"MANAGEMENT OF CLOSED TIBIAL DIAPHYSEAL FRACTURE WITH INTRAMEDULLARY INTERLOCKING NAIL – A PROGRESSIVE STUDY"

Submitted By

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in

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Under the guidance of

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I hereby declare that this dissertation entitled **"MANAGEMENT OF CLOSED TIBIAL DIAPHYSEAL FRACTURE WITH INTRAMEDULLARY INTERLOCKING NAIL – A PROGRESSIVE STUDY"** is a bonafide and genuine research work carried out by me under the guidance of **DR. O.B.PATTANASHETTY** PROFESSOR AND H.O.D. OF ORTHOPAEDICS.

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LIST OF ABBRIVIATION

AO	Arbeitsgemainschaftfur Osteosynthes fragen
AP	Anteroposterior
ARDS	Abult Respiratory distress syndrome
ASIF	Association for study of internal fixation
BP	Blood pressure
DCP	Dynamic Compression plate
GA	Gustilo Anderson
HS	Hore Sommi
IM	Intermuscular
IV	Intravenous
NBM	Nil by month
PG	Prostaglandin
TPR	Temperature, pulse, Respiratory rate
TX	Thromboxane

ABSTRACT

Background and Objectives:

Fracture shaft of tibia are increasing due to high velocity trauma and industrialization. Not only they are common but often difficult to treat. Until recently surgeons had to rely on non operative methods, ‘V’ nailing, ‘plates and Screws’ and external fixators but they had their non drawbacks like prolonged immobilization, infection, delayed union, nonunion, malunion and cumbersome for patients, with the introduction of reamed intramedullary interlocking nail for tibial shaft fractures has overcome some of these complications and encourages the patients for early mobilization. This study has been done to evaluate the results and complications of reamed intramedullary interlocking nail for tibial shaft fractures in closed and Gustilos type I and II fractures.

Methods:

Forty two adult patients with fresh tibial shaft fractures were treated surgically with reamed intramedullary interlocking nail between October 2009-September 2011.

Results:

Among forty two patients treated with reamed intramedullary interlocking nail 24 fractures united at an average of 17.36 weeks with an union rate of 96%. Two fractures showed delayed union. Three cases of superficial infection were noted. Three patients had anterior knee pain.

Functional results were graded according to the criteria by Johner and Wruh. 57.14% of patients achieved excellent results, 38.04% achieved good results and 4.77% achieved fair result.

Conclusion:

This study with fresh closed fractures of the tibia treated with reamed intramedullary interlocking nailing is a safe and effective technique for management of closed tibial fractures with high union rates, low incidence of complication. Good functional results are achieved by careful preoperative planning and respecting the principles of reamed intramedullary interlocking nailing technique.

Key words:

Reaming; Intramedullay interlocking nailing.

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INTRODUCTION

Fractures of tibia are among the most common of serious skeletal injuries. Those who sustain then face slow recovery, with possible permanent deformity and disability.

Tibial fractures vary so widely in severity that general prescriptions for treatment are not applicable to each patient. The spectrum of injury extends from trivial enough to be ignored to so severe that amputation is the best treatment.

Extremely prepossessed clinical policies so called standards of care may offer a reasonable course of treatment, but so many variables affect a given patients situation that treatment must be individualized.

Both operative and non-operative treatments of tibial shaft fractures have been strongly advocated. Less severe fractures gradually do well with out surgery, the more sever fractures usually requires it.

The rationale for operating on closed tibial fractures of moderate and major severity is to prevent disability and frequent morbidity associated with these injuries. Problems are usually decreased by appropriate fixation.

AIMS AND OBJECTIVES OF THE STUDY

To evaluate the functional outcome in fracture shaft of tibia treated with intramedullary interlocking nail.

REVIEW OF LITERATURE

A. Historical Review :

The term "Orthopaedics" comes from its origin to the Greek word and was coined by the French Physician **Nicolas Andry** (1741), who published a book titled "La Orthopaedica", meaning art of correcting deformities in children.

Treatment of fractures dates back to **Sushruta,** the greatest scholar of Hindu Medicine, between 6th and 9th century BC.

He wrote in detail about fractures, dislocations and their treatment.

Application of bandages, for healing of wounds, and to make the patient comfortable has been described.

Treatment of fractures in particular of limbs has been described in detail.

Reduction of fractures and immobilization with wooden splints has been described.

Hippocrates also taught about fractures in detail and its management over two thousand years ago.

In the treatment of fractures, he employed traction with a wind loss, supported with a bench.

His work has historic worth, and is also the background of many principle of modern orthopaedic surgery.

Nicolas Andrey (1658-1742) published the first book in Orthopaedic Surgery "La Orthopaedica".

The 19th century also saw the emergence of Orthopaedics as a speciality and the first orthopaedic centre was started.

Plaster cast was used in 1852, by **Methigssen** and he used bandages impregnated with Plaster of Paris.

In the 19th Century, Othropaedics and fractures depended on braces, casts, manipulations and exercise.

John Hilton (1804-1878) advocated absolute bed rest for the fractured limb.

At the dawn of 20th century, there was rapid evolution of surgery in orthopaedics.

The art of correcting deformities and bone injuries, was given a scientific out look.

A more aggressive surgical approach to the injured tissue of the musculoskeletal system was adopted.

B. Historical Review of Intramedullary Nailing :

Literature shows the use of intramedullary fixation since a very long time.

500 years ago **Aztecs** used wooden intramedullary nails.

Parsian Surgeon **J. Friedrich Dieffenbach** in 1841, used Ivory pegs to cross the fracture site.

In 1870, **Berenger Feraud** stated that bone fragments could be held together directly with “Ivory pegs, metal nails”. What was known as “Dieffenbach’s Operation” came into increasing use and ivory or metal nails were used axially in the medullary canal to stabilize fractures.

In 1911, **Rissler** used Ivory and bones as intramedullary devices.

In 1913, **Schone** used silver rods.

In 1916, **Hey Groves** used metal nails.

Early orthopaedic surgeons, such as **Senn, Lambotte** and **Hey Groves** investigated the use of Ivory, Bone and Metal nails.

The Rush brothers, **Leshi and Lewry** from Mississippi, developed the Rush rod in1927. ‘Vase-of-flowers’ analogy of Rush, was usage of straight pins in curved bone and curved pins in straight bone, which is a three point fixation.

1940, **Gerhard Kuntscher,** regarded as Father of Intramedullary nailing, described at the German Surgical Conference, the clover leaf nail. Before this, he has also devised the V-nail.

In 1950, **Kuntscher** added medullary reaming to achieve a uniform diameter of medullary canal better fit, extending the indications, to fractures a little away from the isthmus.

Herzog modified Kuntscher nail with bend at the upper quarter of the nail for tibial fractures to accommodate the eccentric proximal portal of entry.

In Memphis, **Hansen** and **Brewer** fabricated a diamond shaped nail.

J.O. Lottes developed a heavy-cored nail with a threaded drive a facilitate improved driving and extraction.

The Russians developed the Fishkin’s nail. These had fins for distal locking.

In 1968, **Kuntscher** proposed a new device called Detensor Nail for communiated fractures. This principle of “Detensor effect” of achieving stability with transverse bolts through prefabricated holes in the nails has become the basis of the interlocking nail.

In 1972, **Klemn and Schellmann** improved on the nail and bolts, developed instrumentation and standardized the operative techiniques.

In 1976,**Grosse and Kempf** in Strasbourg, France developed the G.K. Nail and broadened the indications.

In the 1990’s **AO/ASIF** introduced solid tibial nails for open fractures.

Recently, a newer concept of 2^{nd} Generation nail have been the un reamed small Diameter interlocking nails, extending its use to the treatment of open fractures also. Studies on this have been done by **Cole and Latta, Sanders, Paul and Krettek** and have shown encouraging results.

There's also study by **D.D. Tanna** on interlocking tibial nail without using an imager intensifier

C. Treatment Modalities in Fractures Shaft of Tibia :

Every fracture of the tibial shaft must be assessed individually The various treatment modalities used are :

Closed Reduction and Plaster Immobilization :

Bohler defined the use of long leg casts. Sarmiento devised patellar tendon bearing cast, and described functional cast bracing of tibial fractures.

In displaced fractures, closed reduction is done by manipulation under anaestthesia. A long leg cast with adequate padding over the malleoli, back of the heel and neck of the fibula is applied with 10 degrees flexion at the knee for 4 to 6 weeks followed by a Sarmiento cast which is a patellar tendon bearing cast, which is applied for about 8 weeks.

Here when the fracture line is oblique and swelling is present, redisplacement can occur. The patient is also prone for fracture disease (i.e., adhesions formation, muscular wasting and stiffness of the joint).

Sarmiento's functional cast bracing is effective in only selected low energy tibial fractures, closed injuries with no more than 15mm of initial shortening or in stable reduced transverse fractures.

Sarmiento reviewed 482 fractures of the tibia, treated with a cast of functional brace with only 2 non-unions. The average healing time was 14 to 15 weeks and the average shortening was 6.4 mm and 8 degrees of angulation.

Plaster and Pins :

This was a standard treatment for unstable fractures. Here, two transfixation pins are inserted in the proximal end and distal end of the tibia. Closed reduction is done and below knee plaster cast is applied. This method maintains the length, prevents rotation and allows the mobilization of knee. It is also used in case of open fractures and communited fractures. The disadvantages are pin tract infection, pivoting of the bone, angulation at the fracture site, diffuse osteoporosis and delayed union can occur due to prolonged treatment and non-weight bearing.

In 1974, **Anderson and Hutching** reporting 208 unstable tibial and fibular fractures treated by closed reduction with insertion of Steinmann pins above and below to fractures and incorporated into a cast. The union rate was 95 % with a 2.4% non-union rate and 2.4% of delayed union.

Calipers and Brace :

Their main aim was to weight bearing and were used after initial consolidation of fracture. A full-length weight –relieving caliper with a clyinderical shin-guard made out of moulded leather of plastic has been used. A caliper should have a fixed heel socket to prevent rotations. Braces, which may be patellar tendon bearing, Sarmiento functional brace are used. These have the advantage of being light, comfortable inexpensive and with few complications. Mean union time by **Sarmiento** was 18.7 weeks, since they are removable, patient compliance is doubtful and cannot be used in open fractures. They help only after initial consolidation of the fracture.

External fixators :

These included Schanz pins or Bone screws, support column and external fixators clamps, for fixation.

They are used in open fractures, as it allows for regular wound dressing and allows for skin grafting.

It is used as both a temporary and definitive stabilization

They can be (1) Ring fixators (2) Frame fixators.

They can have unilateral, bilateral, triangular and quadrilateral frames.

The Illiazorov/Hoffman's fixators are better methods as they give good fracture stabilization. The length, angulation and rotatory adjustments can also be done.

They give a three dimensional correction.

Their problems are that, Pin tract infection can occur, they are bulky and cumbersome. Malunion, Non-union and shortening can occur.

Internal Fixation :

a. Cerclage Wiring :

Applicable in spiral fractures. This was first devised by Goetz in 1993. However, this technique is an inefficient form of fixation and has to be supported externally. Also, if the fracture is widely displaced, percutaneous wiring has the danger of picking tendons and even vessels, unless displacement has been accurately reduced. Complications are secondary malalignment, peroneal nerve palsy and delayed union.

b. Screw Fixation (interfragmentary screw fixation)

Mainly used to fix the butterfly fragment to main fragment. They stabilize oblique and spiral fractures. Here fractures are fixed with, interfragmentary screws placed perpendicular to the fracture line. This allows the fragments to be compressed together causing a gliding action. It has to be stabilized externally with a plaster cast. This is not a stable fixation as the stability and alignment is lost in this technique.

c. Plates and Screws :

Plating of tibial fractures was first described in the 1880’2 by Hansmann in Germany.

Karlstrom in 1972, in treting 135 tibial fractures showed 90% good results with plating..

It has been accepted since then, but gained popularity with the introduction of Dynamic Compression plate by AO Group.

Ideal fractures are transverse fractures, and should be preferably done away from subcutaneous surface of tibia.

Back and Hansen showed non-union, infection and fixation failures in plating. This is mainly because it is a load bearing device.

Den Outer agreed union and malalignment improved with plating but there was no overall advantage to cast and braces.

It causes regional osteopenia due to stress sparing. It causes soft tissue damage, periosteal stripping and cannot be used in comminuted fractures especially for this reason.

Currently, tibial plating cannot be advocated for routine management of diaphyseal fractures.

d. Intramedullary Nailing :

Locked Intramedullary nailing has revolutionized the management of tibial diaphseal fractures.

This is the most accepted surgical treatment modality today. Healing is rapid with abundant callus. These are load sharing devices, fixation is along the mechanical axis, hence implant induced osteopenia is not encountered. Kuntscher's "V" nail, Rush nail, Ender's nail, were the nails often used. To get a better fit in the canal reamed are used for better stability in tibial diaphyseal fractures. Non-reamed nails cause less damage to medullary circulation. Nailing can be used distally till 5 cm of ankle joint. But it is relatively difficult in proximal tibial fractures.

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

In closed nailing the fracture haematoma is not exposed and has a advantage over open nailing in early rate of fracture healing with low infection and less soft tissue injury. But closed nailing is technically demanding. Various methods and advent of C-arm have been made closed nailing a routine procedure.

Kuntscher in 1957, said that medullary nailing represents the ideal treatment of long bone fractures and requires no external splinting or special postoperative care. The principle in this operative method is stable osteosynthesis through flexible impingement of the nails in the bone wide enough to occupy the entire corss section of the medullary cavity and to bear weight of the body and muscle stress. Also he stressed on reaming of the medullary cavity.

Court Brown, showed good results in closed and Gustilo type I open fractures with nailing.

Lottes J.O (1974), reviewed 387 fractures treated with lottes triflanged medullary nail, and reported infections in only 0.9% of 330 closed fractures and 7.3% of 204 open fractures. He reported a 2.3% non-union rate in his overall series using closed method of nailing.

Hooper et al., found intramedullary nailing gave a statistically faster time in union as well as significantly less time off work and hospitalization time.

D. Review of literature on intramedullary nailing

Gerhard B.G. Kuntscher[14] (1958), opined that intramedullary nailing represent the ideal treatment of fractures and requires no external fixation or special postoperative care. The basic principle in this method is stable osteosynthesis through flexible impingement of nail in the bone.

J. Zucman et al[46] (1969), treated 36 two level tibial fractures by intramedullary nailing. The results showed that intramedullary nailing in two-level tibal fractures allows walking with full weight bearing in an average of 3 to 4 months. It decreases the rate of non-union, malunion and it should decrease the rate of infection, in closed fractures compared with other types of internal fixation.

Compound tibial fractures treated by nailing are still cmplicated by infection, but there are no other studies to conclude that other methods could lower significantly the infection rate.

Seven Olerud et al[38] (1972), concluded that secondary intramedullary nailing done in patients after initial treatment with compression osteosynthesis by plating who developed delayed healing, refractures, with fracturing of plate, showing excellent results in 87% of 13cases, with uncomplicated healing.

Neils Olaf Christensen[30] (1973), after treating 35 cases of fracture, which included shaft of femur (20 cases) and fractures of shaft of the tibia (15 cases) between 1966 to 1972, concluded that this method gives remarkably rapid consolidation and restoration of function even in difficult cases on non-union of fracture shaft.

Merle d' Aubigne et al[27] (1974), studied the outcome of tibial shaft fractures treated with plates and screws and intramedullary nailing. Between 1960 and 1972, 849 tibial fractures were treated by intramedullary nailing and 58 by other methods. 23 patients were treated with plates and screws. They showed more rate of non-union (69.6%), in the fractures treated by the plates and screws. The infection rate was 28% including compound and simple fractures. In case of intramedullary nailing non-union was 3.44% and infection was 7.2%.

Weller et al[42] (1979), on the basis of treating tibial fractures said that the indications for intramedullary nailing were middle shaft fractures, fractures in the transition zone between diaphysis and metaphysis and lastly communited fractures. They described both open and closed nailing, its advantages and disadvantages.

Johner and Wruh's[43] (1983), classified tibial fractures based on etiology, morphology and clinical features, documentd in a series, 291 fractures treated by AO/ASIF rigid internal fixation. The fractures were placed in 9 main fracture groups, each with three sub-groups according to location in the proximal, middle or distal segment of the shaft. Group A includes all simple fractures, Group B includes fractures with butterfly fragments and Group C all communited.

They also developed criteria for evaluation of final results as excellent, good, fair, or poor, by using non-union, pain deformity, movements of joints, shortening, neurovascular disturbances and gait as parameters for evaluation.

Lawrence B. Bone et al[26] (1986), treated 112 cases of tibial fractures by reaming and intramedullary railing. They opined that it is also indicated in the treatment of non-union and malunion in the absence of sepsis. In segmental fractures, excellent result were noted with average time in union at 19 weeks.

Average time to full weight bearing was 4 weeks. 50% of primary nailing and 40% of secondary nailing healed within 3 months. They concluded that interlocking nailing is an excellent management for unstable fractures and for secondary procedures in fractures not associated with infection.

Kessler S.B. Hallefeldt et al[22] (1986) published articles, stating that fractures of tibia can be treated successfully with interlocking nailing.

Arne Ekeland et al[2] (1988) treated 45 tibial shaft fractures, in 43 patients with Grosse-Kempf interlocking intramedullary nail between 1979 to 1982. Median age of the nailed patients was 35 years, it included 15 females and 28 males. 23 fractures (51%) were caused by high energy trauma, 5 fractures (11%) were open. Median time of full weight bearing was 30 days. Median time of bone union was 16 weeks with 29 excellent, 13 good and 2 fair results. 1 patient had non-union. They said that interlocking intramedullary nailing is the ideal treatment for communited, segmental and unstable fractures, and in patients with polytrauma.

Scott L. Sledge et al[36] (1989), in a study of 51 patients of non-union tibia, treated with intramedullary reaming and nailing between 1980 to 1986, showed that 49 patients had union of the fracture site at an average time of 7 months postoperatively.

This, they concluded that intramedullary nailing with reaming, can produce union as effectively as other alternatives, while enabling the patient to function more normally without external immobilization or walking aids.

Court Brown et al[8]. (1990), treated 125 closed and type I open tibial fractures. The mean time of union was 16.7 weeks, and no fractures required bone grafting.

There was 1.6% infection rate, 40.8% of patients had knee pain and 26.4% needed to have the nail removed, other complications were minor. They used Grosse Kempf interlocking nail in 100 men and 23 women with a mean age of 32.4 years. There were 114 closed and 11 type I open fractures, 14 fractures involved only tibia and 111 involved both bones of leg. 6 fractures were in the proximal third of tibia, 46 in the middle third and 64 in the distal third. 9 fractures were sport injuries and 35 occurred after fall, while 6 patients were assaulted. Mean time in union was 16.7 weeks, two patients (1.6%) had nonunion, two deep infections (1.6%) developed, 5mm shortening in three patients, and unacceptable deformity or shortening in 2.4% of patients. They suggested that closed intrameddulary nailing with an interlocking nail is an excellent method of treating closed and type I open tibial fractures.

Court Brown et al[8]. (1990), studied adults aged 12 years and above with tibial fractures of the diaphysis excluding extra-articular fractures in the proximal and distal 5 cms of the tibia. They found six causes of injury, simple falls, falls down stairs, falls from a height, sports injuries, direct blows or assaults and rod traffic accidents. They reviewed 523 tibial diaphyseal fractures with an average age of 37.2 year. There were 54 % AO type A, 27.8% type B ad 18.3% type C. 400 fractures were closed fractures in the middle and distal third and these were relatively common. There were 37.5% road traffic accidents and 30.9% sports injuries. The fibula was intasct in 117(22.3%) of diaphyseal fractures.

Gross and Kempf[15] (1991), treated 397 cases of fracture shaft of the tibia by locked intramedullary interlocking nailing. In two-third of cases, the procedure was static and in one-third, it was dynamic. Full weight bearing was allowed on a mean period of 60 days. 267 cases were closed and 132 open fractures. There were 15 deep infections (3.7%), out of which 9 (2.2%) were open fractures, 15 cases of non-union (3.7%), 22 compartment syndromes, 6 cases of malunion in varus and 54 cases of malunion in valgus greater than 5 degress out of which 15 were greater than 10 degrees.

Hooper et al[18]. (1991), reviewed fractures of tibia treated with conservative treatment and closed intramedullary nailing. The results showed that the intramedullary nailing gives more rapid union with less malunion and shortening Nailed patients had less time off work, with a more predictable and rapid return to full function. Out of 62 tibial fracture, 33 fractures were treated by conservative method and 29 fractures by closed naling. Time of union in nailed fractures was 15.7 weeks and time off work was 13.52 weeks. Mean hospital stay was 11.6 days.

Habernek H. et al[16] (1992), showed 109 patients treated by interlocking nailing for tibial fractures between 1985-1990 by K.H. Schwanz and the LKH Bad Ischl, Austria. 92 cases were followed up. An increased number of compound fractures were evaluated. Except for 14 malalignment and 2 leg infections after new injuries, no other serious complications were detected. Interlocking nailing can be safely recommended even for open fractures upto second degree at any level from the second fifth to the fourth fifth of the tibia.

Wu C. C.Shih C.H.[44] (1993), have reported in the Canadian Journal of Surgery on a retrospective study done in 11 tibial shaft fractures with static interlocking nailing followed by dynamization, which was carried on average of 7.8 months. The success rate 54 %. The follow up was atleast 2 years. The interval from nailing to dynamization did not correlate with the success rate, the longest interval associated with successful healing was 20 months. The authors found that static interlocking nailing without dynamization can still produce a high union rate and if there is spare callus formation during the healing process, due to low osteogensis, dynamization will result in fracture union in half of the cases. To improve the union rate cancellous bone grafting may be necessary.

Krettek C. et al[24] . (1994), reported a series of 152 cases of tibial fractures treated with AO unreamed tibial nail between March 1989 and June 1994. Of these, 75 cases were followed up for a period of 11-37 months. Fractures were classified according to Muller, there were 14 type A, 37 Type B and 24 Type C fractures. The main intra operative complications were breakage of locking bolts (16) between 16 and 20 weeks, there were 3 deep infections. Meantime for union was 23.9 weeks.

In cases non-union was observed. The overall result was judged with the Karlstrom-olerud score, which was applicable on 66 of 75 cases. There were 2 no scoring was attempted because of severe injuries around the knee of ankle.

Watson J.T.[41] (1994) , concluded from a review of literature that unstable closed and type I open fractures are preferably treated with intramedullary nailing with or without reaming.

In Grade II and III A fractures, rate of union rate of infection is similar in reamed and unreamed intramedullary nails, but secondary surgery may be needed in unreamed nailing.

Watson J.T[41] (1994), concluded that the presence of a fibular fracture in association with tibial fracture often indicates an unstable fracture as well as high energy mechanism of injury. He says that good results have also been reported with use of techniques with reaming. The reaming of the medullary cavity allows the insertion of larger nail, thereby increasing the stability of fixation, because of biomechanical limitations, there may be high rate of failure of small diameter locking nails. If union is not achieved earlier, fatigue failure of the nail or interlocking screws with subsequent non-union may occur. Wiss D A et al [2], in 1995 evaluated one hundred thirty-four acute unstable fractures of the tibia were treated with a reamed intramedullary nail with locking capabilities. There were 101 closed and 33 open fractures (20 Grade 1 fractures, 12 Grade 2 fractures, and 1 fracture from a gunshot wound). Patients were seen in follow-up for an average of 16 months after nailing. The time of fracture union averaged 28 weeks in closed fractures and 39 weeks in open fractures. The authors conclude that reamed intramedullary nails should be restricted to unstable, closed tibial shaft fractures. Its use in open fractures even on a delayed basis cannot be recommended because of unacceptably high infection rates.

Greogory P et al [3,] in 1995 evaluated forty-seven closed, unstable tibial shaft fractures were treated with locked intramedullary nailing without reaming and Follow-up was possible for 38 (81%) fractures. Thirty-three fractures healed within 6 months (87%). All patients had unlimited ambulation without assistive devices, and the ability to climb stairs in a normal fashion. Range of motion of the knee, and subtalar joints at final follow-up was normal, except in those patients who had concomitant joints injuries. There were 2 delayed unions (57%) and 3nonunion (4%). Three patients had angular deformities. Interlocked, intramedullary nailing inserted in an unreamed manner has become the treatment of choice for the closed, unstable tibial shaft fracture.

Moed R. R. et al[28]. (1995), published an article in C.O.R.R., on ultrasound for the early diagnosis of fracture healing after interlocking nailing of the tibia without reaming. 14 fractures were studied and assessed for atleast 1 year. The ultrasound results were obtained at 2 week intervals for 10 weeks. Ultrasound correctly predicted fracture healing in all 9 fractures that subsequently progressed to fracture union of the 5 fractures that did not heal and required secondary procedures, ultrasound predicted delayed healing in 4 fractures. Overall ultrasound was able to predict fracture healing before it was radiographically evident. It may provide an important prognostic information concerning tibial fracture healing after interlocking nailing without reaming.

Anglen. J.O. et al[1] (1995), have reported in the journal of trauma, on comparison of reamed and unreamed nailing of the tibia. A retrospective review was done on all tibial fractures treated by interlocking nailing at the author's institution, over the past five years, in order to compare reamed and unreamed nailing. The unreamed nailing had lower average operative time and lower average estimated blood loss. There was a statistically significant difference in healing times, with unreamed nailing taking an average of 242 days to heal while reamed nailing took 158days .6 non-unions occurred, 1 in reamed nailing and 5 in unreamed nailing. Malunions occurred in 4 reamed nailing and 6 unreamed nailing. Patellofemoral complication were more common in unreamed nailings.

Riemer et al[33]**.** (1995), in his article of "Non-reamed nailing of tibial diaphyseal fractures in blunt polytrauma patients, reported a high reoperative rate of 42 % in an unreamed nail. Reamed nail showed better union rates. He also recommended dynamization in an unreamed nailing if callus response was poor, which was not necessary in a reamed nail.

Court Brown et al[10] (1995) in their article "Reamed or unreamed nailing for closed tibial fractures said that reamed nailing showed better results of union and unreamed nailing showed prolonged union rates.

The average union time is less and the incidence of non-union and malunion is low in reamed nailing.

Court Brown et al[10] (1996), performed a prospective randomized study on 50 patients with Tscherne C1 tibial diaphyseal fractures, comparing treatment with reamed and unreamed intramedullary nailing. The showed that reamed nailing is associated with significantly lower time of union and a reduced requirement for a further operation. Unreamed naling should not be used in the treatment of the common Tscherne C1 tibial fractures.

Fang –Yao Chiu et al[12] (1996), treated unstable closed tibial shaft fractures. Randomly 60 tibiae were fixed with inter locking nails and 56 tibiae were fixed with Ender nails The follow up period was 24 months. They concluded that in treating more comminuted tibial shaft fractures, the interlocking nail is recommended because of its higher success rate.

Blachut P.A et al[4] (1997) in 152 closed fracture of tibia managed between 1989 to 1994, with or without reaming, concluded that there are no major advantages to nailing without reaming as compared to nailing with reaming for the treatment of the closed fractures of the shaft of the tibia.

There was a higher prevalence of delayed union and breakage of screws after nailing without reaming. The study included 70 fractures treated with nailing with reaming and 56 that were treated with nailing without reaming. Both united without the need for an additional surgery.

Templeman D. et al[39] (1997) in treating 71 tibial fractures with an unlocked of dynamically locked intramedullay nail demonstrated that spiral and oblique fractures were not sufficiently stabilized by these nails. These fractures should be treated with statically locked interlocking tibial nails to prevent postoperative changes in alignment. Fractures outside middle third of the tibia should be treated with static interlocking tibial nails. Loss of alignment was defined as 1 cm or more of shortening or angulation greater than 5 degree in the frontal plane or 10 degrees in the sagittal plane.

Utvag et al[40] (1998), in a study in rats, said that there was no evidence that the degree of reaming significantly affected healing pattern in segmental fractures.

Hupel et al[19] (1998), in their article "Effective limited and standard reaming on cortical bone flow and early strength of union following segmental fracture note, no deleterious effect was seen on limb blood flow in presence of intact soft tissue envelope, and noted that muscle perfusion was significantly higher after reamed nailing.

Schemitsch et al[35] (1998), noted that there was no difference in bone formation between reamed and unreamed nailing in sheep bone and noted that, initially blood flow (overall tibial blood flow) decreased as the amount of reaming increased, but 11 weeks after surgery the tibial perfusion had increased to the same levels in both reamed and unreamed groups. They noted that no long-term benefit was seen in limited reaming. They found no evidence that the degree of reaming significantly affected healing pattern.

Blachut PA; Ricard S et al[5] (1998), treated 121 reamed in 120 patients and 104 unreamed fractures in 103 patients for review at an average follow up of 12 months. There were three nail failures in the reamed group and none in the unreamed group. Whereas screw failures occurred much more frequently in the unreamed group. Mal-union occurred in four fractures in each group. They concluded that Reamed nailing of closed tibial fractures is preferable to unreamed nailing.

Benjamin Litternberg et al[6] (1998) in their meta analysis have opined that closed reduction and placement of an intra medullary rod decreased the duration of external immobilization of the extremity, the alignment of the fracture was maintained, and the possibility of lower rate of infection when compared with open reduction and internal fixation.

Gaston P. et al[13] (1999), concluded that the Tschrne classification of closed fractures, based on the mechanism of the injury, the radiological features and the extent of the soft tissue damage is the more predictive of the time taken or regain function, with 6 of 12 functional measurements showing significance.

Krettek C. et al[25] (1999), In a study of 20 patients showed that Poller screws gave good supplement to stability after fixation with statically locked intramedullary nails of small diameter in nailing of metaphyseal fractures with a short proximal or distal fragment where an increase in malalignment can occur in the coronal plane. Healing was evident in radiographs at 5.4 ± 2.1 months. Mean varus-valgus alignment of -1.0 degree and mean antercuravtum –recurvatum alignment of 1.6 degrees was noted.

Mohit, Bhandari et al[29] (1999), conducted a retrospective chart review of 200 tibial fractures. They showed that plate fixation was associated with a greater incidence of complications when compared with intramedullary nail fixation. Complication rates were significantly greater in the delayed surgical group. Surgical delay results in longer post-operative hospital stays, greater complication rates, and increased total cost of the health care system. Wu CC et al[4,] in 2000 reported thirty-seven consecutive adult tibial shaft malunions which had not undergone surgical treatment were prospectively treated with reamed intramedullary nailing. Indications for this treatment modality included a malunion of a tibial shaft which had been treated conservatively , . The malunions were treated with fibulotomy, closed wedge tibial ostetomy, open reaming of the marrow cavity, stable reamed intramedullary nail stabilization with or without supplementation, and cancellous bone grafting. Thirty four (92%) patients were followed up for at least 1 year (range 1.0-4.3 years), and all achieved a solid union. The union period was 5.8+/-0.8 months. Complications included 2 (6%) patients with deep infection and 1 (3%) with cortical perforation. However, all 3 patients recovered completely after management. In conclusion, a reamed intramedullary nail is an ideal instrument for tibial shaft malunions in indicated cases. Good exposure of the bony segments to ream the marrow cavity precisely can avoid cortical perforation. Gentle dissection of the tissues may lower the infection rate. Concomitant cancellous bone grafting can improve the union rate.

Karladani A.H. et al[21] (2000), concluded that displaced tibial fractures both closed and type I open fractures treated with intramedullay nails had fewer malunion problems and less restricted range of motion compared to cast treatment.

Hernigo P. et al[17] (2000), in a report on proximal entry for intramedullary nailing of the tibia, concluded that it is important to enter the medullary canal at the right point, so that the nail is introduced in line with the axis of the tibia in both the coronal and sagittal planes. If the entry point is low, posterior tibia is endangered, if high, then unrecognized articular penetration can occur injuring the menisci and ligamentum transversum.

The unrecognized articular penetration was seen commonly and this caused anterior knee pain. The safe zone is anterior to the ligamentum transversum and anterior to the anterior horn of each meniscus. In some bones the safe zone is smaller than the size of the standard reamers and the proximal part of the some nails.

Cyna Khalily et al[11] (2000), in their survey from the 1997 orthopedic Trauma Association showed that the treatment of choice of all the respondent surveyed, a significantly larger proportion chose intramedullary nailing as the treatment of choice over casting, plating , or external fixation.

Jarmo. A.K. Toivanen et al[20] (2002), in a prospective randomized study of intrameddulary nailing of fractures of the tibial shaft, compared the results of anterior knee pain in two different nail insertion techniques. The incidence of chronic anterior knee pain was seen in upto 56 % of patients They noted that irrespective of incision used, whether transtendinous, or paratendinous incision (by a medial longitudinal incision without violating the patellar or its sheath), the prevalence of anterior knee pain is the same.

They concluded by saying that intramedullarly nailing is the treatment of choice for displaced tibial shaft fractures and any change in approach in nail insertion does not change incidence of anterior knee pain. Schmidt A H et al [5] in 2003 evaluated closed tibial shaft fractures are common injuries that remain challenging to treat because of the wide spectrum of fracture patterns and soft-tiossue injuries. Understanding the indications for surgical and nonsurgical treatment of these fractures is essential for good outcomes. Although cast treatment of stable tibial shaft fractures has traditionally been successful and continues to be widely used, recent clinical studies have shown that intramedullary nails may be more advantageous for fractures healing and function than casting. Surgical treatment (intramedullary nailing, plate fixation, or external fixation) of closed tibial shaft fractures varies depending on multiple factors. Metaphyseal fractures are well suited for plating, although newer intrameduulary nail designs provide the option of intramedullary nailing of proximal or distal metaphyseal tibia-fibula fractures. External fixators are well suited for skeletally immature patients with unstable fracture patterns or for patients with unacceptably small intramedullary canals. Interlocking nails are the treatment of choice for most unstable tibia-fibula shaft fractures.

Kutty S et al[6] in 2003 evaluated Fourty-eight patients underwent intramedullary nailing between 1995 and 2000 using the AO UTN. Follow-up details were available for 45 patients. In which Fourty-four fractures united (97%). Complications included one non-union (2.2%) , 15 delayed unions 33%), nine had either broken or bent interlocking screws (20%). Six malunions (13%) and three patients underwent at least one fasciotomy for compartment syndrome (7%). Twenty – one patients underwent atleast one additional operation to obtain operation union (47%). Of these, five underwent exchange nailing (11%). They concluded that AO UTN does have a high complication rate and, should it be used, we feel that early dynamisaton or exchange nailing be considered to hasten union and prevent screw breakage.

Andrew Schmidt et. al[3] (2003) in the instructional course on treatment of closed tibial fractures, summarized that intramedullary nailing is more convenient, and it may provide superior results, but prospective randomized studies need to be done to confirm this. Operative treatment is recommended for open or closed unstable fractures and for fractures that cannot be held in adequate alignment. Intra medullary nail fixation is the treatment of choice for the majority of tibial fracture that require stabilization.

Larson LB et al[7] in 2004 studied to determine if any differences exist in healing and complications between reamed and unreamed nailing in patients with tibial shaft fractures, Stablization of tibial fractures either with a slotted, stainless steel reamed nail or a solid, titanium nail. The average time to fracture healing was

16.7 weeks in the reamed group and 25.7 weeks in the unreamed group. They concluded Unreamed nailing in patients with tibial fractures may be associated with higher rates of secondary operations and malunions compared with reamed nailing. The time to fracture healing was significantly longer with unreamed nail.

Nazri MY et al[31] (2004) A retrospective study was done in 30 patients with infected closed fractures, treated and showed that 77% of infected fractures with a stable implant united even in the presence of infection.

Petrisor B et al[32] (2005) 35 patients with tibial diaphyseal fractures were reviewed. All patients were treated with reamed intra medullary nailing and concluded that a number of deep infections after reamed intramedullary tibial nailing are avoidable. Particular attention must be paid to correct reaming, exchange nailing and fasciotomy closer in closed fractures.

Bekmeze T et al[8] '2005 evaluated the use of expandable intramedullary nails, their efficacy, and short term results in the treatment of tibial shaft fractures, The study included 19 patients (8 females, 11 males; mean age 38 years; range 17 to 65 years) who were treated with expandable intramedullary nails (Fixion) for tibia shaft fractures. The results were evaluated using the Johner-Wruhs criteria; the mean follo-up was 23 months (range 9 to 39 months). The mean operation time was 47 minutes (range 25 to 53 minutes). Union was achieved in all the patients in mean of 11.5 weeks (range 8 to 18 weeks). According to the Johner-Wruhs criteria, the results were excellent in 17 patients (89.5%) and good in two patients (10.5%). Treatment of fragmented-oblique fractures of the distal metaphysis (42-B2) resulted in a valgus angulation of 5 degrees in two patients, and extremity shortening of 5mm in one patients, both of whom had good results.

SURGICAL ANATOMY

The anatomy of the leg makes tibia susceptible to open fractures. The entire medial border is subcutaneous and is covered only by skin and subcutaneous tissues. It also makes a tempting target for the enthusiastic surgeon, as the surgical approach to the tibia is simple.

The anterior tibial border in the diaphyseal region of tibia is very dense and extends from tibial tuberosity proximally to just above the ankle joint distally. The subcutaneous prominence of tibia lends itself very readily to pin fixation due to lack of muscles and tendons traversing the anteromedial portion.

Shaft of the Tibia:

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

The shaft of the tibia has three borders and three surfaces. The anterior border or crest is sharp in its upper two third and subcutaneous throughout its length. The medial border is rounded and palpated throughout its length. The lateral border is sharp for the attachment of interosseous membrane. It is covered by muscles and cannot be palpated. The medial surface is subcutaneous throughout its extent. The posterior and lateral surfaces are covered by muscles. The high percentage of open injuries among fractures of the tibia is largely due to the fact that the anterior and medial border and medial surfaces are subcutaneous.

Muscles of the Leg:

Tibia is surrounded by muscular envelope and is divided into three compartments by the unyielding deep fascia of the leg.

Anterior compartment:

It contains the tibialis anterior, extensor digitorum longus, extensor hallucis longus and the peroneus tertius muscles. This anterior compartment also contains the anterior tibial artery and deep peroneal nerve. The tendons are close to the tibia and the fracture in this area may cause callus formation that may restrict gliding of these tendons.

Lateral compartment:

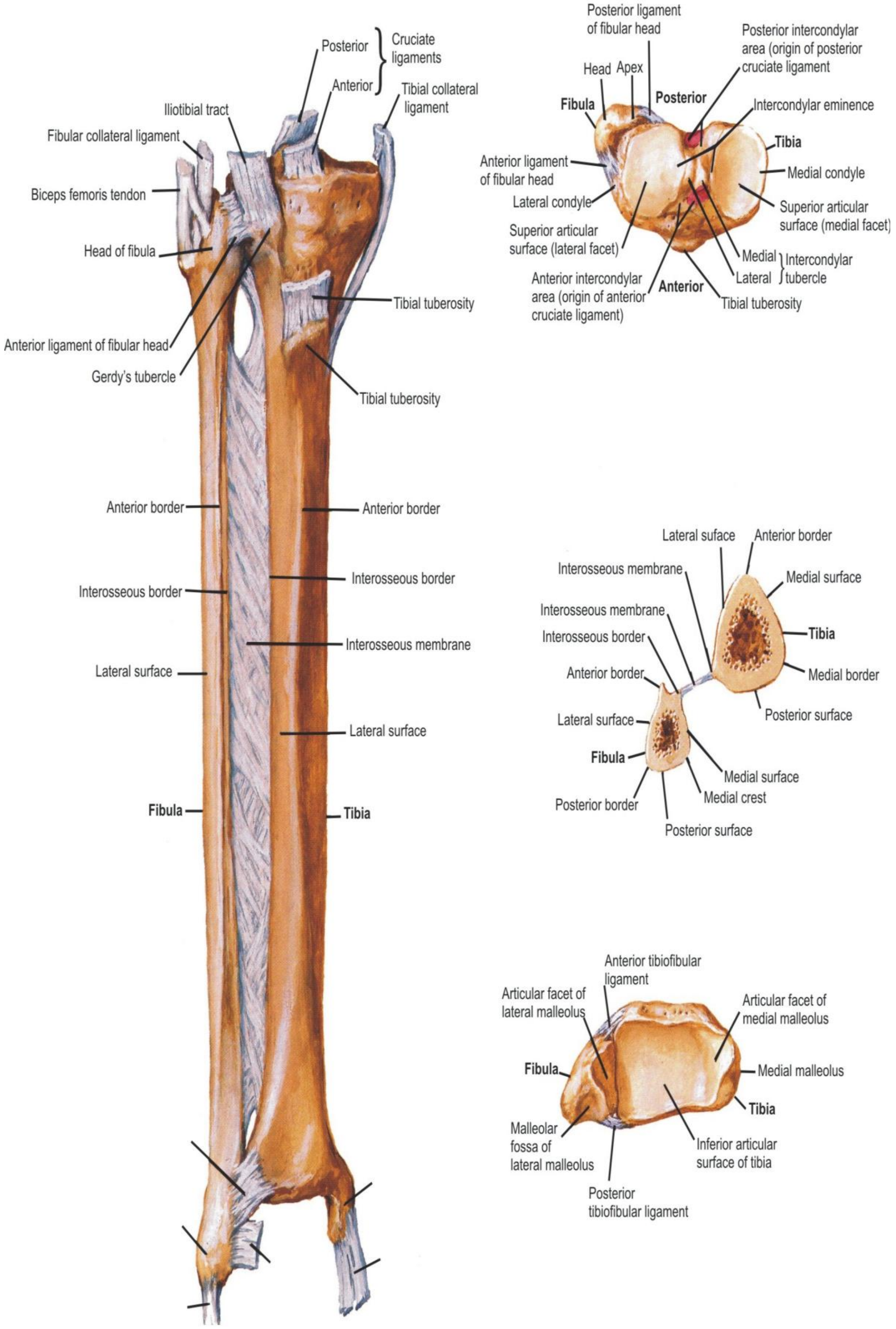
Lateral compartment contains the muscles peroneus longus and peroneus brevis and they protect the fibular shaft except near the ankle, so isolated fractures of the fibula owing to direct trauma are uncommon. The superficial peroneal nerve is in between the peronei and the extensor digitorum longus in the intermuscular septum. Thus the nerve is rarely involved in fracture of fibular shaft. It is at risk in fractures at fibular neck.

Posterior compartment:

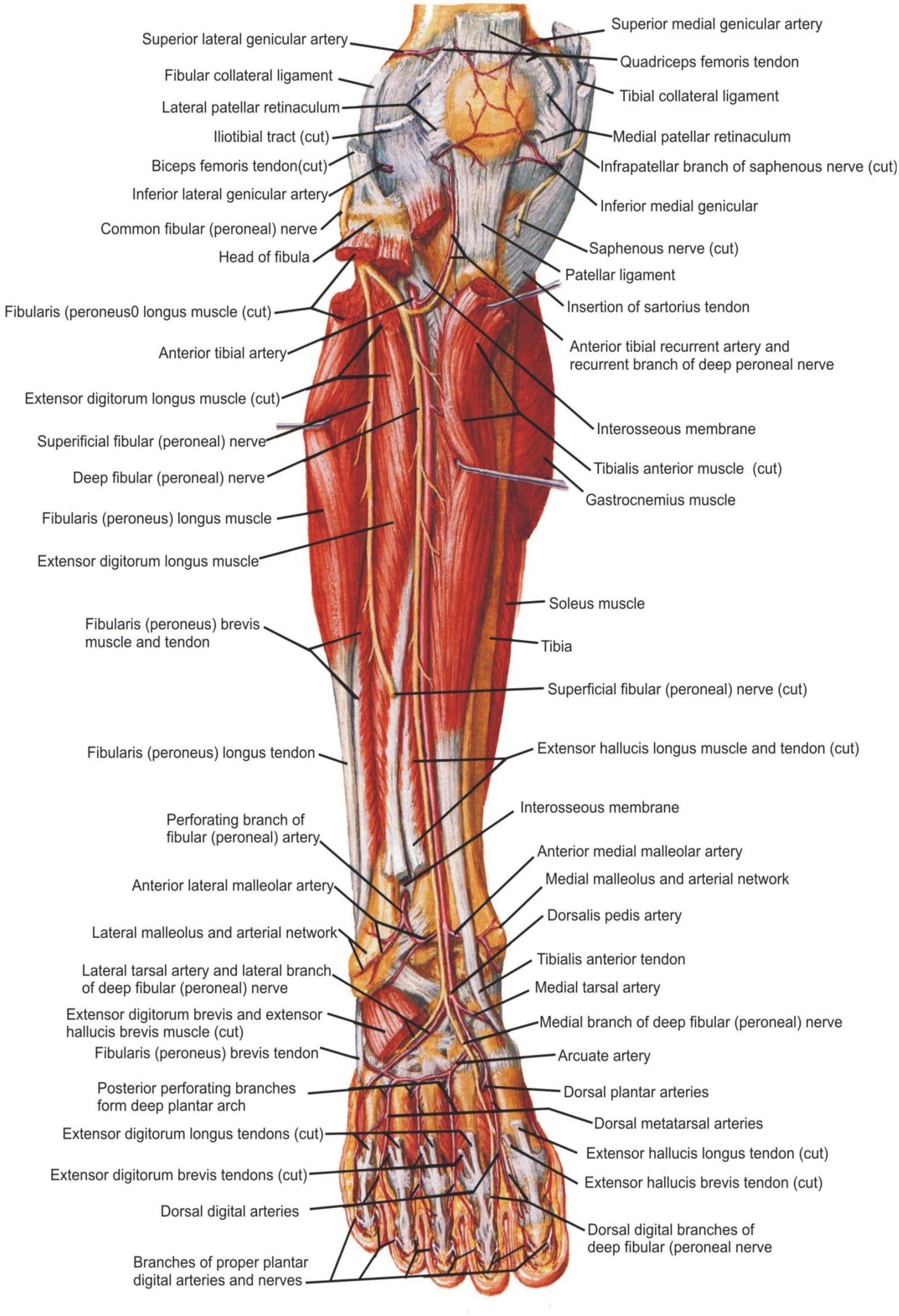
This is further divided into superficial and deep compartment.

It contains soleus, gastrocnemius, popliteus, tibialis posterior, flexor hallucis longus and flexor digitorum longus and posterior tibial nerve and posterior tibial artery.

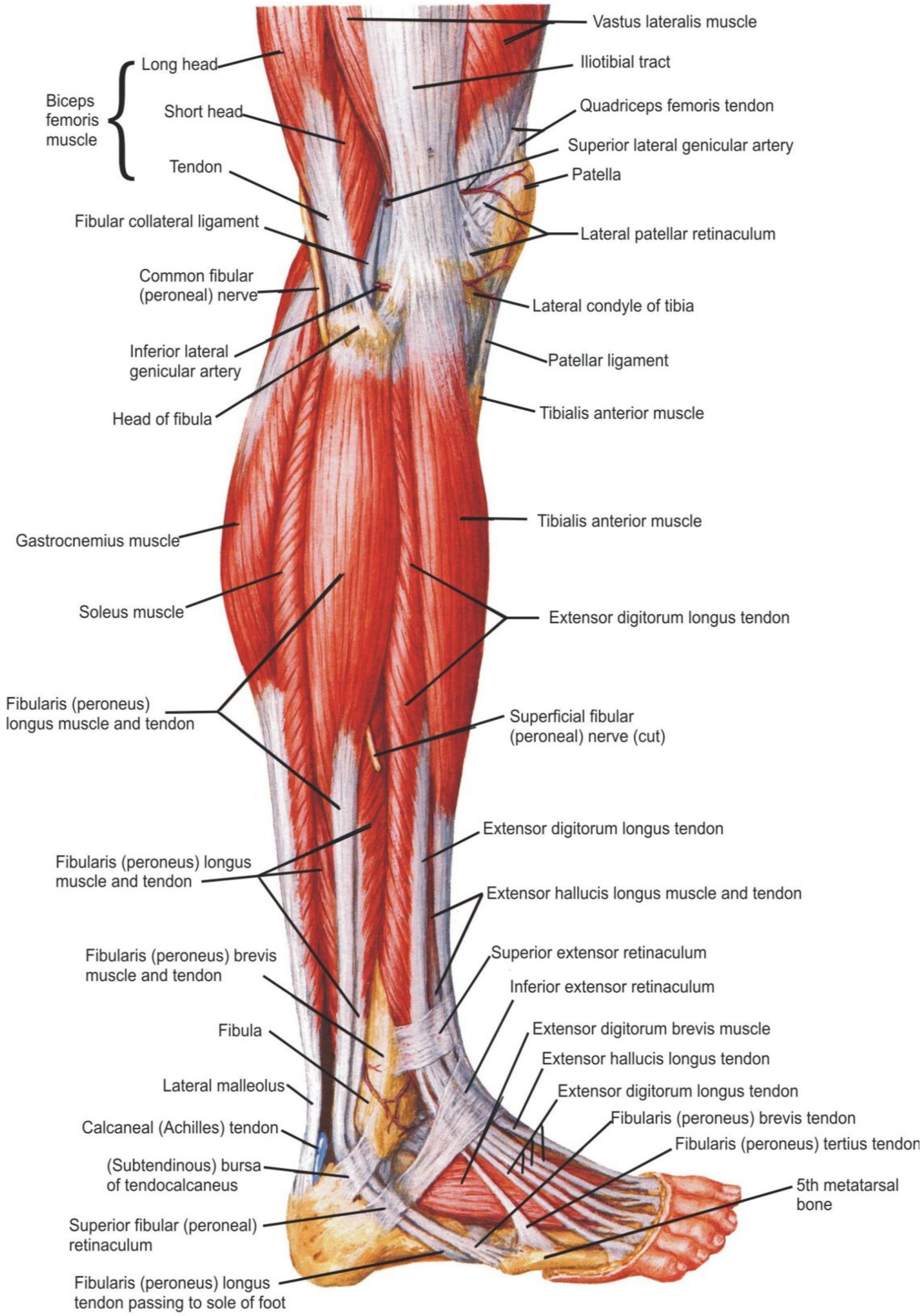
Tibia and Fibula



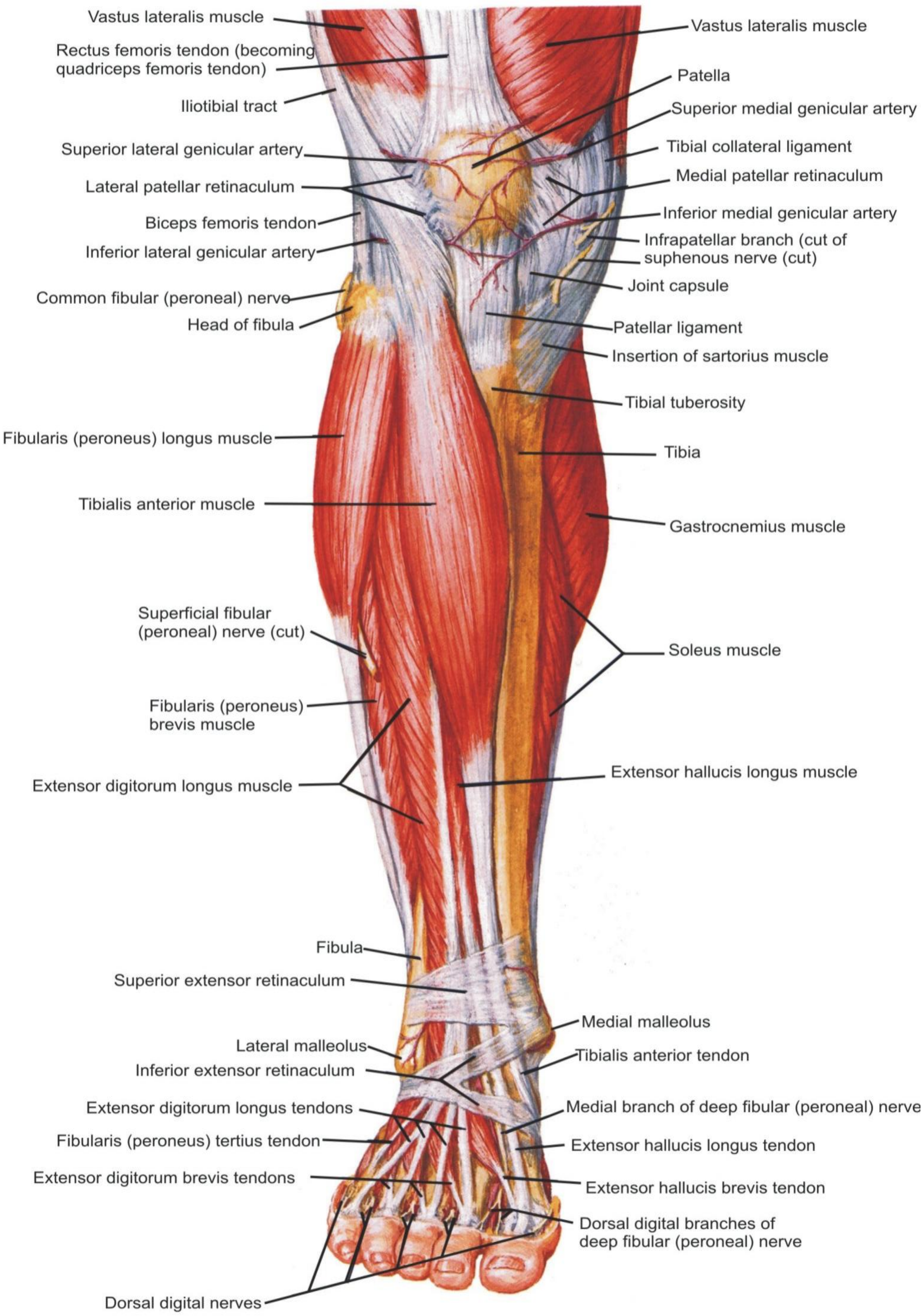
Muscles of Leg (Deep Dissection): Anterior View



Muscles of Leg: Lateral view



Muscles of Leg (Superficial Dissection): Anterior View



Tibial fractures in the upper third are complicated by the compartment syndrome. This may occur more commonly in the anterolateral compartment and also the posterior compartment.

The superficial compartment contains the gastrocnemius, soleus muscle serving as a source of local muscle flaps for defects in the proximal and middle third of tibia.

The posterior tibial artery is usually well protected. It is the major arterial supply after a severe open fracture and is a potential source for anastomosis with the free flaps for soft tissue reconstruction of the leg.

Interosseous membrane:

This is a strong sheet of fibrous tissue, which closes the spaces between the tibia and fibula except at its upper end, where there is a small opening for the passage of anterior tibial vessels. Separation of the tibia and fibula occurs when the membrane is extensively torn. Since the majority of its fibres run downwards and outwards, the membrane serves to distribute indirect violence acting on the tibia to the fibula.

The blood supply:

The anterior and posterior tibial and peroneal arteries are the main blood vessels of the leg. The anterior tibial artery is one of the terminal branches of the popliteal artery and passes forward through the opening in the interosseous membrane to reach the anterior compartment, where it passes downwards on the interosseous membrane to terminate in the dorsalis pedis artery. The posterior tibial artery is the direct continuation of the popliteal artery. It passes downwards in the space between the deep flexor muscles and the calf muscle to terminate in the plantar arteries. The peroneal artery passes downward in close relation to the posterior surface of the tibia.

Blood supply of tibia as with all other long bones is periosteal and endosteal. The periosteal blood supplies the outer third of the cortex, while the endosteral blood supplies the inner two-third of the cortex.

Periosteal blood supply comes from the surrounding musculature, while endosteal comes from nutrient artery which is a branch of the posterior tibial artery at the soleal line. Usually the blood flow is centrifugal, however, in case of a fracture when the endosteal blood supply is damaged, the flow is reversed and it changes from centrifugal to centripetal. When intramedullary nailing is done, the endosteal blood supply is interrupted. It is extremely important to preserve the soft tissue attachment. This is achieved by a closed intramedullary nailing.

The nutrient artery divides into three ascending branches which supply the proximal two-third of the tibia, and gives a smaller descending branch which supplies the distal one third of tibia. Hence, the proximal tibia has good endosteal blood supply, while the distal tibia has poor supply. The soft tissue attachments to the distal tibia are less, making the periosteal blood supply scanty. This differential pattern of blood supply makes tibia susceptible to atrophic non union at the junction of the middle and distal third. Unfortunately, majority of the open tibial fractures are at this junction.

Tibial blood supply in intramedullary nailing**: Girdlestone** in 1932 stated "that there is danger inherent in mechanical efficiency of our modern methods least the crafts man forget that union cannot be imposed but may have to be encouraged".

The tibial blood supply in intramedullary nailing will be jeopardised during surgery and the technique of surgical procedure used.

Rhinelander[33] suggested that:

In Loosely fitted nails there is rapid regeneration of nutrient system and

In Tight medullary nailing an intra cortical regeneration of nutrient system occurs.

A nail that filled the reamed medulla completely produced rigid fixation but cause complete necrosis of the cortex. The best configuration for an intramedullary nail is one with open spaces or flutes extending longitudinally between the flanges. The flanges will give firm support to all sectors of endosteal cortex and the flutes will permit regeneration of essential medullary circulation as rapidly as possible.

Medullary canal:

The medullary canal of tibia is more triangular in cross section than circular. Lack of curvature of the tibial medulllary canal as against that of femur makes a longitudinal interference fit with an intramedullary nail very difficult.

Role of fibula:

When the fibula is intact the tibial fracture is stable. It is a surgeon's friend in the management of tibial fractures. It maintains length in comminuted fractures and with bone loss, it acts as an internal splint.

But, sometimes it also acts as a double edged sword. For example, it prevents the union by preventing the collapse at the fracture site or in case of comminuted fractures, it can cause varus angulation at the fracture site.

Reaming:

Implantation of a medullary nail without previous reaming cause relatively minor damage to the blood circulation while the reaming process results in the destruction of all vessels in the medullary canal.

Necrosis of the inner 50-70% of the cortex takes place. Due to the anatomy of the medullary blood supply, the essential damage is caused by the first reaming. Subsequent reaming has little effect on cortical vascularity or viability.

Reaming is performed only to such an extent as to ensure sufficient fracture stabilization. Reaming particles, which possess bone inductive potential, are occasionally considered to be of great importance in fracture healing. Indeed, new bone formation can be observed around the reaming dust on histology sections and in roentgenograms, if it is surrounded by vital tissue. On the other hand, the reaming dust represents a large amount of necrotic particles or micro sequestrae, if they are deposited in devitalized zones of the medullary canal. This must be considered in view of the possible bacterial contamination, when conducting open intramedullary nailing.

The medullary canal is irregular in size in the long axis as well as in cross section. Stable intramedullary fixation requires a firm fit for a variable distance. On reaming the medullary canal, a cylindrical channel of uniform diameter is prepared for the nail, which improves the stabilizing effect of the implant. Furthermore, the bending stiffness increases with progressively larger diameter nails,therefore it is necessary to ream to a certain extent. A minimal amount of reaming is sufficient for static interlocking nailing. It is recommended that the medullary canal should be reamed 0.5-1mm larger than the chosen nail diameter to facilitate nail introduction.

Reamed versus unreamed nails:

Rhinelander[33] showed that reaming the diaphysis of long bone eliminates the endosteal blood supply. Because endosteal blood supply is responsible for the vascular supply to the vast majority of the inner cortex, the cortex is nearly completely devascularized. In open fractures there is substantially more stripping of soft tissues and periosteum than in closed fractures. Therefore the likelihood that entire cortex has been devascularised after reaming is very high. During this period of devascularization, the risk of infection is high, especially for acute reamed nailing of highly contaminated open fractures. These infections can be devastating; complete loss of the diaphysis is possible.

Rhinelander[33] also showed that after reaming there is a reversal of the normal centrifugal blood supply to the cortex to a centripetal pattern. This occurs within the first few weeks after nailing. Complete revascularization process occurs relatively early in the fracture healing process.

Non reamed nails have major advantages in open fractures because they cause less damage of the endosteal blood supply and allow more room for revascularization.

The disadvantage of non reamed nails is that they provide less stability. Delayed union, non union and malunion are more frequent. These advantages and disadvantages in the use of these devices must be balanced.

CLASSIFICATION OF TIBIAL SHAFT FRACTURES :

Classification :

Numerous classification system, have been proposed for tibial fractures from the simple stable versus unstable to more detailed Alphanumeric systems as proposed by AO/ASIF/OTA classification.

Any classification of injury is useful only if it alerts the physician to potential danger or helps to determine appropriate treatment.

The most important morphological variable are :

Anatomical location

Pattern or patterns of fracture lines

Associated injuries of fibula

Position and number of fragments

Extents of soft tissue damages.

Ellis classified tibial fractures into three groups of severity.

Minor : Non –displaced with minor communiation or small open wound.

Moderate : Total displacement or angulation with small degree of communiation or minor open wound.

Severe : Complete displacement of fracture fragments with major communication or major soft tissue damage.

Weissmann and Associates :

Also classified tibial fractures. This classification is based on the initial displacement of fracture. But this is often difficult to ascertain because the fractures may have been reduced from their initial displacements before X-rays.

It depends on :

Degree of initial displacement

Communiation

Soft tissue wounds

He arbitrarily assigned one of 3 grades from each factor. Nil or slight, moderate and severe.

OTA (Orthopaedic Orauma Association) /AO Classification

This was initially described by the AO Group

This is a morphologic classification based on the initial anteroposterior and lateral radiographs.

It consists of three types subdivided into three groups, each of which are further subdivided into three sub-groups.

Type A fractures are Unifocal fractures.

Their division into sub-groups is based on orientation of the tibial fracture and the presence or absence of a fibular fractures.

A1 - Spiral Fractures

A2 - Oblique Fractures

A3 – Transverse Fractures

If there is no fibular fracture, suffix. 1 is used, with . being used for fibular fracture distant from tibial fracture and .3 for fractures where tibial and fibular fractures are at the same level.

Type B fractures are Wedge fractures.

B1- Spiral wedge fractures.

B2- Bending wedge fractures

B3- Fragmented wedge fractures

Types C are classified on severity of tibial fracture, and not on position of fibular fracture.

C1 – Complex spiral fractures

C1.1 - Two intermediate fragments

C1.2 - Three intermediate fragments

C1.3 - Four intermediate fragments

C2 - Segmental fractures

C2.1 - One segmental fragment

C2.2 - Segmental fragment and additional wedge fragment

C2.3 - Two segmental fragments

C3 - All communited fractures.

C3.1 - Two or three intermediate fragments

C3.2 - Limited communication (<4cm)

C3.3 - Extensive communication (>4cm)

ORTHOPAEDIC TRAUMA ASSOCIATION (OTA) AO CLASSIFICATION OF TIBIAL DIAPHYSEAL FRACTURES

Type A : Unifocal fractures		
Group A1		**Spiral fractures**
Subgroups	A1.1	Intact fibula
	A1.2	Tibia and fibula fractures at different level
	A1.3	Tibia and fibula fractures at same level
Group A2		**Oblique fractures (fracture line >30 degrees)**
Subgroups	A2.1	Intact fibula
	A2.2	Tibia and fibula fractures at different level
	A2.3	Tibia and fibula fractures at same level
Group A2		**Transverse fractures (fracture line <30 degrees)**
Subgroups	A3.1	Intact fibula
	A3.2	Tibia and fibula fractures at different level
	A3.3	Tibia and fibula fractures at same level
Type B : Wedge fractures		
Group B1		**Intact Spiral wedge fractures**
Subgroups	B.1.1	Intact fibula
	B1.2	Tibia and fibula fractures at different level
	B1.3	Tibia and fibula fractures at same level
Group B2		**Intact bending wedge fractures**
Subgroups	B2.1	Intact fibula
	B2.2	Tibia and fibula fractures at different level
	B2.3	Tibia and fibula fractures at same level
Group B3		**Communited wedge fractures**
Subgroups	B3.1	Intact fibula
	B3.2	Tibia and fibula fractures at different level
	B3.3	Tibia and fibula fractures at same level

Type C : Complex fractures (multifragmentary, segmental or comminuted fractures)		
Group C1		**Spiral Wedge fractures**
Subgroups	C1.1	Two intermediate fragments
	C 1.2	Three intermediate fragments
	C 1.3	More than three intermediate fragments
Group C2		**Segmental fractures**
Subgroups	C2.1	One segmental fragment
	C2.2	Segmental fragment and additional wedge fragment
	C2.3	Two segmental fragments
Group B3		**Communited fractures**
Subgroups	C3.1	Two or three intermediate fragments
	C3.2	Limited communication (<4cm)
	C3.3	Extensive communication (>4cm)

Tscherne Classification :

This is a classification for closed tibial diaphyseal fractures.

This is based on extent of soft tissue abrasions, and confusions, radiologic features of fracture, presence of closed degloving, rupture of major vessels and the presence of compartment syndrome.

Tscherne CO- Fracture has little or no soft tissue injury.

C1 - The fracture has mild-to-moderate severe fracture configuration with superficial abrasions.

C2 - The fracture has a moderately severe fracture configuration and deep contamination with local skin or muscle contusion.

C3 - The fracture has severe fracture configuration and extensive contusion or crushing of skin or destruction of muscle.

Biomechanics :

Biomechanics of Bone Fracture :

To understand why bone fractures, in certain patterns, one must appreciate, that some is weakest in tension and strongest in compression.

Therefore, when a force creates tensile stresses at a particular region in the bone, one can expect that region to fail first, resulting in the crack, which then progresses transversely through the material, and inner layers, which also become subjected to tension until a transverse fractures is formed. This is seen in a bending force.

Compressive load causes failure of cortical bone by shear. Oblique fracture is a combination of both compression and bending.

Bending starts an oblique fracture and compression causes shearing.

The butterfly fractures is an extension of combined compression and bending applied to oblique fracture patterns.

Torsional fractures are low energy fractures have good prognosis. Communited, transverse, short oblique fractures are high energy fractures, the prognosis here is bad.

Basic forces are : Compression, transverse loading, torsion and bending. They cause bone to deform. Compressive force results in shortening of length of bone, while tension elongates it. Torsion causes rotation of bone about its long axis while bending causes it to bow in the center.

In the OTA classification : Acccording to Court Brown et al "The Epidermiology of Tibial fractures", published in the Journal of Bone and Surgery".

Type A fractures of tibia are the most common seen in 54% of cases. Type-B are seen in 27.8% cases and Type C are seen in 18.3% of cases.

In Type A, Group A3 transverse fractures (23.9%) are the most commonest (fracture line <30 degrees.

Followed by Group A1(16.8%) they are all fractures. Followed by Group A2 (!3.3%), they are all oblique fractures (fracture line>30 degrees.

Group B3 account for (11.8%) of tibial fractures, they are communiuted wedge fractures.

Group B2 account for (10%) of tibial fractures. They are intact bending wedge fractures.

Commonest Type C fracture is Group C2.2, which are segmental fractures with an additional wedge, which acconts for (4.8%) tibial fractures.

Five major causes of tibial diaphyseal fractures are due to fall, sports injuries, direct blows or assaults, motor vehicle accidents and gunshot injuries.

Biology of fracture healing with Intramedullary locked nail :

The intramedullary nail fixation showed a statistically faster time in union and abundant callus formation.

The intramedullary nail follows the process of natural bone healing, since the fracture haematoma is preserved.

Here the initial bridging callus i.e, external callus is seen to form abundantly unlike in a plate fixation and union is usually rapid.

The perisoteal activity is increased and adds to the increased external callus formation in a reamed nail, secondary to slight suppression in initial medullary flow, which subsequently improves.

Fracture healing proceeds mainly by formation of periosteal callus.

By a stable fixation which controls rotation and gives angular stability, it helps in differentiation of osteoid tissue and resorptive activity of osteoclasts take over, osteoblasts then appear and concentric new bone is laid and remodeling occurs.

The biomechanical quality of bone is good. The locked intramedullary nail provides early fracture stability, which promotes vascularization that is vital for fracture healing. Preservation of Periosteum also facilitates vascularization process.

Biomechanics of Intramedullary Locked Nails :

The intramedullary nail is a load sharing device.

It provides a 3 point fixation and elastic impingement and also provides stability via screws/bolts.

It acts as an internal splint and aids in transmission of forces from one end of the fractured bone to the other, thereby producing stresses in the implant.

The behaviour of an intramedulary nail depends on the quality of material, width, curvature, locking capacity and configuration and cross-sectional geometry.

Length, width and curvature are designs to match the bone in question.

Curvature of tibial nail is designed to accommodate the insertion portals offset from the cenre of the medullary canal.

Too much curvature may make the removal of the nail difficult causing refracture.

Materials :

Include 316 L steel, titanium, titanium aluminium vanadium and titanium aluminium niobium alloys. Recently, bioabsorbable nails have also been tried but they are not cost-effective.

Expect in nails of small diameter used without reaming, material property is less significant in terms of fracture healing, than nail diameter and wall thickness or biologic viability of bone.

The smaller diameter nails should be made of alloys having superior fatigue strength Ex. Titanium.

Cross-Sectional Geometry :

Intramedullary nail can be solid or hollow, open or closed sectional (slotted) cylindrical, rectangular or diamond configured.

‘The wall thickness in a hollows nail may be variable to alter the strength and stiffness.

Hollow nails are ideal after canal preparation by reaming and inserted over a guide wire.

Solid nails are suitable for placement without canal preparation by reaming. Abolishing the open slot in cross, increases the rotational stiffness.

Bending strength and stiffness in torsion can be increased by using an unslotted thick nail with large diameter.

Locking Capacity and Configuration :

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

The closer to the ends of the nail that the screws are located, the more fractures that may be treated with the device.

2 parallel screws perpendicular to the long axis of nail are used in distal locking of tibial nails.

The ASIF tibial nails has the possibility of one of its three distal screws being oriented 90 degrees to the other two, extending the indications to include more distal fractures.

Dynamic fixation allows nearly full axial load transfer by bone, at the same time it controls bending and rotational deformity. Dynamic Locking is done in non-unions and stable fractures.

Static fixation or locking controls rotation, bending and causes axial loading and makes the implant load bearing, with potential for fatigue failure. Static locking is useful in segmental fractures and communiated fractures.

Dynamization is conversion of statically locked nail into dynamic mode by removal of less critical transverse screw.

This is done in case of delayed union, usually at 6 weeks. It increases the fatigue life of a nail.

We have to balance between fracture stability, biological effect and clinical practicality in fracture fixation.

The rigidity and stiffness of a cylindrical structure in bending and torsion is proportional to the fourth power of the radius. (i.e. the polar moment of inertia) and quality of material.

As the diameter and thickness of the nail increases, bending stiffness increases.

1 mm increase in diameter, increases stiffness by 30 to 45% and bending strength is doubled by a 25% increase in diameter of the nail.

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

Gripping strength is the resistance to slipping at the implant bone interface and is essential for the transmission of torque between fracture fragments.

Grip can be increased by cortical reaming to increase the length of cortical contact. Interlocking nails optimize grip by rigidly affixing nail to bone with screws.

Material Properties :

As load is applied to a construct in a testing machine (i.e, bone with fixatuib device applied) it deforms.

This deformation is termed elastic because if the load is removed, the construct, returns to initial shape.

At some point, the fixation becomes overloaded entering the plastic range. If the load is released after loading into the plastic range, some residual deformation remains.

The point at which plastic behaviour starts is termed as yield point.

The elastic range represents the working range for the fracture fixation device.

Its two most important properties are its yield point or maximum load it can carry without deforming and its stiffness or the amount that its deforms under a certain load.

The product of force applied and the distance the plate bends is the work done.

Toughness represents the amount of work required to fracture the material.

A material may be flexible and tough (Ex. Rubber), or stiff but brittle (Ex. Glass, elderly bone) if the material cannot undergo much deformation without fracturing.

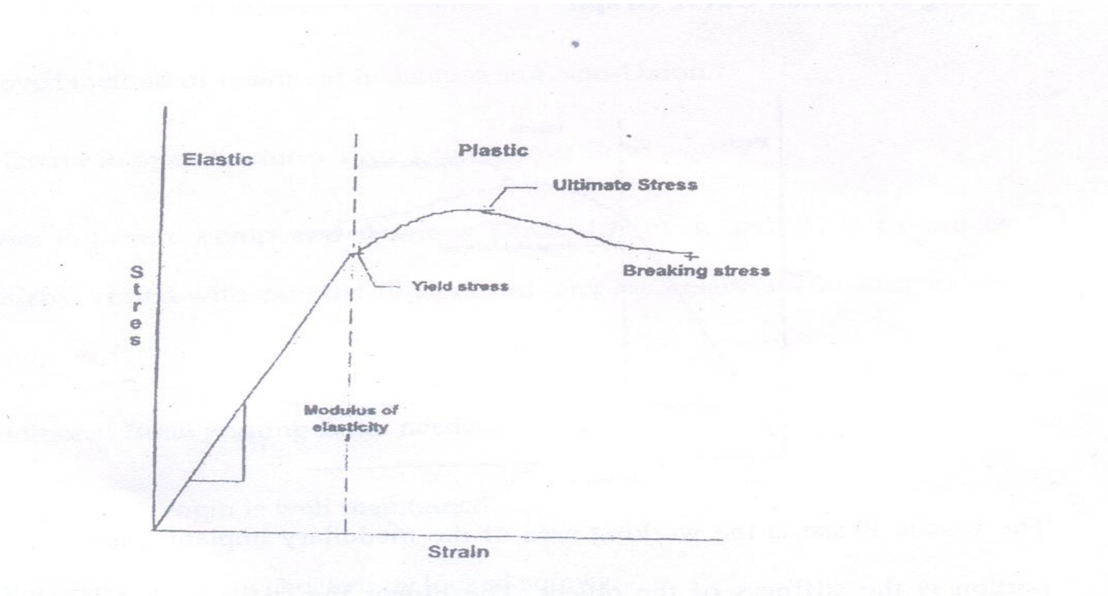
The factors that govern stiffness and yield load is the material from which the device is made and its shape.

The elastic modulus defines the stiffness of a material as opposed to a construct.

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

The elastic modulus (Young's Modulus) is found by dividing the stress applied to a material by the resulting strain.

Stress Stain Curve :



The slope of this curve is called “Modulus of Elasticity” (Young’s Modulus). It is the constant proportionality between the stress and strain. It is a material property. Ex. A material with a high modulus is stiff i.e., for high stress, little strain is produced.

The modulus of titanium is about one-half of stainless steel and has one-half the stiffness of stainless steel.

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

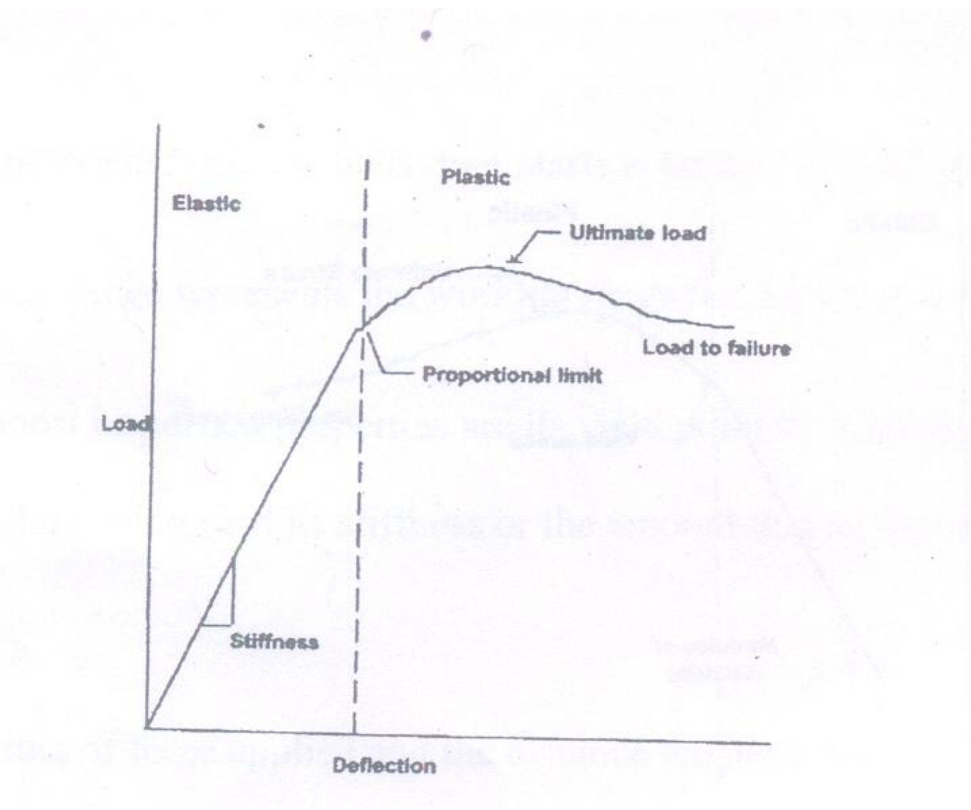
Loading Deflection Curve :

The shape of the curve is divided into :

Elastic Phase

Plastic Phase

Loading Deflection Curve Graph :



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

Advantages, Disadvantages and Complications of Intramedullary Nailing

Advantages of the Intramedullary Interlocking Nailing

It is a load sharing mechanism.

Healing occurs biologically

Fracture haematoma is preserved

Periosteal vascular damage is minimal.

Provided method of treatment in delayed and Non-Union.

Effective in open fractures Type I and II with clean wound.

Even in severe compound fractures Grade III, III A and III A (it can be initially treated with external fixators and later secondary interlocking can be done)

Additional Bone grafting is not needed.

Stability and length is well maintained.

Rotational instability checked by locked screws.

Joint motion preserved.

Early mobilization and early weight bearing can be started

There is no skin necrosis.

Disadvantages of Intramedullary Interlocking Intramedullary Nailing

Long learning curve is present, it is technically demanding and therefore a larger period of exposure and training is required.

Exposure irradiation occurs by using the C-arm.

It is not suitable in fixation of proximal and distal 1/5th of tibia.

Complications of Intramedullary Nailing

Anteriod Knee Pain

This is the commonest complication.

Keating et al reported a 57% incidence of anterior knee pain.

Court Brown et al reported 56.2% incidence of anterior knee pain.

Causes of anterior knee pain may be prominent nail or heterotopic ossification of patellar tendon.

It may be due to intrarticular damage to menisci or associated ligaments.

Neurologic abnormalities

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

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

Vascular Damage :

It is seen as result of drill damage to popliteal artery in the area of arterial trifurcation.

Damage to medial inferior genicular artery has also been noted.

Hardware Breakage

Screw breakage is common in unreamed nails, which use smaller screws. Titanium has lower screw breakage rates.

Broken nails are associated with untreated non-unions.

Breaking of drill bits are common and they may remain in the bone or soft tissues.

Thermal Necrosis

Is unusual

It is caused by excessive use of force and blunt reamers.

Tourniquet should not be used as it eliminates heat transfer by shutting down global blood flow to whole limb.

Bone Damage

Incorrect starting point or failure to aim the nail may damage bone and splinter the proximal entry point.

Intramedullary nailing may precipitate adult respiratory distress syndrome in patients with blunt thoracic trauma due to marrow emboli and reaming of the bone may precipitate emboli formation

MATERIALS AND METHODS

SOURCE OF DATA:

All confirmed cases of fracture shaft of tibia in Department of Orthopedics in BLDE University's Shri B.M.Patil Medical College and Research Centre, Bijapur.

A minimum 42 cases of either sex will be studied.

Patient will be informed about the study in all respect and written and informed consent will be obtained.

Period of study will be from Oct. 2009 – 2011.

Follow up period will be 6 weeks, 3 months and 6 months

METHOD OF COLLECTION OF DATA

* By clinical examination

* By follow up at interval of six weeks, three months, six months.

Sample size :

Incidence rate of fracture shaft of tibia due to RTA is 37.5% (Rockwood Greens Fractures in adults 5^{th} edition. Vol 2) at permissible error 35%

Size of sample works out to be 42 using statistical formula $n=4pq/l^2$. All cases with inclusion and exclusion criteria are selected during the period of October 2009 to September 2011

Inclusion criteria:

Patient who has been diagnosed as fracture shaft of tibia.

Age group of more than 18 years of age of either sex.

Patient who are fit for surgery.

Exclusion criteria:

Skeletally immature individual..

Gustilo – Anderson classification of open fractures of shaft of tibia Type IIIB and IIIC.

Patient unfit for surgery.

Patient not given written consent for surgery.

Patient will be selected on the basis of History, clinical examination and radiography.

X – ray of full length of tibia antero – posterior and lateral view will be taken.

All fractures will be classified as per Orthopedic trauma association (OTA) AO classification of tibial diaphyseal fractures.

All cases will treated with intramedullary interlocking nail.

Follow up and assessment will be performed using JOHNER AND WRUTH'S CRITERIA.

Preoperative preparation of patients:

Patients were kept NBM for 8-10 hours before surgery

IV fluids as per the need were given

Adequate amount of compatible blood if needed was arranged

Preparation of whole extremity, private parts and back was done

Written and informed consent was taken

Soap water enema HS

Tranquilizers HS

IV antibiotics half an hour before surgery

Shifting of the patients 30minutes before surgery to operation theatre

Preoperatively the length of the nail is calculated by subtracting 3 to 4cm from measurement taken from the knee joint line to tip of the medial malleolus clinically and medullary canal is measured at the isthmus on X-rays. Accordingly a stock of interlocking nails 2cm above and below the measured length and 1mm above and below the required diameter were always kept. We have used cannulated tibial nails in our cases.

Surgical technique:

Patients were operated under spinal / general anaesthesia. Patient is placed in supine position over a radiolucent operating table. The injured leg is positioned freely, with knee flexed 90^0 over the edge of operating table to relax the gastro soleus muscle and allow traction by gravity. The uninjured leg is placed in abduction, flexion and external rotation to ensure free movements of the image intensifier from AP to lateral plane. The table is adjusted to a comfortable operating height.

AO pneumatic tourniquet was used in all patients. The affected limb is thoroughly scrubbed from mid thigh to foot with Betadine scrub and savlon. Then limb is painted with betadine solution from mid thigh to foot. Rest of the body and other limb is properly draped with sterile drapes. Sterile gloves are applied to the foot and steri-drape over the leg from knee joint to ankle.

Determination of Nail Length:

Hold the radiographic ruler parallel to the tibial shaft in such a way that the proximal end comes to lie at the level of the insertion point. Mark the skin at the appropriate point. Position the image intensifier over the distal tibia. Align the measuring ruler at the skin marking. With correct reduction, we can now read off the required nail length on the image intensifier picture at the level of epiphyseal cartilage.

Another way to measure the length of Hollow and Tubular nails is to subtract the exposed length of the guide rod from its total length of 950mm.

Determination of Nail Diameter:

The markings on the radiographic ruler may be used to determine the diameter of the medullary canal. Position the square marking over the isthmus. If the transition to the cortex is still visible both to the left and right of the markings, the corresponding nail diameter may be used.

Procedure:

Make a vertical patellar tendon splitting incision over skin extending from centre of the inferior pole of patella to the tibial tuberosity, about 5cm long. Split the patellar tendon vertically in its middle and retract it to reach the proximal part of tibial tuberosity. Next step is to determine the point of insertion. As a general rule, the insertion point should be slightly distal to the tibial plateau, slightly medial and exactly in line with the medullary canal. If the insertion point is too distal, there is a danger of fracturing the distal cortex of the main proximal fragment, particularly in the case of proximal fractures.

On the other hand, inserting too far proximally bears the risk of opening the knee joint, patella comes in the way of zig or removal of nail may be difficult. After selecting the point of insertion, curved bone aw1 is used to breach the proximal tibial cortex in a curved manner, so that from perpendicular position, its handle comes to be parallel to the tibial shaft. In the metaphyseal cancellous bone, create an entry portal, making sure it is in line with the centre of medullary canal.

Point of entry is widened with curved tibial awl.

After widening the medullary canal of proximal third, the ball tipped guide wire 3mm diameter x 950mm length passed into the medullary canal of proximal fragment and the fracture fragments reduced under image intensifier by maintaining longitudinal traction in the line of tibia.

After reduction, the tip of ball tipped guide wire is adjusted to pass in the distal fragment upto 0.5-1cm above the ankle joint under image intensifier. Confirm its containment within the tibia by anteroposterior and lateral views. Medullary canal is then reamed starting from 8mm reamer size to 0.5 to 1mm larger than the diameter measured using radiographs. Reaming is done in 0.5 mm increments, initially with the end cutting reamer and then replaced by side cutting reamer. Then the ball tipped guide wire is exchanged with smooth guide wire using the medullary tube. Next step is to pass an assembled nail into the medullary canal over the smooth guide wire.

Insert the connecting screw through the insertion handle and coupling block, then screw this assembly into the proximal end of the selected nail. Ensure that the notches of the insertion handle fit into the grooves of the coupling block. The coupling blocks ensure a torque-resistant connection between insertion handle and nail. The insertion handle guides the nail and controls rotation during insertion. Apply the insertion handle to the medial side of the tibia for insertion and proximal locking. Tighten the whole assembly with a combination wrench. Check that the assembly is firmly screwed together. Over tightening should not be done.

Now introduce the tibial nail as far as possible manually into the medullary canal with the help of the mounted insertion instruments. Use the image intensifier to check passing of the nail through the fracture site. Insertion can be aided by gentle blows with the slotted hammer. Insert the nail until it is slightly counter sunk in the bone. Confirm the placement of nail in situ under image intensifier in both AP and lateral planes.

Routinely we prefer proximal locking first, but if gap is present at the fracture site we carried out distal locking first, which enables the use of the rebound technique to prevent diastasis.

The insertion handle is used to locate the holes for proximal locking bolts. The insertion handle of the insertion instrument is in the medial position. The skin is incised. Insert the trocar into the protection sleeve and push it down onto the surface of tibia through the corresponding hole in the insertion handle. Remove the trocar and insert the drill sleeve. To prevent the drill bit from sliding off the tibial surface, ensure that the drill guide is sitting firmly on the bone and is not deflected by skin or soft tissue.

Drill through both cortices using the drill bit. We used the power drill. Determine the required length of the locking bolt by reading it directly off the calibrated drill bit or by measuring with the depth gauge. When using the depth gauge, we added 2mm to the measurement found so that the bolt can find purchase in the opposite cortex.

Insert the locking bolt with the hexagonal screw driver. Insert the second locking bolt in the same way.

Incised wound is washed with betadine and normal saline, patellar tendon sutured with delayed absorbable sutures and skin is sutured. Fracture site is visualized in C-ARM and if there is distraction, compression at the fracture site is obtained by gentle hammering of the heel. It is important to maintain compression at the fracture site because a gap of 1mm will take at least 10 months to unite

Next step is distal locking using a free hand technique with an image intensifier which provides a convenient method for targeting the distal locking holes.

The leg is extended over the table from its flexed position. In Indian nail two distal locking holes are present both in the anteroposterior plane. In our study we locked both anteroposterior holes in all cases. The image intensifier is placed in the anteroposterior position with the beam exactly at the anterior aspect of the tibia with foot held in neutral position. Adjust the image intensifier until the most distal hole is clearly visible and appears completely round.

Place a scalpel on the skin with the top of the blade over the centre of the hole to determine the stab incision point. Make a stab incision. Place the tip of the 2.5mm ‘K’ wire centered in the locking hole image. Adjust it until the K wire is in line with the X-ray beam and appears as radio opaque solid circle in the centre of the outer ring. Hammer the K wire into the bone. The DCP drill sleeve is passed over the ‘K’ wire and the sleeve is held firmly over the bone. The K wire is removed and the hole drilled through both cortices with drill bit. Measure the hole with the depth gauge for locking bolts. Add 2mm to this reading to ensure that the locking bolt will engage the far cortex. Insert the locking bolt and tighten with the hexagonal screw driver. Position of the screw is again confirmed under image intensifier. The entire leg and the fracture site is visualized finally in both views for the proper placement of nail. Incised wound is washed with betadine and normal saline, skin is sutured. Sterile dressing applied over the wound. Compression bandage given. Elastocrepe bandage is applied for stable fractures and good fixation. Above knee slab is also considered if the fracture fixation is not stable. Tourniquet is deflated, capillary filling and peripheral arterial pulsations checked.

Postoperative Care:

Immediate:

NBM 4-6 hours postoperatively

IV fluids/ blood transfusion if necessary

IV antibiotics: In most of the patients injection cefotoxime and injection gentamycin were used for 5 days

IM analgesics

Tranquilizers HS

Limb elevation over pillows

Watch for active bleeding

Active toe movements

TPR/BP chart every hourly

Input/output chart

Check X-ray of the operated tibia (full length) including knee and ankle joints in both AP and lateral views.

Postoperatively elastocrepe bandage is applied and limb is kept in elevation. IV antibiotic is given for 5 days postoperatively. Culture from the wound if necessary is sent. Switch over to oral antibiotics is done on the 5^{th} postoperative day. Analgesics if required given. Active knee, ankle and toe mobilization started after recovery from anaesthesia. Patient was allowed non weight bearing with crutch walking / walker on next postoperative day according to the general condition and tolerance of patient. Skin sutures / staples were removed on 10^{th} - 12^{th} postoperative day. Depending upon the culture report and wound condition antibiotics are stopped/continued. Partial weight bearing with crutch walking /walker commenced after 10 days, depending upon the type of fracture, rigidity of the fixation and associated injuries.

Further follow up is done at 6 weekl, 3 months and 6 months and each patient is individually assessed clinically and radiographically according to the proforma.

Efforts were made to obtain definite coverage of the wound within seven days when indicated after nailing.

The management protocol in this study was as follows:

The fixation of fractures was done as an elective procedure

Life threatening injuries or complications were given priority

Appropriate referral was given to neuro surgeon, plastic surgeon and vascular surgeon for the management of their respective injuries. Physician reference was given for any medical illness.

Preoperative antibiotics started just before induction and continued for five postoperative days.

We used image intensifier for all cases.

All fractures were treated with closed interlocking intramedullary nails.

Wound inspection was done on third postoperative day and suture/ staple removal was done on 10-12th postoperative day.

Johner and Wruh's Criteria for Evaluation of Final Results

Sl. No	Criteria	Excellent (Left = Right)	Good	Fair	Poor
1.	Non-unions , Osteitis, Amputation	None	None	None	Yes
2.	Neurovascular Disturbances	None	Minimal	Moderate	Severe
3.	Deformity				
	Varus / Valgus	None	2^0-5^0	6^0-10^0	>10^0
	Anteversion / Recurvation	0^0-5^0	6^0-10^0	11^0-20^0	>20^0
	Rotation	0^0-5^0	6^0-10^0	11^0-20^0	>20^0
4.	Shortening	0-5 mm	6-10mm	11-20mm	>20mm
5.	Mobility				
	Knee	Normal	>80%	>75%	>75%
	Ankle	Normal	>75%	>50%	<50%
	Subtalar	>75%	>50%	<50%	-
6.	Pain	None	Occasiona l	Moderate	Severe
7.	Gait	Normal	Normal	Insignific ant Limp	Significant Limp
8.	Strenuous activites	Possible	Limited	Severely Limited	Impossible
9.	Radilogical Union	Consolidat ed	Consolida ted	Union	Not Consolidateds

Keeping all these criteria in mind the final functional outcome was assessed.

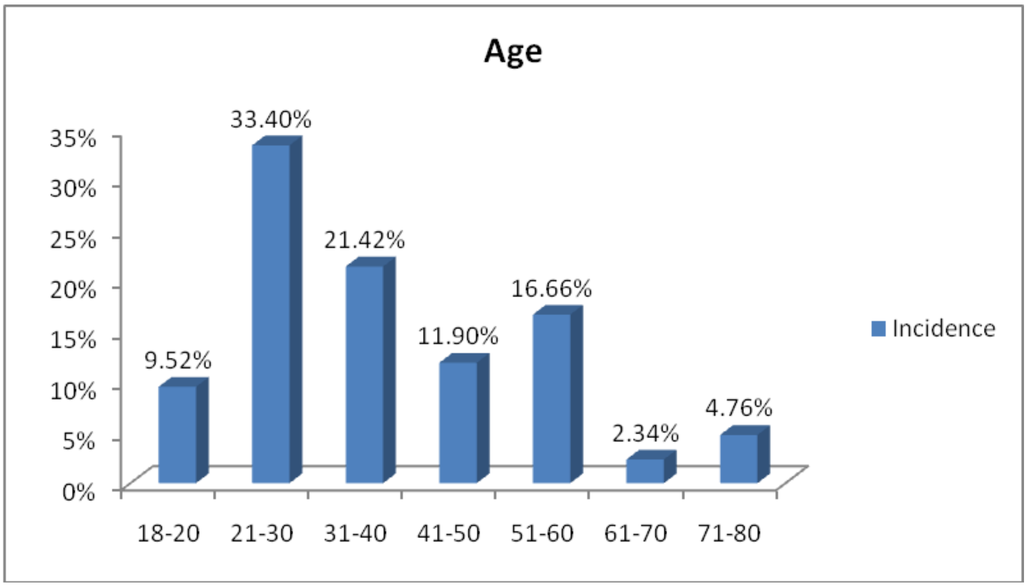
OBSERVATION AND RESULTS

The study was done in the B.L.D.E. University's Shri B.M.Patil Medical College and Hospital, Bijapur. 42 patients with fracture shaft of tibia were treated with closed interlocking nailing. The results are observed here.

Age :

Age	No. of patients	Incidence
18-20	4	9.52%
21-30	14	33.4%
31-40	9	21.42%
41-50	5	11.90%
51-60	7	16.66%
61-70	1	2.34%
71-80	2	4.76%

Graph 1

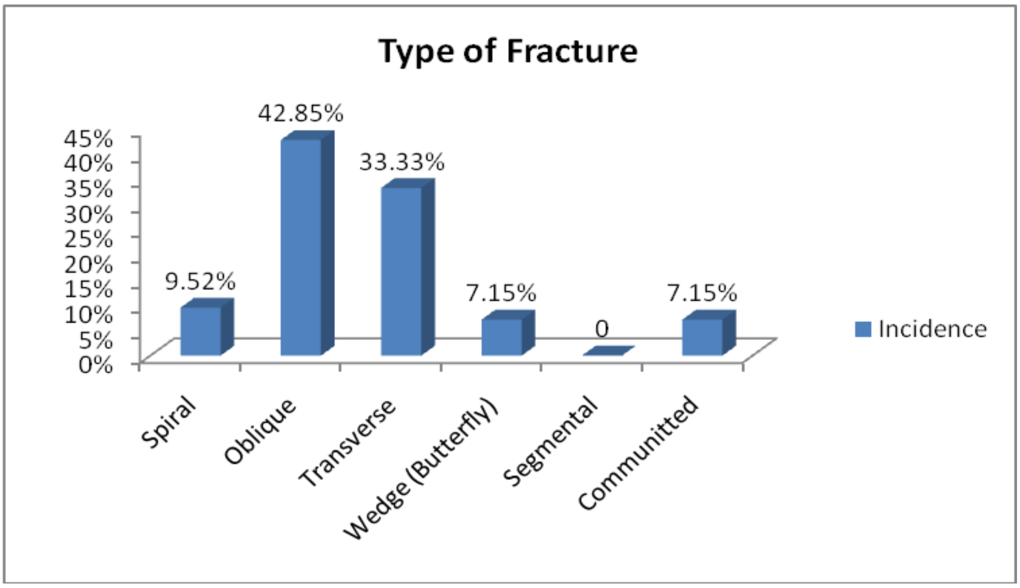


Type of Fracture :

Table No :

Type of fracture	**No. of patients**	**Incidence**
Spiral	4	9.52%
Oblique	18	42.85%
Transverse	14	33.33%
Wedge (Butterfly)	3	7.15%
Segmental	0	0
Communitted	3	7.15%
Total	42	100

Graph 2



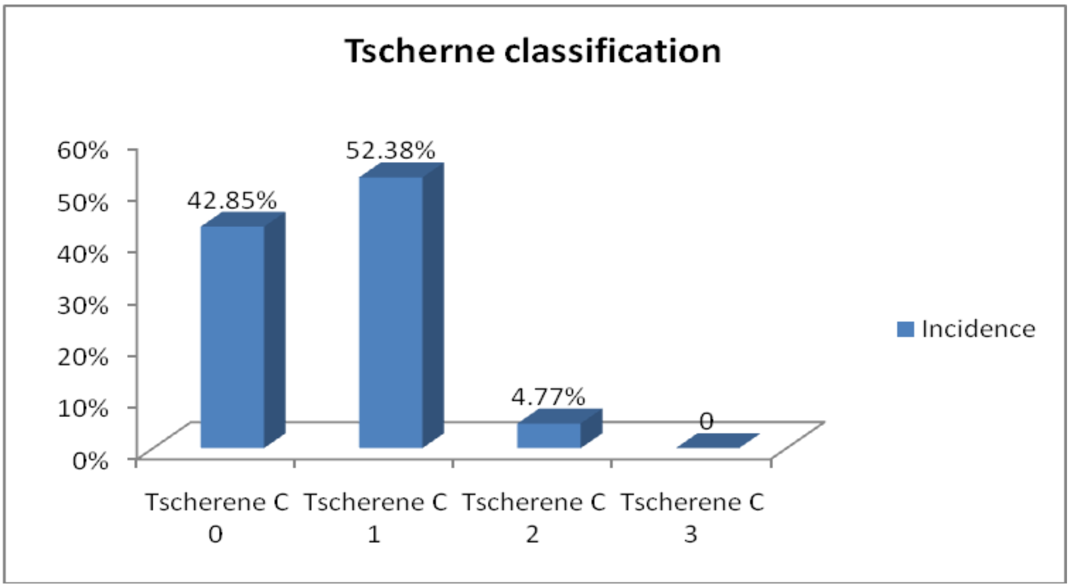
In this, olique fractures were seen in 42.85% of patients, followed by transverse fractures in 33.33% of patients. Wedge fractures were seen in about 7.15% of patients.

Tscherne classification for closed fractures :

Table No :

Tscherne classification	No. of patients	Incidence
Tscherne C 0	18	42.85%
Tscherne C 1	22	52.38%
Tscherne C 2	2	4.77%
Tscherne C 3	0	0
Total	42	100

Graph 3



Incidence of Tscherne Type in closed fractures

In our study of closed fractures, the incidence of Tscherne C1 fracture was the highest. Tscherne C1 fractures in our study made up of 52.38% of closed fractures in 22 patients.

Incidence of Intact Fibula

In our study 36 cases (85.71%) had ipsilateral fibular fractures, 6 cases (14.28%) had an intact fibula.

Associated Injuries

In our study, Three patients had (R) sided fracture clavicle middle one third without displacement, which was treated with strapping and cuff collar sling.

Two patients had fracture Neck fibula (R) side without neurological complication, which was treated conservatively.

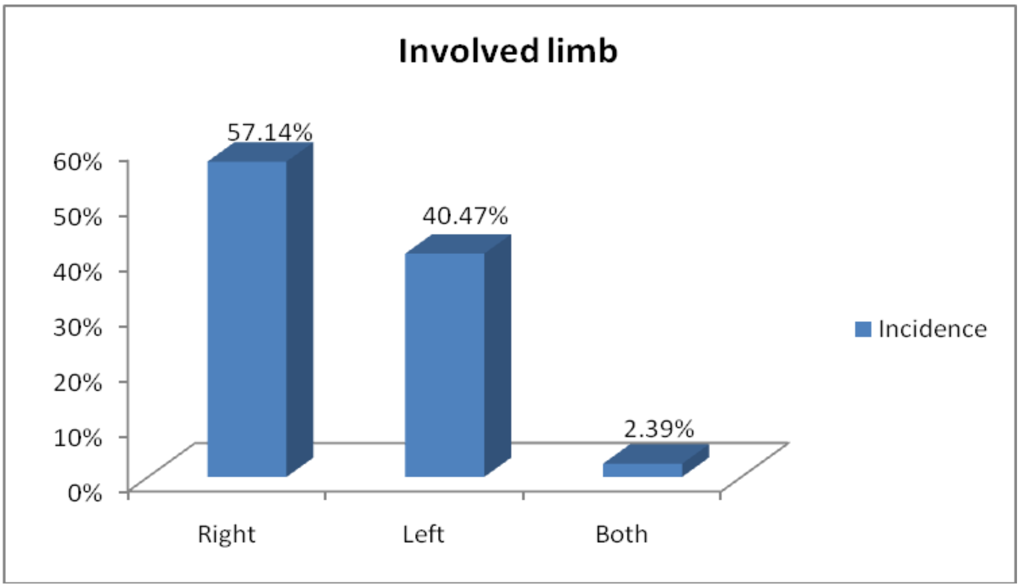
Three patients had mild head injury and were managed conservatively

Involved limb :

Table No :

Involved limb	**No. of patients**	**Incidence**
Right	24	57.14%
Left	17	40.47%
Both	1	2.39%
Total	42	100

Graph 4



In this study the right tibia was affected in 57.14 % of all patients and the left tibia in 40.47% of all patients.

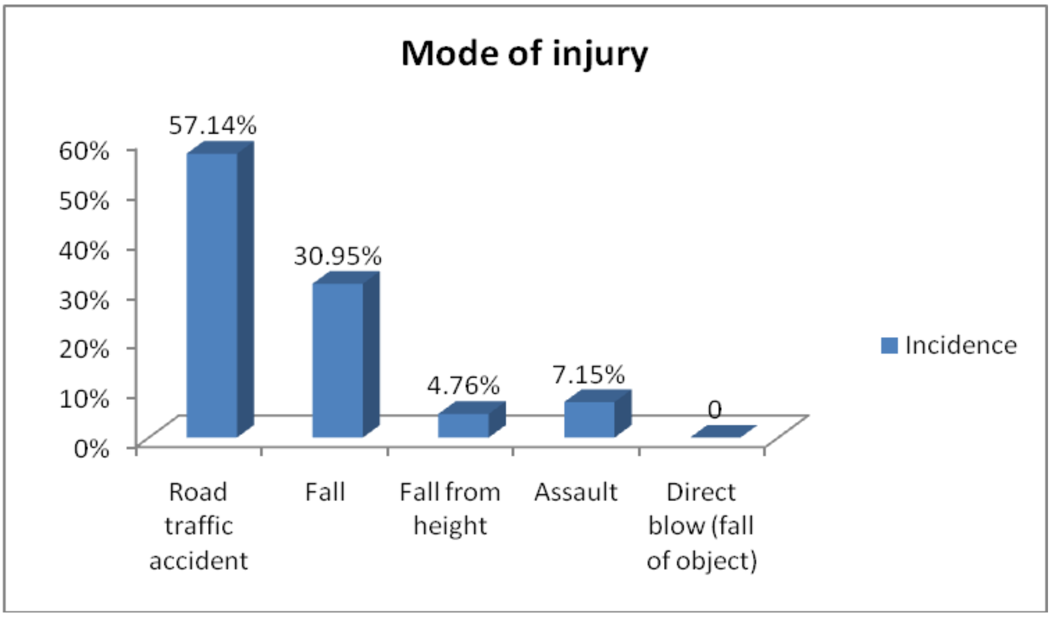
There was one case of bilateral fracture shaft of tibia

Mode of injury :

Table No:

Mode of injury	**No. of patients**	**Incidence**
Road traffic accident	24	57.14%
Fall	13	30.95%
Fall from height	2	4.76%
Assault	3	7.15%
Direct blow (fall of object)	0	0
Total	42	100

Graph 5



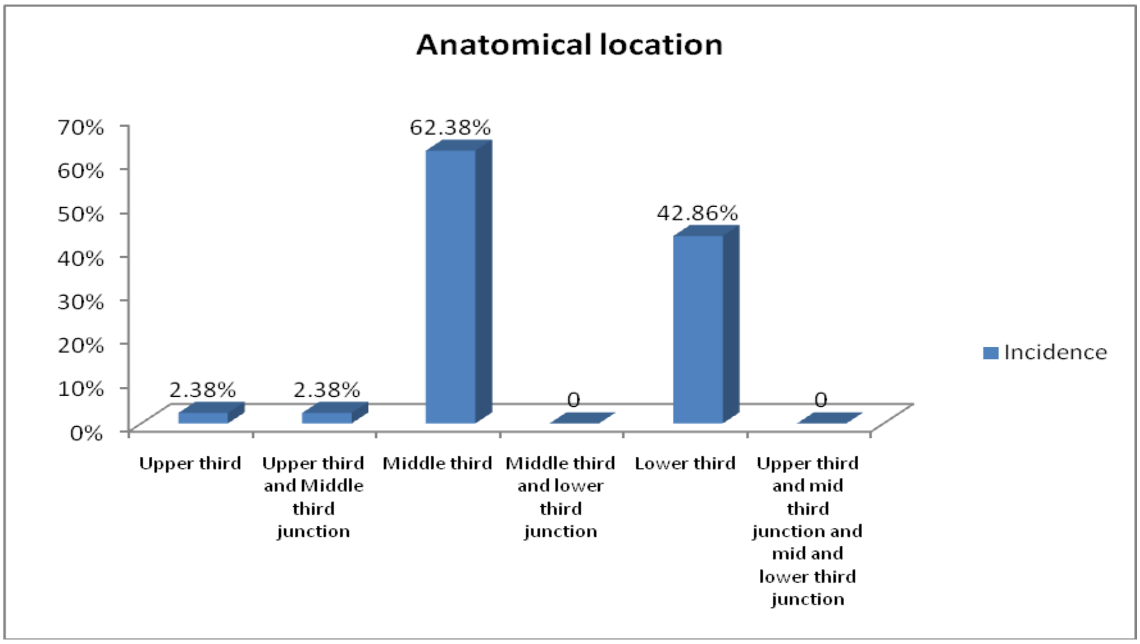
In this study, road traffic accidents were the most common mode of injury causing tibial shaft fractures in 24 of all patients. They accounted for 57.14% of tibial fractures.

Anatomical location :

Table No :

Anatomical location	**No. of patients**	**Incidence**
Upper third	1	2.38%
Upper third and Middle third junction	1	2.38%
Middle third	22	62.38%
Middle third and lower third junction	0	0
Lower third	18	42.86%
Upper third and mid third junction and mid and lower third junction	0	0
Total	42	100

Graph 6

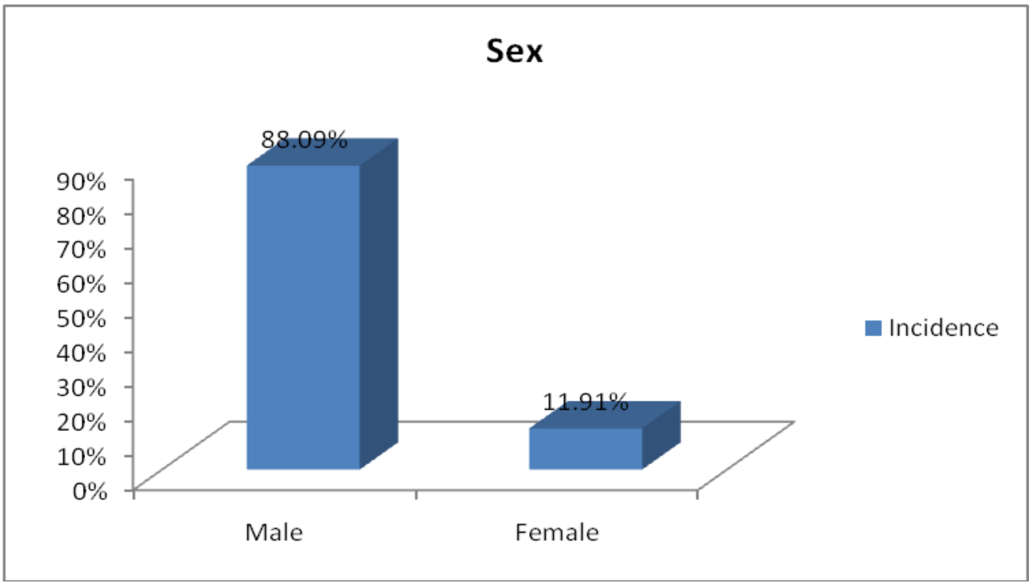


The commonest anatomical location of fracture was at the middle third of the tibia. This constituted 62.38% of tibial shaft fractures.

Sex Incidence :

Sex	**No. of patients**	**Incidence**
Male	37	88.09%
Female	5	11.91%

Graph 7

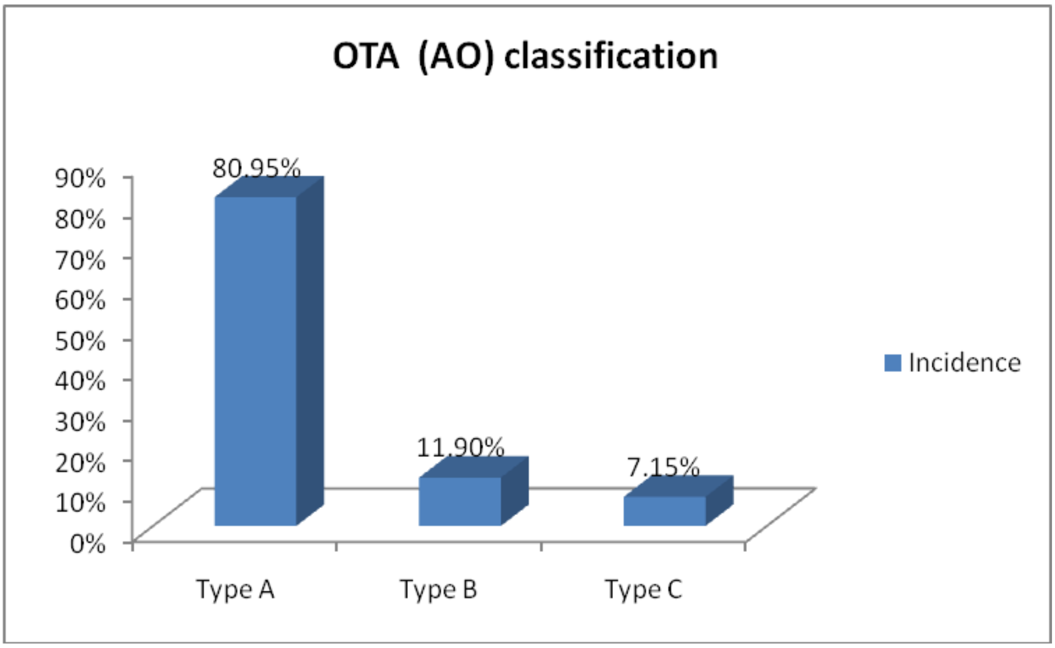


OTA Classification

Table No :

OTA (AO) classification	**No. of patients**	**Incidence**
Type A	34	80.95%
Type B	5	11.90%
Type C	3	7.15%
Total	42	100

Graph 8

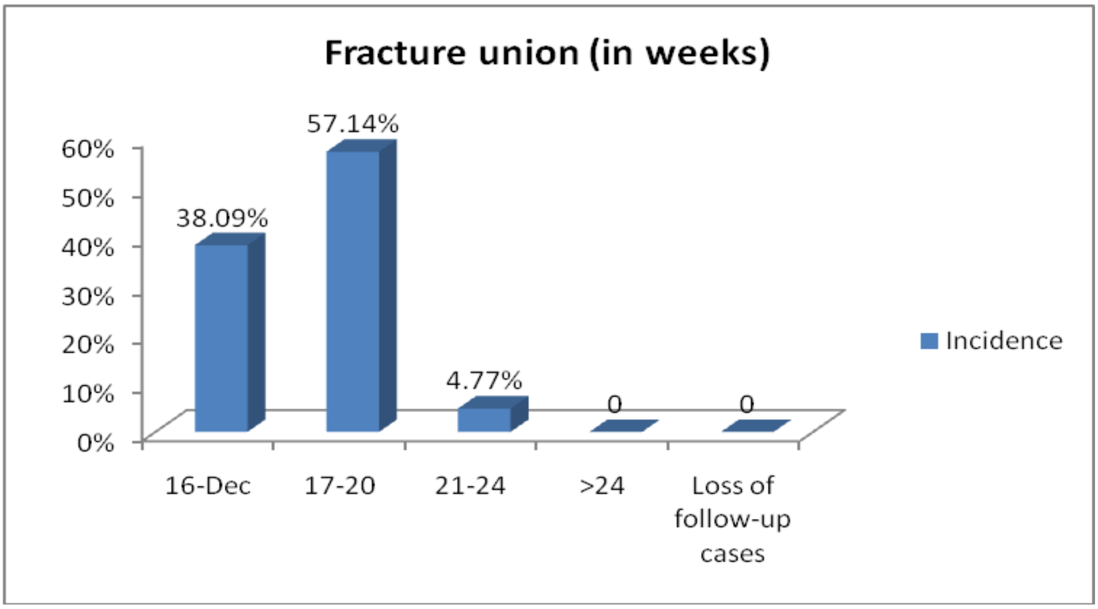


In OTA (AO) classification, Type A factures were seen in 80.95% of patients in this study, 11.90% of patients had Type B fractures.

Fracture union (in weeks)

Fracture union (in weeks)	No. of patients	Incidence
12-16	16	38.09%
17-20	24	57.14%
21-24	2	4.77%
>24	0	0
Loss of follow-up cases	0	0
Total	42	100

Graph 9

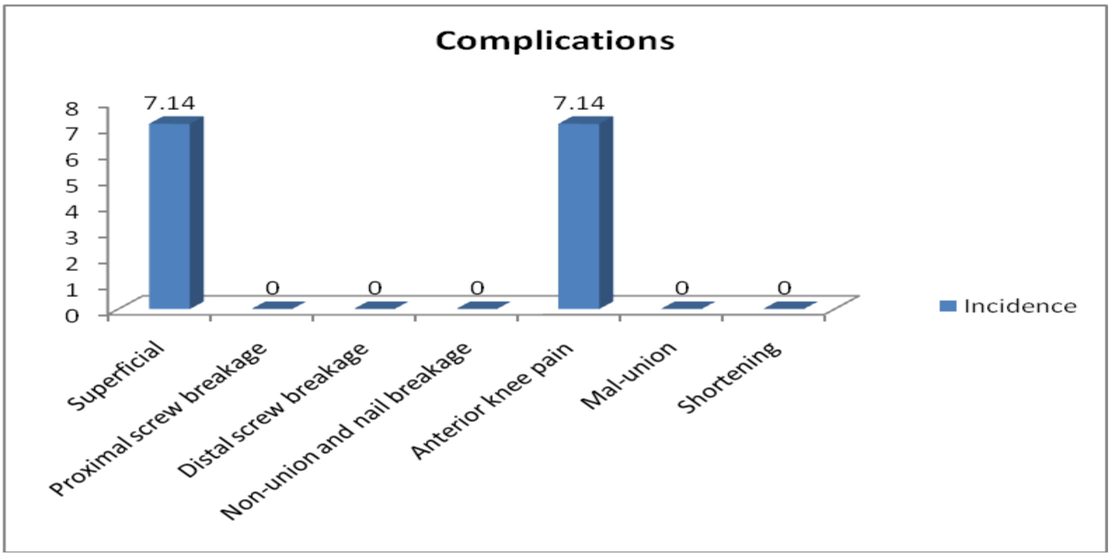


In our study, majority of fractures united within 20 weeks. This is comparable with other series..

Complications

Complications	No. of patients	Incidence
Superficial	3	7.14
Proximal screw breakage	0	0
Distal screw breakage	0	0
Non-union and nail breakage	0	0
Anterior knee pain	3	7.14
Mal-union	0	0
Shortening	0	0
Total	6	14.28

Graph 10



Complications

Total number of patients with complications were 6. of which 3 (50%) had superficial infection,and the remaining with anterior knee pain (50%).

- Superficial infections healed by dressing and antibiotics, and proper management of Diabetes Mellitus.

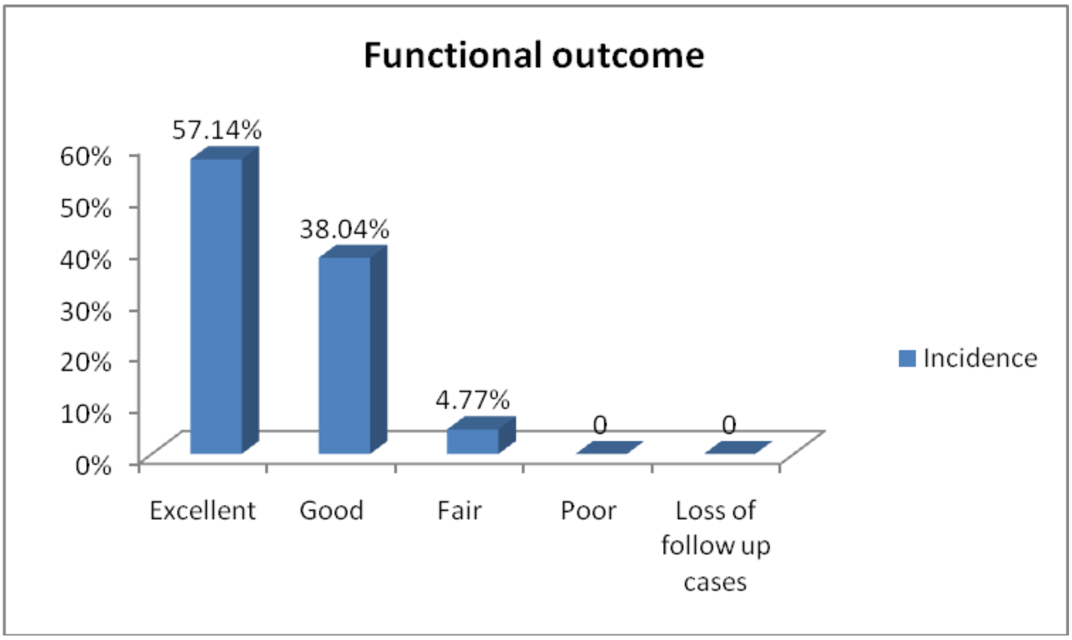
- Anterior Knee pain was seen in three patients. In one patient nail was abutting the patellar tendon and tibial tuberosity and this can be relieved after removal of the nail. The cause for anterior Knee pain in another two patients could be heterotrophic ossification of patellar tendon.

Functional outcome :

Table no :

Functional outcome	**No. of patients**	**Incidence**
Excellent	24	57.14%
Good	16	38.04%
Fair	2	4.77%
Poor	0	0
Loss of follow up cases	0	0
Total	42	100

Graph 11



DISCUSSION

This study includes 42 patients who were admitted to the Orthopedic Wards of B.L.D.E. University's Shri B.M. Patil Medical College and Hospital, Bijapur. This group of 42 patients comprising of males and females in the age group of more than 10 years were included in this study.

In our study, the fractures were fresh closed diaphyseal fractures of tibia treated with closed intramedullary interlocking nailing.

Age Incidence

In our study, the majority of the patients were in the age group of 21 to 30 years. There were 14 patients in this age group in our study series. Tibial shaft diaphyseal fractures were seen in the younger age group as they are the persons who are physically active, were engaged in increased various outdoor activities and as a result most of the injuries sustained were high-velocity injuries.

Arne Ekeland et al[2] (1988), in study series of 45 patients noted the average age of patients to be around 35 years.

Court Brown et al[8]. (1990) noted the average age to be 32.4 years. Average age was seen to be around 37 years in a study b Court Brown et al[9] in 1995 in a study titled "The Epidemiology of Tibial Fractures".

Our series with an average age of 34.59 years is comparable to the other worker's series, with respect to the average age of the patients in fractures of the tibial diaphysis.

Sex Incidence

In our series, males predominated the females. There were 37 male patients 88.09% and 5 female patients 11.91%. The incidence of males is higher because of their more outdoor activities, while women majorly confined themselves to the domestic activities.

Court Brown et al[8]. (1990), in their series noted the male incidence to be around 81.3%, while the female incidence to be around 18.7%.

Hooper et al1[8]. (1991) noted male incidence at 82% and female incidence at 18%.

Gaston et al[13] . (1999), also noted the percentage of males to be around 81%, while females around 19%

Our series of 88% males, the incidence is higher when compared to above workers series, where as 9% females in our study is lower when compared to workers series.

Mode of Injury

In our series, we have found that majority of the tibial diaphyseal fractures occurred due to road traffic accidents 24 patients. In the majority of cases, they involved the patients who were the motorists, while the remaining patients tended to be pedestrians of motor vehicle occupants.

The incidence of fracture shaft of tibia due to road traffic accidents (57.14%) seemed to be higher in our series compared to Court Brown er al[9]. (1995), in whose series, the incidence was around 37.5% . But in this series also, the commonest mode of injury was road traffic accidents followed by Sports Injuries This can be attributed to the poor road traffic sense and poor quality of roads, leading to a higher incidence of road traffic accidents in our country.

Lawtence B. Bone et al[26]. (1986), reported in an earlier series a 90% incidence of Road Traffic Accidents in tibial shaft fractures.

Hooper et al[18]. (1991), reported a 59% incidence in his series.

Anatomical Location of Fractures

In our series, the anatomical location of the fracture was in the middle-third of the shaft of tibia in 22 (52.38%) patients, followed by the lower third in 18 (42.86%) of the cases.

This is comparable to Lawrence B. Bone et al[26] (1986) series, where 53.5% were middle – third fractures, Hooper et al[18]. (1991) where middle – third fractures and Court Brown er a[l9]. (1995), where 44% were middle – third fractures.

The middle third fractures are common because of anatomical features of more rigidity of the bone and its subcutaneous nature make it more vulnerable to the injuring force.

Type of Fracture

In our series Type A fractures were the most commonest, they constituted 34 (80.95%). Type A fractures are unifocal fractures and in our series the incidence in higher to the series of Court Brown et al[9]. (1995), who found that Type A accounted for 54% of all tibial fractures.

Our series had an higher incidence of oblique fractures in 42.85% of cases, transverse fractures made up 33.33% cases. Oblique and transverse fractures made up 76.19% fractures 32 patients.

This is comparable to Sankarsan Patro et al[34]. (1998), in whose series, there were 59% of these fractures.

Court Brown et al[9]. reported 37.2% and Arne Ekeland[2] (1988), reported 42% of transverse and oblique fractures.

The Tshcerne type of closed fracture in our series has been classified using the radiological criteria and in our series Tscherne Cl fracture made up of 52.38% of closed fractures 22 patients. This is comparable to Tscherne Cl fracture of about 53%

in the series by Court Brown et al[9]. (1995). Cl type of closed fractures is commonly seen in road traffic accidents.

The fibula was fractured along with the shaft of tibia in our series in 85.71% of cases, this is comparable to the series of Court Brown etal[9]. (1995), where the fibula was also fractured in 77.7% of the cases. The associated fracture of the fibula , in most of the cases reflects on the high – velocity injury pattern in our series, as most of the injuries are due to road traffic accidents.

Preoperative, Operative and Nailing Procedure

In our series we had 42 closed tibial fractures with Tscherne Co fractures in 18 patients, Tscherne C_1 fractures in 22 patients, Tscherne C_2 fractures in 2 patients and no patients in Tscherne in C_3.

There were Five superficial preoperative abrasions in patients. After healing of superficial abrasions these fractures were operated after 3 days to maximum of 23 days after injury, The causes of delay for surgery included head injury, Bronchial asthama, superficial blebs and associated systemic illness like anemia, hypertension and diabetics. The average delay was 11.5 days.

All the fractures were stabilized on a calcaneal traction till surgery. All patients in our series were given spinal anesthesia,

In our series, we have used intramedullay nails ranging from 8 to 10 mm in diameter and from 280 to 360 mm in length.

41 reamed and 1 unreamed closed intramedullary nailing were done in our series, unreamed nailing was done in a patient with signs of breathlessness. This patient was treated preoperatively for the same, and unreamed nailing was done.

Christie[7] (1996), noted embolic phenomenon during nailing. In our series, however, we have not come across any embolic phenomenon after this surgical procedure.

Schemitsh et al[35]. (1998), noted difference in bone formation between reamed and undreamed nailing.

Utvag et al[40]**.** (1998), noted no evidence that the degree of reaming significantly affected healing pattern.

In an unreamed nailing, the nail size in our series was 8mm. Static locking was done in our series.

Postoperatively, in our series, no complications like fat embolism, compartment syndrome, neurological or vascular injury occurred. Superficial infections occurred in three patients at the site of surgical incision over knee and both the superficial infections healed by dressing and antibiotics.

In majority of our patients, active Hip, Knee, ankle movements and quadriceps exercises were started on the first postoperative day in 18 patients, in 1 patient with polytrauma it was delayed. Majority of patients were mobilized with the walker from the third postoperative day, without bearing weight on the operated leg. Suture removal was done in all patients by one to two weeks, at an average of 10 days. Complete relief of pain was seen in majority of patients in two weeks.

Follow up was done at 3 weeks, 3 months and 6 month. At follow-ups, clinical and radiological assessment was done regularly with suitable follow-up advice.

Depending upon the type of fracture and stable fixation of fracture, partial weightbearing was started. In our series, partial weight bearing was started in the majority of patients 30, by the 4th week.

Patellar tendon bearing cast was used in our series in 8 patients with 7 in lower one – third fracture 1 in upper one-third fracture, for about 4 to 6 weeks.

Full Weight bearing

Full weight bearing in our series was started at 10th week in 30 patients 71.42% and at 12th week in 10 patients (23.80%). The appearance of bridging callus was used to assess and allow the patient full weight bearing. The average time of full weightbearing was 10.81 weeeks. Full weight bearing has been delayed in 2 patients as there were communited fractures (1patient), fracture in the lower one-third with communition (1 patient).

This is comparable to **Lawrence B. Bone et al**[26]. (1986), where in his study weightbearing has been delayed in unstable fractures.

Grosse and Kempl[15](1991), allowed full weightbearing at 8.5 weeks.

36 patients 85.71% in our series recovered and got normal knee, ankle, and subtalar joint movements.

In Five patients, there was restricted mobility of knee, ankle and subtalar joints.

Fracture Union

Fracture Union was considered when patient was full weightbearing without pain, fracture site was not tender on palpation and radiograph showed osseous union.

In our series , majority of fractures united within 20weeks (24 patients). The average time of union 17.36 weeks. This is comparable to **Anglen J.O. et al**[1]. (1995), where 22.5 weeks was the average union in time in a reamed nailing.

Lawrence B. Bone et al[26]. (1986), reported average union time at 19 weeks. **Court Brown et al**[8].(1990), reported average union time at 16.7 weeks. **Arne Ekeland et al**[2].(1988, reported average union time at 16 weeks.

In our series, average time of union was 17.36 weeks for both reamed and undreamed nailing.

Complication

Lawrence B. Bone et al[26].(1986), Noted an infection rate of 6.25%

Arne Ekeland et al[2]**.** (1988), noted infection rate of 4.4%

Blachut P.A.et al[4].(1997), noted an infection rate of 1%.

In our series, which is comparable to the above workers study series superficial infection rate was 7.14% and it healed with dressing and antibiotics and proper management of Diabetes Mellitus.

Anterior knee pain was seen in three patients 7.14%. In one patient the nail was abutting the patellar tendon and tibial thuberosity, causing anterior knee pain and this can be relieved after removal of the nail. The cause for anterior knee pain in another patient could be heterotropic ossification of patellar tendon.

Anterior knee pain can be compared to **Hernigou P**.**et al**[17].(2000), who noted improper entry of nail into medullary canal, may cause anterior knee pain.

Jarmo A.K. Toivnnen et al[20].(2002), noted anterior knee pain.to be common in tibial intramedullary nailing.

Functional Outcome

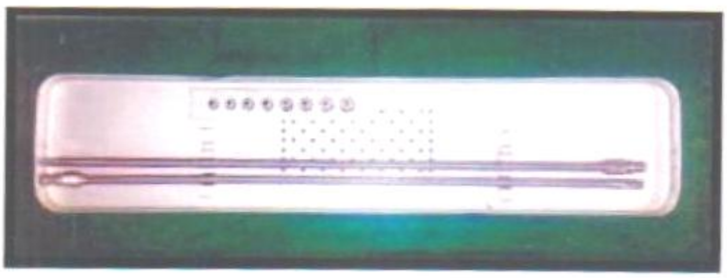
Final assessment in our series was done at 6 months using the **Johner and Wruh's**[43] criteria, taking into account of the following objective and subjective symptoms of gait, pain, deformity, range of motion of knee, ankle and subtalar joints, shortening, Neurovascualr disturbances, ability to do strenuous activities, radiological union and presence or absence of non-union. Functional outcome was graded into Excellent, Good, Fair and poor.

In our series, 57.14% (13 patients) have got excellent, 38.09% (16 patients) have good, 4.77% (2 patients) have fair.

Klem et al[23].(1986), reported 62.50% excellent, 31.8% good, 4.5% fair and 1.2% poor results.

Atne Ekeland et al[2].(1988), reported 64.4% excellent, 28.8% good and 4.4% as fair.

TIBIAL INTRAMEDULLARY INTERLOCKING NAILING INSTRUMENTS



Proximal Tibial entry point exposed

Guide wire insertion

Nail insertion

Proximal locking

Distal Locking

Wound suturing

Post-operative Scar

Knee Flexion

Weight bearing

X-ray

Pre Operative

Immediate
Post operative

At 6 weeks

At Union

SUMMARY

From October 2009- February 2011, 42 patients with closed fractures of the shaft of tibia, were treated by closed intramedulary interlocking nailing at B.L.D.E.University.'s Shri B.M.Patil Medical College and Hospital, Bijapur.

- Majority of patients were in the age group of 21 to 30 years.
- The males predominated the females (Males- 37 patients, females- 5 patients)
- Road Traffic Accidents were the main mode of injury in 57.14% of patients.
- Among closed fractures, Tscherne Cl was the commonest in 22 patients (52.38%)
- Majority of fractures were located in the middle-third (52.38%) in 22 patients and in lower-third in 18 patients (42.86%).
- Type A 80.95% was the most commonest in 34 patients. Transverse and oblique fractures were 76.19%,
- Fibula was fractured in 85.71% of cases.
- 42 reamed and unreamed closed intramedullary interlocking nailing were done.
- Static locking was done in all cases in our series.
- 30 patients were started on partial weightbearing by 4th week and 30 patients started on full weight bearing by 10th week , and 12th week in 10 patients.

- Final assessment was done after 6 months taking into account gait, pain, deformity, movement of knee, ankle and subtalar joints, ability to do strenuous activity, shortening and radiological union, taking into account Neurovascular disturbances.
- The average healing time was 17.36 weeks.
- There were three superficial infections and three patients with anterior knee pain.
- In our study 24 patients 57.14% had excellent, 16 patients 38.09% had good, 2 patients 4.77% had fair results.

CONCLUSION

- Tibial diaphyseal fractures are commonly seen in physically active young people and are commonly seen as result of road traffic accidents.
- The interlocking nailing combines control of length. Alignment and rotation, preserves periosteal blood supply, some amount of endosteal blood supply and with biological osteosynthesis, lowers the infection and malunion.
- The advantage of locking screws over the conventional methods reduces the rate of malunion, loss of alignment, angulation and shortening which are commonly found in a plaster cast or functional brace. The addition of locking screws extends its indications to within 5 cm of ankle and knee joint.
- The method of treatment employing closed intramedullary interlocking nailing to stabilize both principal fragments on the nail is an excellent one for closed fractures with communition.
- Patients operated with this technique can be ambulated early without external immobilization in majority of cases, patients are allowed to resume work as early as tolerated and this procedure also reduces the hospital stay and boosts the morale of the patient.
- The method of intramedullary interlocking nailing is ideal because of excellent results 57.14% which is comparable to other series.
- The method has a long learning curve but with the excellent results, the advantage of rapid rehabilitation and relatively of few complications serves to recommend it for wider use.

BIBLIOGRAPHY

1. Anglen J.o.: A comparison of reamed and undreamed nailing of tibia; Journal of trauma, 1995:351
2. Arne Ekeland, B. Jorn. O. Thoresen , Antti' Alho, Kunt Stromsoe, Gunnar, Fillers and Aren Haukeb.: Interlocking intramedullary nailing in the treatment of tibial fractures 1988; CORR, 231:208-215.
3. Andrew Schmidt et al (2003); Treatment of closed tibial fractures in Journal of JBJS 2003.
4. Blachut P.A.,P.J. O'Brien, R.N. Meekm H.M.Broekhuyse.: Interlocking nailing with or without reaming further treatment of closed fractures of tibial shaft; Journal of Bone and Joint surgery, 1997, 79 A: 640-646.

5.Blachut P.A; Richard S et al (1998); Reamed v/s undreamed locked Intra Medullary nailing of closed tibial shaft fractures in JBJS in 1998.

6. Benjamin Littenberg et al (1998); Closed fractures of tibial shaft; A metaanalysis of three methods of treatment in JBJS 1998.
7. Bekmezci T, Baca E, Kocabas R, Kayanak H, Tonbul M. Bekmezci T, [Early results of treatment with expandable intramedullary nails in tibia shaft fractures. Acta Orthop Traumatol Turc, 2005;39(5): 421-424.
8. Christie J.: The coagulative affects of fat embolization during intramedulary manipulative procedures; Tech Orthop, 1996, 11:14-17.
9. Court Brown C.M, Christie J, Mc Queen M.M.: closed Intramedullary tibial nailing; Journal of bone and joint surgery, 1990, 72B:605-611.
10. Court Brown C.M,J.Mc Brine.: The epidemiology of tibial fractures; Journal of bone and joint surgery, 1995, 77B:417-421.

11.Court Brown C. M, Will, E, Christie. J, Mc Queen M. M.: Reamed or unreamid nailing for closed fractures; Journal bone and joint surgery, 1996,75B;580-583.

12. Cyna, Khalily et al (2000); Treatment of closed tibial shaft fractures; A survey from 1997 in Journal of Orthopedic trauma 2000.

13. Fang-Yao Chiu et al (1996) Treated unstable closed tibial shaft fractures in Journal of trauma June 1993.

14. Gaston P., Will. E, Elton RAet al.,: Tibial fractures. Can their prognosis be predicted ?; Journal bone and joint surgery, 1999, 81B:71-76.

15. Gerhard B.G. Kuntscher.: The Kuntscher method of Intramedullary fixation; Journal of Bone and Joint Surgery, 1958, 40A: 17-26.

16. Grosse A. G. Taglang and Kempf.: G.K. Locking System, Howmedica; 1991;28.

17. Gregory P, Sanders R. The treatment of closed, unstable tibial shaft fractures with undreamed interlocking nails.: Clin Orthop. 1995 Jun; (315): 56-63.

18. Habernek H. Kwansy O, Schmid L, et al.,: Complications of interlocking nailing for lower leg fractures; Journal of Trauma, 1992:963.

19.Hernigou. P.et al.,; Proximal entry for intramedullary nailing of tibia; Journal of Bone and Joint Surgery, 2000, 82B: 33-41.

20. Hooper G.J, Kidell P.G, Pennaj I.D.: Conservative management or closed nailing for tibial shaft fractures, randomized prospective trial; Journal of Bone and Joint Surgery, 1991, 73B: 83-85.

21. Hupel T.M, Aksenov S A, Schemitsh E H.: Effective limited and standard reaming on cortical bone blood flow and early strength of union following segmental fractures; J. Orthop Trauma, 1998, 12: 400-406.

22. Jarmo. A. K, Toivannen et al.,: Anterior knee pain after intramedullary nailing of fractures of tibial shaft; Journal of bone and joint surgery, 2002, 84A: 580-585.

23. Kuttu S, Farooq M, Murphy D, Kelliher C, Condon F, McElwain JP. Tibial shaft fractures treated with the AO undreamed tibial nail. Ir J Med Sci. 2003 Jul – Sept; 172(3): 141-2.

24. Karladani A. H. et al.,: Displaced tibial shaft fractures: A prospective randomized study of closed intramedullary nailing versus cast treatment in 53 patients; Acta Orthop, Scand, 2000,71:162-167.

25. Kessler S.N. Hallfeldt, Perren, Schwiberer.: The effects of reaming and intramedullary nailing on fracture healing; Clinical Orthop, 1986,212.

26. Klaus W. Klemm, M.D. Martin Borner,: Interlocking nailing of complex fractures of femur and tibial; CORR, 1986, 212:89-100

27. Kretteck. C, Schandelmaier P, Tscherne H.: Mon-reamed interlocking nailing of closed tibial fractures with severe soft tissue injury; Clinical Orthop, 1994; 315: 34-37.

28. Kretteck C et al.,: The use of pollar screws as blocking screws in stabilizing tibial fractures treated with small diameter intramedullary nails; Journal of bone and joint surgery, 1999, 81B: 963-968.

29.Larsen LB, Madsen JE, Hoiness PR, Ovre S. Should insertion of intramedullary nails of tibial fractures be with or without reaming? A prospective, randomisd study with 3.8 years' follow-up. J Orthop Trauma. 2004 Mar; 18(3): 144-9.

30.Lawrence B. Bone, Kenneth D. Johnson.: Treatment of tibial fractures by reaming and intramedullary nailing; Journal of Bone and Joint Surgery, 1986, 68A:877-886.

31. Merle D' Aubigne, P. Maurer, J. Zueman, Y. Mosse.: Blind intramedullary nailing for tibial fractures; Clinical Orthop, 1974, 105:267.

32. Moed R.R. Watson J.T.: Ultrasound for early diagnosis of fracture healing after interlocking nailing of tibia without reaming ; Clinical Orthop, 1995: 137.

33. Mohit, Bhandari et al (1999); Early v/s delayed operative management of closed tibial fractures in CORR 1999.

34. Niels Olaf Christensen.: Kuntscher intramedullary reaming and nail fixation for non-union of fracture femur and tibia; Journal of bone and joint surgery, 1973, 55B:312-318.

35. Nazri MY, Halin YA et al (2004); Med.J. Malaysia 2004 Dec; 59(5); 665-9. Outcome of infection following internal fixation of closed fractures.

36. Petrisor B. Anderson S. court Brown CM et al (200); J Othop trauma 2005 Aug; 19(7) ; 437-41. Infection after intramedullary nailing of tibia; a case series review.

37.Riemer B L, Di Christina D Q, Cooper A, et al.,: Non – reamed nailing of tibial diaohyseal fractures in blunt polytrauma patients; J Orthop Trauma, 1995, 9:66-75.

38.Sankarsan Patro, B.K. Sadangi, B.M. Mohapatro, U.N. Misra, S. M. Mohanty, M.R. Mohanpatro.: Interlocking nailing in tibial fractures without ‘C arm; Indian Journal of Orthopedics, 1998, 33: 175-178.

39. Schemitsch E. H, Tutchin D.C, Kowalski M.J, et al.,: Quantitative assessment of bone injury and repair after reamed and undreamed locked intramedullary nailing; J Trauma, 1998, 45: 250-255.

40. Schmidt AH, Finkemeier CG, Tornetta P 3rd. Treatment of closed tibial fractures . Instr Course Lect. 2003; 52:607-22.

41. Scott L, Sledge, Kenneth D. Johnson, M. Bradford Henley, J. Tracy Watson.: Intramedullary nailing with reaming to treat non-union of tibia; Journal of Bone and Joint surgery, 1989, 71 A : 1004-1019.

42. Sarmiento A .: Functional cast bracing of tibial fractures; clinical Orthop, 1974, 105: 202-219.

43. Sven Ilerud et al.,: Secondary intramedullary nailing of tibial fractures; Journal of Bone and Joint Surgery, 1972, 54A: 1419-1428.

44.Temleman D, Larson C, Vareeka T, et a.,: Exchange reamed intramedullary nailing for delayed union and non-union of the tibia; Clinical Orthop, 1997; 315:169-175.

45. Utvag. S. E, Grundness O, Reikeras O.: Effects of degrees of reaming on haling of segmental fractures in rats; J Orthop Trauma, 1998, 12: 192-199.

46. Watson J.T.: Current concepts review, treatment of unstable fractures of the shaft of tibia; Journal of Bone and Joint Surgery, 1994, 76A: 1575-1583.

47. Weller S, E. Kuner and Schweikert Medullary nailing according to swiss study group principles; CORR, 1979,138: 45-54.

48. Wruhs.O.Johner R. : Classification of tibial shaft fractures and correlation with results after rigid fixation ; Clinical Orthop, 1983: 178.

49. Wiss .DA, Stetson WB. Unstable fractures of the tibia treated with a reamed intramedullary interlocking nail. Clin Orthop Relat Res. 1995 Jun; (315) : 56-63.

50. Wu CC, Chen WJ, Shih CH, Tibial shaft malunion treated with reamed intramedullary nailing : a revised technique. Arch Orthop Trauma Surg. 2000: 120 (3-4) : 152-6.

51. Wu.C.C. Shih C.H.: Effect of dynamization of a static interlocking nail on fracture healing ; Canadian Journal of Surgery. 1993: 302.

52. Wu.C.C. Shih C.H.: Treatment of segmental tibial fractures by interlocking ; Journal of Orthopaedic Trauma, 1993: 468.

53. Zucmann J. Et al.,; Two-level fractures of tibia ; Jounal of bone and joint surgery , 1969, 51B: 686-693.

PROFORMA

Case No :

Name of Patient : Age : Sex : IP No

Occupation : Date of Injury :

Address : Date of Admission :

Date of Surgery :

Date of Discharge :

I. Presenting Complaints

Pain / Swelling / Deformity / Abnormal mobility / Loss of function

Nature of Injury

- ❖ Road Traffic Accident
- ❖ Assault
- ❖ Fall
- ❖ Fall of an Object
- ❖ Industrial Injury
- ❖ Sports Injury
- ❖ Faming Injury

II. General Examination

Nourishment Pallor

Pulse Blood Pressure Temperature

Respiratory Rate

III. Systemic Examination

- ❖ CVS :
- ❖ RS :
- ❖ PA :
- ❖ CMS and neurological status:

IV. Local Examination

1. Gait	
2. Involved Limb	Right / Left
3. Deformity	Present /Absent
4. Swelling	Present / Absent
5. Type of fracture	Closed
6. Tenderness	Present / Absent
7. Crepitus	Present / Absent
8. Abnormal Mobility	Present / Absent
9. Shortenng	_______________ cms.
10. Complications	Shock / Fat Embolism / Compartment Syndrome

a. Associated Injuries

b. Associated Diseases

c. Personal Habits

d. Treatment given in the Casualty

- Injections – Tetanus Toxoid
- Splinting / Skeltal Traction

V. Radiological Examination : AP/ Lateral View

a) Level of the fracture and site

1) Upper 1/3rd

2) Upper and Middle 1/3rd

junction

3) Middle 1/3rd

4) Middle and Lower 1/3rd

5) Lower 1/3rd

b) Type of Fracture

- Unifocal (Spiral / Oblique / Transverse Fracture)
- Wedge (Spiral wedge / Bending wedge / Communited wedge)
- Complex (Spiral wedges / Segmental / Communited)
- Tscherne Type –C0 / C1 / C2 / C3
- Fibular fracture – Present

VI. Investigations

Hb %	RBS	Urine	
PCV	Blood Urea		Albumin
TC	Serum Creatinine		Sugar
DC	ECG in all chest levels		Microscopy
ESR	Chest x-ray in P-A view	Stool	
HIV	Blood Grouping and typing		Ova
HbsAg			Cyst
VDRL			Microscopy

VII. Pre-operative planning for Surgery

1) Type of Nail and Size :
2) Preparation of the Patient :
3) Low Molecular Weight Heparin : Administered / Not administered
4) Education of the Patient regarding Surgery and Outcome :
5) Consent for Surgery :

VIII. Surgical Treatment

- Date of Operation :
- Type of Anesthesia :
- Approach : Vertical Patellar Splitting
- Nailing : Reamed / Unreamed :
- Locking of Nail : Static / Dyanamic

I. Proximal - i) Done (1screw / 2 screws) ii) Not done

II. Distal - i) Done (1screw / 2 screws) ii) Not done

IX . Intra operative Complications

Splintering of Bone / Breakage of Drill bit

a) Immediate Post-operative Complications

Fite embolism / Neurological Damage / Compartment Syndrome /

Hypotension / Vascular Injury

b) Wound Infection : Superficial / Deep

c) Suture Removal done : __________ day (between 1 to 2 weeks)

d) Weight bearing : Non –weight bearing – Till 4th week.

- Partial : At 4th week / 6th week / 8th week / 12th week / 16th week
- Full Weight bearing : 10th week / 12th week / 14th week / 16th week / 20 week

With / without walking aids.

X. Follow up

		3rd Week	3 months	6 months
1.	Pain			
2.	Deformity			
	✦ Knee			
	✦ Ankle			
	✦ Subtalar			
3.	Range of Motion			
4.	Shortening			
5.	Radiological Union			

XI. List of Delayed Complication

- Screw Breakage
- Nail Bending / Breakage
- Anteior Knee Pain
- Infection – Superficial / Deep
- Malunion
- Shortening
- Non-union

a) Secondary Procedure

Dynamization

- Proximal
- Distal

b) Procedure done in Nail Bending / Screw Breakage

c) Gait : Normal / Limping (Significant / Insignificant Limp)

d) Functional Outcome

- Excellent
- Good
- Fair
- Poor

Johner and Wruh's Criteria for Evaluation of Final Results

Sl. No	Criteria	Excellent (Left = Right)	Good	Fair	Poor
1.	Non-unions , Osteitis, Amputation	None	None	None	Yes
2.	Neurovascular Disturbances	None	Minimal	Moderate	Severe
3.	Deformity				
	Varus / Valgus	None	2^0-5^0	6^0-10^0	>10^0
	Anteversion / Recurvation	0^0-5^0	6^0-10^0	11^0-20^0	>20^0
	Rotation	0^0-5^0	6^0-10^0	11^0-20^0	>20^0
4.	Shortening	0-5 mm	6-10mm	11-20mm	>20mm
5.	Mobility				
	Knee	Normal	>80%	>75%	>75%
	Ankle	Normal	>75%	>50%	<50%
	Subtalar	>75%	>50%	<50%	-
6.	Pain	None	Occasional	Moderate	Severe
7.	Gait	Normal	Normal	Insignificant Limp	Significant Limp
8.	Strenuous activites	Possible	Limited	Severely Limited	Impossible
9.	Radilogical Union	Consolidated	Consolidated	Union	Not Consolidateds

Keeping all these criteria in mind the final functional outcome was assessed.

CONSENT FORM FOR ANAESTHESIA / OPERATION Etc.,

I ………………….…. Hosp. No……… in my full senses hereby give my complete consent for ……………….. or any other procedure deemed fit which is a/and diagnostic procedure/biopsy/transfusion/operation to be performed on me/my son/my daughter/my ward ………….…. Age ….. under any anaesthesia deemed fit. The nature and risks involved in the procedure have been explained to me to my satisfaction. For academic and scientific purpose, the operation/procedure may be televised or photographed.

Date: Signature/Thumb Impression/

of the Patient/Guardian

Name :

Designation:

Guardian

Relationship

Full Address

KEY TO MASTER CHART

Sl. No.	→	.Serial Number
I.P. No.	→	In-patient Number
DOI	→	Date of Injury
DOA	→	Date of Admission
DOS	→	Date of Surgery
DOD	→	Date of discharge
DOHS	→	Duration of Hospital Stay
Pre/Intra OP	→	Pre and Intra operative
Pt. Wb	→	Partial weight bearing
Fu. Wb.	→	Full weight bearing
Pr.	→	Proximal
Sc.	→	Screw
Dy.	→	Dynamization
NR.	→	Nail Removal
P.Lat.B gr	→	Posterio-lateral Bone grafting
Ang.	→	Angulation
ARDS	→	Acute respiratory Distress Syndrome
FE	→	Fat Embolism
HI	→	Head injury
Ips.	→	Ipsilateral
SC	→	Supracondylar
#	→	Fracture
Condy.	→	Condyle
R	→	Right

L	→	Left
BB	→	Both bones
Hu.	→	Humerus
MM	→	Medial Malleolus
MC	→	Metacarpal
U /3	→	Upper third
M /3	→	Middle third
L /3	→	Lower third
RTA	→	Road traffic accident

MASTER CHART

Sl. No.	Name	Age	Sex	I.P. No.	Occupation	D.O.I.	D.O.A.	D.O.S	D.O.D	DOHS (in Days)	Involved Limb	Mode of Injury	Type of Injury	Type of Fracture	Anatomical Location of Fracture	OTA (AO Type)	Tscherne Type	Associated Injury	Complications Pre/ Intra OP	Nail Size	Type of Locking	Type of nailing	PL WB (In weeks)	FU. WB (In weeks)	Fracture Union (In weeks)	Follow up at 6 months								Complications	Secondary Procedure	Functional outcome
																										Pain	Deformity	Range of Motion (%)			Shortening	Gait	Radiological Union			
																												Knee	Ankle	Sub Talar						
01	Mahadev	60	M	02	Farmer	31/1/10	1/2/10	3/2/10	14/2/10	14	R	RTA	Closed	oblique	M/3	A.2.1	C0	HEAD INJURY	HTN+BROCHIAL ASTHMA	9 mm X280mm	Static	Reamed	4	10	12	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	EXCELLENT
02	Prakash	30	M	07	Farmer	18/2/10	20/2/10	22/2/10	4/3/10	13	R	RTA	Closed	spiral	M/3	A.2.1	C1	CLAVICLE	Nil	1mmX320mm	Static	Reamed	4	10	16	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	EXCELLENT
03	Sidraya	30	M	1272	Clerk	11/2/10	12/2/10	14/2/10	25/2/10	13	R	RTA	Closed	oblique	M/3	A.2.1	C0	NIL	Nil	9mmX340mm	Static	Reamed	4	10	20	NIL	Nil	>75	>50	<50	Nil	Normal	Consolidated	Anterior Knee Pain	Nil	GOOD
04	Shantabai	40	F	9210	House Wife	3/3/10	3/3/10	5/5/10	18/3/10	14	L	RTA	Closed	oblique	M/3	A.2.1	C0	NIL	Nil	9mmX340mm	Static	Reamed	4	10	13	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	EXCELLENT
05	Revanthappa	56	M	12327	Farmer	8/3/10	8/3/10	10/3/10	24/3/10	15	R	RTA	Closed	oblique	M/3	A.2.2	C0	FIBULA NECK FRACTURE	Nil	9mm X350mm	Static	Reamed	4	10	17	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	EXCELLENT
06	Dundappa	44	M	13650	Labourer	11/3/10	12/3/10	14/3/10	28/3/10	15	R	RTA	Closed	oblique	M/3	A.2.2	C1	NIL	Nil	9mm X 320mm	Static	Reamed	4	10	15	NIL	Nil	>75%	>50%	<50%	Nil	Normal	Consolidated	Nil	Nil	FAIR
07	Shaihed	33	M	17815	Business man	4/3/10	4/3/10	6/3/10	20/3/10	15	R	FALL	Closed	transverse	M/3	B.2.1	C1	NIL	Nil	9mm X 320mm	Static	Reamed	4	10	12	Nil	Nil	N	N	N	Nil	Normal	Consoilidated	Nil	Nil	EXCELLENT
08	Satteppa	50	M	21370	Farmer	14/4/10	14/4/10	16/3/10	29/3/10	16	R	RTA	Closed	transverse	M/3	A.2.1	C0	NIL	Nil	9mm X 340mm	Static	Reamed	4	10	18	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	EXCELLENT
09	Sunil Patil	30	M	22575	Farmer	4/4/10	5/4/10	7/4/10	17/4/10	10	L	RTA	Closed	transverse	U/3	A.2.1	C0	NIL	Nil	9mm X 320mm	Static	Reamed	PTB 4TH WEEK	12	16	Nil	Nil	>75%	>50%	<%50	Nil	Normal	Consolidated	Nil	Nil	GOOD
10	Basavaraj	18	M	28742	Student	10/4/10	10/4/10	12/4/10	25/4/10	14	R	RTA	Closed	spiral	M/3	A.2.1	C1	NIL	Nil	9mm X 340mm	Static	Reamed	4	10	20	KNEE PAIN	Nil	N	N	N	Nil	Normal	Consolidated	Anterior knee pain	Nil	GOOD
11	Nirangana	21	M	1183	Student	15/4/10	15/4/10	17/5/10	30/5/10	16	L	FALL	Closed	oblique	M/3	A.2.1	C1	NIL	Nil	8mm X 300mm	Static	Reamed	4	10	15	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	EXCELLENT
12	Shrishail	32	M	4263	Farmer	16/4/10	17/4/10	18/4/10	30/4/10	14	R	FALL	Closed	transverse	M/3	A.2.1	C2	CLAVICLE	Nil	9mm X 320mm	Static	Reamed	6	10	18	Nil	Nil	>75%	>50%	<%50	Nil	Normal	Consolidated	Nil	Nil	GOOD
13	Sangeeta	51	F	4472	Clerk	20/4/10	20/4/10	21/4/10	21/5/10	11	R	FALL FROM HEIGHT	Closed	transverse	M/3	A.2.2	C0	FIBULA NECK FRACTURE	Nil	9mm X 320mm	Static	Reamed	6	12	13	KNEE PAIN	NIL	N	N	N	Nil	Normal	Consolidated	Anterior knee pain	Nil	GOOD
14	Sidramma	60	M	6327	Business man	5/5/10	5/5/10	7/5/10	20/5/10	14	Both	RTA	Closed	spiral	M/3	A.2.2	C1	NIL	Nil	9mm X 310mm	Static	Reamed	6	10	17	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	EXCELLENT
15	Satish	30	M	11079	Farmer	6/5/10	6/5/10	8/5/10	22/5/10	17	R	FALL	Closed	oblique	U/3-M/3 JN	B.2.2	C0	HEAD INJURY	Nil	8mm X 320mm	Static	Reamed	4	12	15	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	EXCELLENT
16	Kalawati	30	F	11087	House wife	8/5/10	8/5/10	10/5/10	28/5/10	19	R	FALL	Closed	wedge	L/3	A.2.1	C0	NIL	Nil	9mm X 340mm	Static	Reamed	4	10	14	NIL	NIL	>75%	>50%	<%50	Nil	Normal	Consolidated	Nil	Nil	GOOD
17	Shantappa	50	M	11075	Farmer	9/5/10	9/5/10	12/5/10	28/5/10	19	R	FALL	Closed	oblique	L/3	A.2.1	C0	NIL	Nil	9mm X 320mm	Static	Reamed	4	10	18	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	EXCELLENT
18	Basalingappa	38	M	18924	Farmer	7/6/10	7/6/10	10/6/10	24/6/10	15	R	ASSAULT	Closed	transverse	L/3	A.2.1	C1	NIL	Nil	9mm X 340mm	Static	Reamed	4	12	20	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	EXCELLENT
19	Nirmala	45	F	4820	House wife	8/7/10	8/7/10	10/7/10	20/7/10	11	R	RTA	Closed	transverse	L/3	A.2.1	C1	NIL	Nil	9mm X 340mm	Static	Reamed	PTB 4TH WEEK	12	16	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	EXCELLENT
20	Mallappa	35	M	4927	Automobile worker	16/7/10	17/7/10	19/7/10	30/7/10	12	R	RTA	Closed	oblique	L/3	A.2.2		NIL	Nil	9mm X 280mm	Static	Reamed	4	10	15	NIL	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	EXCELLENT
21	Basappa	75	M	11433	Farmer	4/8/10	4/8/10	6/8/10	24/8/10	19	L	RTA	Closed	wedge	M/3	A.2.2		NIL	HTN+DIABETES MELLITUS	9mm X 320mm	Static	Reamed	4	10	19	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	EXCELLENT
22	Maddeppa	35	M	19551	Farmer	15/8/10	15/8/10	16/8/10	1/9/10	17	R	RTA	Closed	oblique	M/3	B.2.2	C1	NIL	Nil	8mm X 300mm	Static	Reamed	4	10	12	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	EXCELLENT
23	Mamataz	35	F	23454	Housewife	28/8/10	28/8/10	30/8/10	12/9/10	16	L	RTA	Closed	transverse	M/3	C.1.1	C1	NIL	Nil	8mm X 280mm	Static	Reamed	4	10	14	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Superficial Infection	Nil	GOOD
24	Mahantesh	45	M	22329	Engg.	1/9/10	1/9/10	3/9/10	18/9/10	19	R	FALL	Closed	transverse	M/3	A.2.2	C0	NIL	Nil	9mm X 320mm	Static	Reamed	4	10	18	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	EXCELLENT

25	Teju Madar	20	M	25862	Student	4/9/10	4/9/10	6/9/10	20/9/10	17	R	FALL	Closed	oblique	M/3	B.2.2	C0	NIL	Nil	8mm X 300mm	Static	Reamed	4	10	16	NIL	NIL	>75 %	>50%	<%50	Nil	Normal	Consolidated	Nil	Nil	GOOD
26	Dulappa	25	M	27110	Farmer	14/9/10	15/9/10	16/9/10	24/9/10	11	R	FALL	Closed	wedge	M/3	A.2.2	C0	CLAVICLE	Nil	8mm X 300mm	Static	Reamed	4	10	17	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	EXCELLENT
27	Basheer	29	M	25558	Student	4/4/10	6/10/10	7/7/10	24/10/10	21	R	FALL FROM HEIGHT	Closed	spiral	L/3	A.2.2	C0	NIL	Nil	8mm X 300mm	Static	reamed	PTB 4^{TH} WEEK	12	19	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	EXCELLENT
28	Raju	30	M	10673	Farmer	6/10/10	7/10/10	8/10/10	28/10/10	24	L	RTA	Closed	oblique	L/3	A.2.2	C0	NIL	NIL	10mm X 36mm	Static	Reamed	PTB 4^{TH} WEEK	12	16	Nil	Nil	>75 %	>50%	<%50	Nil	Normal	Consolidated	Nil	Nil	GOOD
29	Shailesh	36	M	11967	Business Man	14/10/10	15/10/10	16/10/10	1/11/10	18	L	RTA	Closed	communited	L/3	A.2.2	C1	NIL	NIL	10mm X 320mm	Static	Reamed	PTB 4^{TH} WEEK	14	23	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Superficial Infection	Nil	GOOD
30	Sanjay	62	M	12011	Farmer	20/10/10	20/10/10	22/10/10	6/11/10	17	L	RTA	Closed	oblique	M/3	A.2.2	C1	NIL	NIL	10mm X 360mm	Static	Reamed	6	10	17	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	EXCELLENT
31	Aravind	24	M	12831	Student	24/10/10	24/10/10	26/10/10	10/11/10	17	R	RTA	Closed	oblique	M/3	A.2.2	C1	NIL	NIL	9mmX340mm	Static	Reamed	4	10	20	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	EXCELLENT
32	Ashok	25	M	14306	Automobile Worker	26/10/10	27/10/10	28/10/10	14/11/10	21	R	FALL	Closed	oblique	M/3	A.2.1	C2	NIL	NIL	9mmX340mm	Static	Reamed	4	10	18	KNEE PAIN	Nil	N	N	N	Nil	Normal	Consolidated	Anterior knee pain	Nil	GOOD
33	Kallappa	30	M	14843	Farmer	1/11/10	1/11/10	2/11/10	20/11/10	21	L	FALL	Closed	oblique	L/3	A.2.1	C1	NIL	NIL	9mmX360mm	Static	Reamed	4	10	20	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	EXCELLENT
34	Kedarling	25	M	2042	Farmer	4/11/10	5/11/10	8/11/10	24/11/10	21	L	ASSAULT	Closed	communited	L/3	A.2.1	C1	HEAD INJURY	NIL	9mmX340mm	Static	Reamed	PTB 4^{TH} WEEK	14	24	Nil	Nil	>75 %	>50%	<%50	Nil	Normal	Consolidated	Nil	Nil	GOOD
35	Santosh	40	M	9370	Teacher	6/11/10	8/11/10	9/11/10	24/11/10	19	R	RTA	Closed	transverse	L/3	A.2.1	C1	NIL	NIL	9mmX320mm	Static	Reamed	4	10	20	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	GOOD
36	Prabhu	25	M	10447	Student	10/11/10	11/11/10	12/11/10	28/11/10	19	L	RTA	Closed	transverse	L/3	B.2.1	C0	NIL	HTN+DIABETES MELLITUS	9mmX320mm	Static	Reamed	PTB 4^{TH} WEEK	12	17	Nil	Nil	>75 %	>50%	<%50	Nil	Normal	Consolidated	Nil	Nil	FAIR
37	Revannasiddappa	58	M	11305	Farmer	14/11/10	15/11/10	16/11/10	1/12/10	18	L	ASSAULT	Closed	Transverse	L/3	A.2.1	C1	NIL		9mmX340mm	Static	Reamed	4	10	20	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	GOOD
38	Manjunath	20	M	11525	Student	16/11/10	16/12/10	18/11/10	1/12/10	16	L	RTA	Closed	Transverse	L/3	C.2.1	C1	NIL		9mmX300mm	Static	Reamed	4	10	20	NIL	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	EXCELLENT
39	Ravi	18	M	13388	Student	17/11/10	18/11/10	20/11/10	4/12/10	19	L	FALL	Closed	Communited	L/3	A.2.1	C1	NIL	HTN+DIABETES MELLITUS	9mmX340mm	Static	Reamed	PTB 4^{TH} WEEK	12	20	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	EXCELLENT
40	Kumar	55	M	17892	Farmer	12/12/10	14/12/10	16/12/10	4/1/11	24	L	FALL	Closed	oblique	L/3	C.1.1	C1	NIL		9mmX340mm	Static	Reamed	4	10	19	Nil	Nil	>75 %	>50%	<%50	Nil	Normal	Consolidated	Nil	Nil	GOOD
41	Dharmesh	75	M	13688	Retired Clerk	4/1/11	6/1/11	7/1/11	20/1/11/	16	L	RTA	Closed	transverse	L/3	A.2.1	C1	NIL		9mmX320mm	Static	Reamed	4	10	18	Nil	Nil	N	N	N	Nil	Normal	Consolidated	Nil	Nil	EXCELLENT
42	Prashant	57	M	13991	Farmer	6/1/11	5/1/11	8/1/11	24/1/11	21	L	RTA	Closed	oblique	L/3	A.2.1	C1	NIL		9mmX320mm	Static	Reamed	4	10	17	Nil	Nil	>75 %	>50%	<50%	Nil	Normal	Consolidated	Nil	Nil	GOOD