Grade IIIA compound segmental fracture both bone right leg	Segmental fracture, 13cm above ankle joint	42C2	One / 9 cm	60 days	22/9/2015	Open interlocking nailing for tibia	20 wks	30 wks	nil	Infection, 1 cm shortening	Fair	Fair
12	Mr.Esther George	50/M	24861	RTA pedestrian vs 4 wheeler	Nil	Closed segmental fracture both bone right leg	Single, 12 cm from ankle joint	42C2	One / 13 cm	30 days	2/4/15	Closed interlocking nailing for tibia with plating for fibula	16 wks	24 wks	Nil	Nil	Excellent	excellent
13	Mrs.Susaimary	75/F	61381	RTA pedestrian vs auto	Nil	Grade IIIA compound segmental fracture both bone right leg	Single, 9 cm from ankle joint	42C2	One / 15 cm	19 days	29/6/15	Closed interlocking nailing for tibia	16 wks	20 wks	Nil	1.5 cm shortening	Excellent	good
14	Mrs.Ameer bee	55/F	7845	RTA pedestrian vs two wheeler	Nil	Grade IIIA compound segmental fracture both bone left leg	Single, 15 cm from ankle joint	42C2	One / 15 cm	21 days	19/11/16	Closed interlocking nailing for tibia	16 wks	24 wks	Nil	Shortening 2.5 cm, occasional knee joint pain	Fair	Poor

S NO	NAME	AGE/ SEX	IP NO	Mode of injury	Associated injury	Diagnosis	Fibula fracture	AO classify cation	No of segment / length of segment	Index injury to surgery	Date of surgery	Treatment done	Proximal fracture union (wks)	Distal fracture union (wks)	Secondary procedure done	Complication	Johner and wruhs criteria	Knee society score
15	Mr.Muniyappan	24/M	33270	RTA 2 wheeler vs 2 wheeler	Nil	Closed segmental fracture both bone right leg	Single, 20 cm from ankle joint	42C2	One /9 cm	20 days	23/1/16	Closed interlocking nailing for tibia	20 wks	26 wks	Nil	1 cm shortening	Excellent	Excellent
16	Mr.Gopi	32/M	23663	RTA 2 wheeler vs 2 wheeler	Nil	Grade IIIA compound segmental fracture both bone right leg	No fracture	42C2	One / 6 cm	55 days	5/5/14	Open interlocking nailing for tibia	18 wks	28 wks	Nil	Infection, 1 cm shortening	Excellent	Excellent
17	Mr.Vijayakumar	42/M	76737	RTA Pedestrian vs two wheeler	Nil	Segmental fracture both bone fracture right leg	Segmental fracture, 20cm above ankle joint	42C2	One / 5 cm	21 days	12/11/15	Closed interlocking nailing for tibia	24 wks	24 wks	Nil	Shortening 1 cm	Excellent	Excellent
18	Unknown(Raghu)	21/M	21065	RTA Pedestrian vs two wheeler	Nil	B/l segmental fracture both bone right leg	Segmental fracture, 10cm above ankle joint	42C2	10 Cm	9 days	11/3/16	Closed interlocking nailing for tibia			Nil	Nil	Excellent	Excellent
19	Vimal raj	34/M	27876	RTA pedestrian vs 2 wheeler	Nil	Closed segmental fracture both bone right leg	Single, 15 cm from ankle joint	42C2	9 CM	10 days	22/3/16	Closed interlocking nailing for tibia	16 wks	26 wks		Nil	Excellent	Excellent
20	srinivasan	42/M	23487	RTA 2 wheeler vs 4 wheeler	Closed segmental shaft of femur fracture	Closed segmental fracture both bone right leg with compartment syndrome with fasciotomy done	Single, 15 cm from ankle joint	42C2	4 CM	50 days	22/12/2015 exfix 10/2/2016 tibia and femur nailing	Open interlocking nailing for tibia	30 wks	30 wks	Nil	Infection, Hbs Ag+	Poor	Poor
21	Mr.Jothi	58/M	60060	RTA pedestrian vs two wheeler	Superior pubic ramus fracture	Closed segmental fracture both bone right leg	Single, 17 cm from ankle joint	42C2	One / 10 cm	26 days	15 days	Closed interlocking nailing for tibia	12 wks	24 wks	Nil	1 cm shortening	Excellent	Excellent