"ROTATIONAL ALIGNMENT IN TIBIAL DIAPHYSEAL FRACTURES WITH THE SUPRAPATELLAR SEMI –EXTENDED VERSUS STANDARD INFRAPATELLAR ENTRY TIBIAL NAILING TECHNIQUES – A RANDOMIZED CONTROLLED TRIAL"

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LIST OF ABBREVATIONS:

IM – Intra Medullary

IMIL – Intra Medullary Inter Locking

IMN – Intra Medullary Nailing

IP – Infra Patellar

SP – Supra Patellar

IPN – Infra Patellar Nailing

SPN – Supra Patellar Nailing

OPD – Out Patient Department

ICU – Intensive Care Unit

RCT – Randomized Controlled Trial

TFA – Thigh Foot Angle

AP – Antero Posterior

AKP – Anterior Knee Pain

LEFS – Lower Extremity Functional Scale

VAS – Visual Analog Scale

AKP – Anterior Knee Pain

CT – Computed Tomography

MRI – Magnetic Resonance Imaging

BC – Before Christ

ROM – Range Of Motion

GIRFT – Get It Right First Time

PF – Patello Femoral

TA – Tendo Achilles

EHL – Extensor Hallucis Longus

EDL – Extensor Digitorum Longus

LDTA – Lateral Distal Tibial Angle

MPTA – Medial Proximal Tibial Angle

AO/OTA - Arbeitsgemeinschaft für Osteosynthesefragen / Orthopedic Trauma Association

RTA – Road Traffic Accident

PTB – Patella Tendon Bearing

SD – Standard Deviation

MW – Mann Whitney U test

t – Two sample t test

WT – Welch's t test

MC – Chi square test with Monte Carlo

* - statistical significance

MDC – Minimal Detectable Change

% - Percentage

^{0} – Degrees

-/+ - Minus / Plus

</> - Less than / Greater than

cm – centimeter

mm – millimeter

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ABSTRACT:

INTRODUCTION: Fractures of tibia diaphysis are the most common fractures of long bone. As most of the surgeons noted and many studies showing that the reamed intramedullary interlocking nail fixation done for displaced and unstable fractures provided better functional results and lesser complications than compared with conservative management with cast immobilization, open reduction and internal fixation with plating, unreamed intramedullary nailing or use of external fixators. A potentially debilitating and serious but usually under-appreciated complication of intramedullary nailing for tibia fractures is rotational malalignment. As of now there is very less known about what is the true incidence of malrotation after IMIL nail fixation, what degree of rotation that is actually significant or what are the indications of correcting the malalignment.

The anatomical twist of tibial Proximal versus Distal articulate axis in transverse plane around longitudinal axis is known as tibial torsion. Following the closed intramedullary nailing of tibial shaft fractures, any alteration in the tibial torsion, whether internal or external, is referred to as a malrotation. To evaluate tibial malrotation, one compares the torsion of the affected and unaffected tibia. Concerns have recently been expressed over the high frequency of malrotation that has been documented after tibial intramedullary nailing.

The traditional infrapatellar intramedullary nailing technique is done by placing the knee in hyperflexion over a radiolucent bump and passing the nail through a longitudinal incision made over and parallel patellar tendon fibres. Segmental fractures and proximal one third tibial fractures frequently fall into valgus and procu rvatum due to deforming muscle stresses. The novel semi-extended suprapatellar tibial nailing technique will make it easier to access the beginning site location,

counter the deforming muscle forces, and also allows easier intraoperative imaging. The results of suprapatellar nailing are scarcely reported in the literature, despite the well-established results of typical infrapatellar nailing.

OBJECTIVE : to determine the incidence and degree of tibial rotational malalignment with the suprapatellar semi-extended versus standard infrapatellar entry tibial nailing techniques.

METHODS: A prospective interventional Randomized controlled study was conducted on 40 patients in the Department of Orthopaedics, Jawaharlal Nehru Medical College, KLEs Dr. Prabhakar Kore Hospital & Medical Research Centre, KAHER, Belagavi. The patients who came to casualty or outpatient department (OPD) with tibial diaphyseal fractures who will undergo reamed intramedullary nailing were randomly divided into two groups i.e., tibial shaft fractures treated with IMN utilising the infrapatellar technique(group A) and those treated with suprapatellar technique(group B) during a one-year period (20 in each group) with six months followup. The outcomes of IMN in tibial shaft fractures via IP and SP approach were compared in terms of rotational malalignment as primary outcome, fluoroscopy time, average intraoperative time time, anterior knee pain using Visual Analogue Scale (VAS) score and KUJALA score , average blood loss, fracture union time and functional outcome (in terms of the lower extremity functional score). Two sample t test/Welch’s t test are used to compare the mean of variables over both groups. Mann Whitney U test is used to compare the distribution of variables over groups. P-value less than or equal to 0.05 indicates statistical significance.

RESULTS: When comparing two groups of infrapatellar nailing (IPN) with mean age of 32.8 ± 13.63 years, with suprpapatellar nailing (SPN) mean age of 45.05 ± 18.07 years, the IPN group has a mean rotational difference of 6.7 ± 3.8 degrees, the SPN group shows a lower mean rotational difference of 4.3 ± 3.06 degrees which is significant when measured with clinical TFA and in IPN group, 15 (75%) had rotational difference < 10 degrees and 5 (25%) had rotational difference ≥10 degrees. In SPN group, 19 (95%) had rotational difference <10 degrees and 1 (5%) had rotational difference ≥10 degrees. In IPN group, 14 (70%) had rotational difference <10 degrees and 6 (30%) had rotational difference ≥10 degrees. The IPN group has a mean X-ray rotational difference of 6.5 ± 4.35 degrees, the SPN group shows a lower mean X-ray rotational difference of 4 ± 3.04 degrees which is significant. In SPN group, 19 (95%) had rotational difference <10 degrees and 1(5%) had rotational difference ≥10 degrees. The IPN group has a mean CT rotational difference of 8.21 ± 4.73 degrees, the SPN group shows a lower mean CT rotational difference of 4.87 ± 2.96 degrees which is significant. In IPN group, 13 (65%) had rotational difference < 10 degrees and 7 (35%) had rotational difference ≥10 degrees. In SPN group, 19 (95%) had rotational difference <10 degrees and 1(5%) had rotational difference ≥10 degrees. Secondary outcomes of this tudy also showed siginifacant data as IPN group has a mean intraoperative time of 102.45 ± 6.89 minutes and the SPN group has significantly shorter mean intraoperative time of 82.1 ± 7.49minutes. The IPN group has a mean blood loss of 65.3 ± 4.86 mL. In contrast, the SPN group has a significantly lower mean blood loss of 48.6 ± 8 mL.The IPN group has a mean fluoroscopy time of 119.75 ± 10.57, the SPN group exhibits a significantly lower mean fluoroscopy time of 90.5 ± 5.23. The IPN group has a mean Kujala score of 60.15 ± 5.68. Conversely, the SPN group demonstrates a significantly higher mean

Kujala score of 73 ± 4.76. In the IPN group, the mean VAS score is 4.65 ± 1.27, with a median of 4 (ranging from 3 to 7). On the other hand, the SPN group shows a lower mean VAS score of 3.7 ± 1.3 with a median of 3.5 (ranging from 2 to 6). In the IPN group, the mean LEFS score is 69.35 ± 2.46, with a median of 69 (ranging from 65 to 73). Conversely, the SPN group exhibits a significantly higher mean LEFS score of 74.65 ± 1.66 with a median of 75 (ranging from 72 to 77). In the IPN group, the mean time to union is 6.15 ± 1.23 months, with a median of 6 weeks (ranging from 4 to 8 months). In contrast, the SPN group shows a significantly shorter mean time to union of 5 ± 1.03 months with a median of 5 months(ranging from 4 to 7 months).

CONCLUSION : The study confirms previous research that demonstrates favourable outcomes with suprapatellar nailing in terms of less rotational malalignment when measured with clinical thigh foot angle, x-rays and computerized tomography. The results of this randomized controlled study show that the suprapatellar intramedullary nailing can significantly reduce intraoperative time, blood loss, fluoroscopy time which will improve overall surgical outcomes of the patient. Additionally supraptellar nailing is associated with lesser chronic anterior knee pain VAS score and higher KUJALA score than infrapatellar nailing which have an incremental effect on the activities of daily living of the patient.

Keywords:

Tibia, tibia diaphysis , Tibial shaft fractures , infrapatellar , suprapatellar , rotational malalignment, intramedullary nail , randomized controlled trail.

INTRODUCTION

Diaphyseal fractures of tibia are most common long bone fractures[1]. More than any other long-bone fracture, tibia fractures have proven to be a difficult surgical case. Whether it is closed or open, this fracture has a history of being difficult to heal. Until the discovery of antibiotics, an open tibial fracture would frequently result in the death of the patient from infection. It is estimated that in the Crimean War (1853 to 1856) the survival rate after tibial gunshot injuries was less than 20%. During World War I, the unstable lower limb tibial fractures , the bulk of which were open, have accounted for one in five combat casualties. During that period, tibial fractures had an amputation rate of more than 20% and a mortality rate of almost 10%[2].

Tibial fractures are bimodally distributed, with patients under 30 yrs old more likely to have comminuted and high energy transverse fractures and patients over 50 yrs old more likely to have low-energy spiral patterns. Tibial fractures are nearly 3 times more commonly seen in female than in male among patients aged 65 and above, with no discernible racial disparity[3]. However, males are roughly two times to females in suffering high-energy tibial fractures in younger patients[4].

Tibia shaft fractures are very common and have long been acknowledged as catastrophic and incapacitating injuries. Although most fractures are closed, open fractures are more commonly seen in tibia than in many other bones due to its subcutaneous location. A tibia fracture can cause severe mutilation, crushing injuries, or even a traumatic amputation. It can also result in undisplaced fractures with little to no soft tissue damage. The anterior side of the tibia is directly beneath skin and lacks muscular cover, which are some anatomical features that make managing tibial fractures more difficult and complicated. For this reason, even in closed fractures, the majority of tibia fractures are linked to damage to the skin and subcutaneous

structures. The tibia's subcutaneous shaft makes it vulnerable to severe comminution and open fractures, which can lead to nonunion and infection. Because of the closed osseofascial compartments of the leg, there is high risk of compartment syndrome in high energy tibia fractures. The tibia is more vulnerable to blood loss than other long bones that have circumferential muscle covering. Fractures near proximal 1/3rd of tibia enhance the risk of vascular damage due to its close proximity to popliteal artery.

When evaluating tibia fractures, a thorough physical and neurovascular examination should be combined with a proper history taking. The leg is examined for soft tissue crush, contusions, deformities, and open wounds. An absent or feeble pulse and any neurovascular defecit can be a indicator of vascular injury or 'compartment syndrome', which should be considered as emergency and is necessary to diagnose and treat as soon as possible. Stabilizing the vitals will be of primary goal and assess the patient from top to bottom to eliminate any associated head injuries, spinal injuries, blunt chest and abdominal injuries. The pelvis with both hips femur, foot, knee and ankle joints of affected side also should be examined after proper exposure of the patient. After the inspection, the affected limb is carefully straightened and splinted in place. Tetanus, analgesics, and antibiotic prophylaxes are given as needed. A plain radiograph of the knee and ankle including AP view , lateral view are acquired, as well as mortise view radiograph if needed. In certain fractures with comminution or bone loss, radiographs of unaffected tibia are required to assess the normal length of tibia. Computerized tomography can be done to know about the fracture in detail or in comminuted fractures. MRI is indicated when there is suspicion of ligamentous injuries. CT angiogram is done when in doubt of vascular compromise.

The Edwin Smith Papyrus is a 1500–1600 BC ancient Egyptian medical document that contains descriptions of how to treat tibial fractures[5]. The rates of non-union and mal-union in tibia fractures are comparatively higher than those in other parts of the body[6]. Getting a good healed, properly alligned fracture with ealy union, full weight bearing pain free walking, and full pain free ROM in the ankle and knee joints are the constant objectives of treatment. The best course of action should help achieve these objectives while reducing side effects, particularly infection prevention. When limbs are badly damaged, crushed, mangled, or in comminuted fractures, these objectives might not be reached. The range of indications for treating tibia shaft fractures both surgically and non-operatively is still being worked out. Even though it was once widely utilized, non-operative treatment is now typically saved for certain stable less-velocity fractures, nil or less displaced fractures brought on by less-energy trauma[7]. Operative management allows early motion, stable fixation, correction of deformity, and avoids complications associated with immobilization[7]. Patients with swollen or obese limbs may have difficulty maintaining alignment with casts or braces. Reduction may be impaired in patients who are noncompliant with conservative management, while delay in the union and non-union are common in patients who do not weight bear for longer periods. Currently, the preferred course of treatment for open fractures, fractures associated with vascular injury, compartment syndrome and close injury with significant soft tissue involvement is operative treatment. External fixation, intramedullary interlocking nail fixation and open reduction with plate and screw fixation are options for treating fractures for which closed therapy is not appropriate and many studies between intramedullary nailing and casting have shown that the former results in better functional scores and also higher union rates. Even though many studies demonstrate that intramedullary nailing

is better than casting, additional comparative research is required to validate these findings and create stricter treatment recommendations[8]. 'A recent international survey found that surgeons favour intramedullary nailing over other fixation techniques (Bhandari et al.). Current recommendations for the therapy of open tibial shaft fractures support operative care (Giannoudis et al, Okike and Bhattacharyya')[9,10]. But when it comes to the decision between 'reamed' and 'unreamed' IMIL nailing for fractures of tibia, orthopedic traumatologists' practice patterns still differ significantly (Bhandari et al.)[10] and while a recent systematic analysis (Forster et al.[11]) indicated greater non-union rates linked to unreamed nailing, it was based on only three studies with significant methodological flaws.

Currently, the most adopted treatment protocol for fractures of tibia diaphysis needing operational fixation is IMIL Nailing. In fractures around the metaphyseal-diaphyseal junction, plating is typically utilized. For severe open fractures and fractures with periarticular extension, external fixation is helpful. When limbs are severely damaged, amputation should be taken into consideration. Reamed intramedullary nail fixation is often used to treat displaced and unstable tibia shaft fractures because numerous studies have demonstrated that this method yields better functional outcomes and lesser complications in comparsion to nailing without reaming, external fixators, plate and screws or casting[12]. Rotational malalignment is a potentially dangerous but frequently overlooked consequence of this procedure. Torsional abnormalities can cause knee and ankle joints wear and many functional difficulties in addition to cosmetic problems[12].

Little is now understood regarding the degree of rotation that is relevant, what amount of mal-rotation is significant that occurs after IMIL nailing, or the indications for correction[12]. Malrotation after tibial intramedullary nailing is rarely documented in

the literature; in major investigations, the incidence ranges from 0% to 6%[13, 14]. The aim of intramedullary nailing is to promote bone union and get accepted tibia's length, alignment, and rotation. It also has benefit of requiring less surgical dissection, and also the implant acts as 'load-sharing mechanism', providing not only biomechanical fracture stabilization but also enables early patient mobilization[15]. In order to enhance patient outcomes, malrotation in particular has to be addressed because it significantly impairs both the patient's physical and mental health[15]. The objective of intramedullary nailing is to maintain the original bone length while achieving a quick union with appropriate axial and rotational alignment[16].

Following the treatment of fractures of tibia diaphysis with closed intramedullary nail, any alteration in the tibial torsion, whether it be external or internal, is referred to as malrotation[16]. Concerns have recently been expressed over the significant frequency of malrotation that has been documented after tibia IMIL nailing[17].

In addition to causing cosmetic abnormalities and changing the loading characteristics in nearby joints, axial or rotational malalignment and shortening can accelerate the onset of post traumatic arthritis. There is uncertainty regarding how much shortening and misalignment is significant. Malalignment of the distal tibia may not be tolerated as well as more proximal malalignment. shortening.

	Accepatible suggestions by literature :	Usually we aim to achieve:
Shortening	10 to 20 mm	< 15 mm
AP mal-alignment	$5 – 20^0$	$<10^0$
Valgus &Varus mal-alignment'	$4 - 10^0$	$<5^0$
Rotational mal-alignment'	$5 - 10^0$	$< 10^0$

Table 1: acceptable measurements and what we should we try to achieve

In most of the studies torsional variation of more than 10° (range 5–15°) is significant with respect to the unaffected limb was considered malrotation[12]. Due to the development of more precise methods for measuring tibia malrotation, the reported incidence in subsequent research has increased from 23%-36% from the extremely low prevalence seen in the first investigations, which ranged from 0% to 6%[17]. When tibial malrotation is measured clinically, it is stated to have a 0-6% incidence in many studies. However, when other measurement techniques, including computed tomography scanning, are used, the incidence is reported to be 22-36%. A study discovered that rotational mal-alignment occurs 30% of the time[16].

The standard surgical procedure for inserting an IMN for a tibial shaft fracture is the infrapatellar route. The quadriceps muscle pushes the proximal fragment into extension, causing angulation abnormalities and fragment displacement, making this method challenging to apply appropriately in proximal third tibial shaft fractures[18]. 'Proximal 1/3rd and segmental fractures of tibia frequently go into valgus and 'procurvatum' due to the deforming muscle forces'[18]. Furthermore, one of the most common side effects following IMN implantation is persistent postoperative knee discomfort, with reported incidences ranging from 10 to 80%[19,20]. The severity of tibia fractures can vary, resulting in serious injuries and traumatic amputations, as well as undisplaced fractures with little soft tissue injury. The therapy of tibial fractures is more difficult due to certain anatomical factors. First presented in 2000, the semiextended method for tibial IMN insertion was later changed into the suprapatellar approach[21]. It avoids the patellar tendon, aids in fracture reduction, and has easier access to the proximal tibia entrance point. Furthermore, the lower limb's extended posture makes fluoroscopic imaging simpler[18]. According to Zhan et al., suprapatellar technique may be useful in preventing degenerative knee joint disease and lowering

the occurrence of postoperative knee pain[22]. Nevertheless, a few investigations suggested that an intraarticular damage could be a possible side effect of this method. The results of suprapatellar nailing are scarcely reported in the literature, despite the well-established results of typical infrapatellar nailing.

In this study we will determine the rotational alignment in tibia diaphyseal fractures with the suprapatrellar semi-extended versus standard infrapatellar entry tibia nailing techniques.

AIMS AND OBJECTIVES OF THE STUDY:

Assessing the degree and incidence of tibial rotational malalignment with novel suprapatellar semi-extended entry nailing approach compared to traditional infrapatellar entry nailing technique in tibial diaphyseal fractures.

REVIEW OF LITERATURE

When it comes to managing closed tibial fractures, 80 percent of orthopaedic trauma surgeons chose operative protocol. Locked IMIL nail is now the preferred management option for tibia shaft fractures, including type 1, 2, 3A closed, open fractures. Busse et al polled orthopaedic surgeons in trauma regarding treatment of fractures of tibia[23]. They found that 80% surgeons preferred operative management for closed tibial fractures. Moreover, the ability to proximal and distal locking of IMIL nail provides stability . In anatomical deformities, or wounds on nail entrance site and open physes nailing is not advised[23].

Almost fifty years after Küntscher invented cloverleaf and V-shaped nails in the 1930s, rigid IMIL nailing became a commonly used and acceptable management protocol. Old studies tell that ninety seven percentage of open and ninety eight percentage of closed fractures managed using Küntscher straight unreamed nails had good outcomes[24]. The modification of this nail to allow easy entry into medulla by giving a bend to nail is done by HERZOG. To boost the strength and rotational control of the nail while simultaneously improving its fit inside the tibia, some authors suggested reaming the medullary canal. Nails with interlocking screws were created by Kempf, Klemm, Grosse, and Schellmann in the 1970s, and this led to an expansion of using IMIL nail to encompass much lower, proximal, and more un-stable fractures[25]. When a nail's diameter is increased, biomechanical results indicate that fracture site mobility is much improved. By allowing the use of bigger diameter nails and reaming improves stability by enhancing endosteal contact between the nail and bone and also resisting fatigue failure[26]. Writers also cautioned against employing reamed interlocking nails in dynamic or basic mode, stating the bulk of difficulties in their series happening with dynamic locked nails, despite the excellent outcomes of

these nails, especially in closed fractures. For unstable and displaced tibia diaphyseal fractures, IMIL nail fixation is still the preferred course of treatment. By creating a bone union, intramedullary nailing attempts to repair the broken tibia's length, maintaining the acceptable rotation and alignment, and. It also has the benefit of providing biomechanical fracture stabilization, locking, rotatory stability, and early patient mobilization.

There are often complications associated with surgeries, and IMN for tibial shaft fractures is no exception. When IMIL nailing is used for tibial fractures, there have been high documented occurrences of malrotation, malunion, and nonunion. A potentially dangerous yet frequently overlooked side effect of intramedullary nailing of tibia is rotational malalignment. Torsional abnormalities can cause lower limb arthrosis and many functional abnormalities in addition to cosmetic issues. The true occurence of malrotation after IMIL nail fixation of tibia, the amount that is relevant, and need for correction are currently poorly understood. Malrotation that occurs after tibia IMIL nailing is rarely documented in the literature, with many studies reporting an incidence ranging from 0 to 6 percentage[27]. Tibial malrotation manifests in subtle ways that may even go unnoticed until the patient identifies some issue, likely more common in lower degrees of malrotation. The patient may be able to identify tibial malrotation on their own, particularly if the foot has an aberrant cosmetic look.

Because of the significant size difference in the tibial proximal third between the wide tibial metaphysis and the tibial nail, malalignment occurs more likely in proximal-third fractures than in other tibial shaft fractures treated with IMIL nails[28]. The most frequent abnormalities observed are anterior displacement or apex anterior angulation and valgus angulation proximal fragment. An entry portal that begins too

far medially and oriented laterally may result in valgus deformity. This kind of portal direction can result from a medial parapatellar incision due to patella impingement[28].

Nail direction that is very posteriorly oriented or a portal which originates very distally over the tibia can both result in anterior displacement of the proximal fragment or apex anterior angulation. Nail wedging against the cortex may result in displacement of proximal fracture fragment anteriorly if the nail's proximal bend is at or slightly beneath the point of the fracture. If nail is locked proximally with flexed knee , the proximal fragment may fall into extension as a result of the patellar tendon being pulled. The occurrence of this problem has been significantly decreased by technique modifications, such as more accurate entry portal placement and the use of additional fixation in the form of unicortical plates, polar screws blocking screws and two-pin external fixators[28].

The literature tells that, although being a frequently performed procedure, intramedullary nailing of the tibia lacks a standard technique; it is possible to speculate that this lack of standardization is a factor in the reported problems. In order to improve patient outcomes, it is crucial to address complications such as malrotation, which in particular has a significant negative influence on the patient's physical and psychological health. IMIL nailing being carried out as a closed surgical procedure with accurate reduction done under radiographic imaging and clinical assessment; yet, in practice, malrotation has been reported to occur nearly thirty percent of the time[12,29,30]. Tscherne-led Hanover group has reported that, among 21 patients receiving unreamed IMIL nailng for closed, high-energy fractures of tibia with comminution, the incidence of malrotation when measured clinically was around 15 percentage[16]. This study's findings also points a specific pattern of injury that

might be vulnerable to malrotation. There seems to be a correlation between significant rotational malreduction and high energy fracturse, more prereduction displacement, and distal 1/3rd tibia fractures. According to this study, more than 20% of patients, or one-quarter of the total, had a incidence of rotational malalignment of more than 10° when measured radiologically .

According to a literaturde review on incidence of tibial malrotation following IMIL nailing by Andre Coelho Fernandes, Jennifer Oluku, Karanjeet Sagoo, and Kamalpreet S. Cheema, while intramedullary nailing is the preferred fixation technique, it's critical to recognize the significant risk of malrotation and the detrimental effects it can have on a patient's quality of life[31]. This systematic review identified gaps in the literature and in the way these patients are managed and recommended that, in order to improve outcomes, a systematic approach utilizing GIRFT i.e, "Get It Right First Time," validated intraoperative assessment tools, and postoperative imaging should be used.

The considerable degree of variability in tibial torsion contributes to the technical complexity and difficulty in evaluating rotational alignment after surgery. According to a study by “Nikhil Ponugoti, Branavan Rudran, Amr Selim, Sam Nahas, and Henry Magill”, although malalignment is one of the known side effects of tibia intramedullary nailing, itis made more difficult to accurately recognize tibial torsion due to absence of a standardized and trustworthy method for clinical or radiological examination[33]. Hutter and Scott first proposed in vivo assessment using standard radiography in adult patients in 1949, and other people later updated the idea. But majority of these techniques have been found to be unreliable and non-

reproducible[34].The use of conventional fluoroscopy for intraoperative assessment has been well-documented by Clementz and Magnusson[35]. They have demonstrated that this approach can be precise and reproducible, at least in their own research. In 1980, Jakob et al. conducted research on the assessment of tibial torsion using CT and concluded that "The accuracy of the data was comparable to that of cadaveric skeleton measurement when they were compared to other measuring techniques".

Malrotation can be measured both clinically, radiographic intraopertively and postoperatively. In terms of radiographic results, anteroposterior and lateral tibia radiographs taken after surgical fixation were used to measure the anatomic alignment. For both upper amd lower 1/3rd tibia fractures, infrapatellar nailing is a technically challenging treatment that has historically presented challenges in minimizing deforming stresses and preserving proper fracture reduction in the sagittal plane. In the hyperflexion posture, proximal tibial fractures frequently result in malreduction and an apex-anterior deformity in the sagittal plane[36]. Freedman et al. studies showed "almost 58% of proximal one third fractures were malaligned (defined as 5° angular deformity in any plane) compared to only 7% of midshaft fractures during last follow-up"[37].

If there is a doubt of malalignment during or after surgery, computerized tomography is the recommended imaging technique since it is effective, dependable, and independent of observer bias. A study on rotational malalignment after reamed IMIL nail fixation in tibia fracture done by S. Puloski, MD, C. Romano, FRCSC, R. Buckley, FRCSC, and J. Powell, FRCSC explained that "torsional mal-alignment be considered as a likely cause for less than optimal result after treatment of tibial fractures by closed IM nailing and to investigate this further by performing CT

scans"[12].The incidence of tibial malrotation post intramedullary nailing in tibia fractures is reported to be as high as 22–36% with other measurement options such as CT scanning[12,38]. "A 24% rate of malalignment in fractures of distal tibia treated with infrapatellar nail insertion" was reported by Vallier et al[39].

Because of the various corrections made during imaging, the traditional technique of infrapatellar tibial nailing(IPN) remains technically hard although it is the standard care of management[40]. This method necessitates a flexed knee to insert the nail which is more challenging to use in upper 1/3rd fractures because of the action of quadriceps muscle which pushes the proximal fragment into extension and thereby causing fragment displacement along with abnormalities in rotation and angulation[18].

A unique approach was developed with 20-30 degree flexed knee to alleviate drawback of infrapatellar nailing. This is introduced for first time in 2000 which was later modified to suprapatellar nailing technique[21]. To prevent the proximal fragment falling into extension deformity, Tornetta et al devised a method of tibia nailing in a semiextended position of knee with medial parapatellar arthrotomy[41]. This method eliminates the issues of hyperflexion leading to fragment malalignment, reduces fracture easily, and makes radiographic imaging lesser and easier. Later on, this technique was modified by newly developed instruments that enable a more percutaneous application of this procedure simplifying the proximal tibia entrance site, aiding in fracture reduction, and preventing dissection of patellar tendon.

Since suprapatellar nailing provides a more precise entry point and reduction of fracture, it is a frequently utilized surgical technique now a days[18, 40]. "This

technique produced excellent tibial alignment, early union, and painless and better knee range of motion" as demonstrated by Sanders et al. He recently published the results of a series of 55 patients who had suprapatellar semiextended tibial nailing technique. His study had follow up until 12 months after surgery with radiographic, clinical, MRI and even arthroscopy. One important finding that the authors of this study found was after a year of follow-up, in comparison to infrapatellar nailing, there are no appreciable differences in pain, disability, or knee range of motion with suprapatellar technique[42]. Furthermore, easier fluoroscopic imaging is made possible by the semi-extended position of leg and also the need of using reduction tools like blocking or polar screw have been reduced[18]. In view of malrotation in tibial shaft fractures, "Courtney et al. reported that the post-operative sagittal plane malalignment is lower in the SP group (2.90°) than in the IP group (4.58°)" [43]. "Less severe malalignment with the SP group has been proposed in distal tibia fractures by Avilucea et al. and Lu et al"[44]. According to Kulkarni et al, SP group showed less postoperative malalignment in extra-articular proximal tibia fractures compared to IP group[45]. All being stated the main reason behind this is in infrapatellar nailing technique, hyperflexion of the knee might make it difficult to maintain alignment and prevent the best entry point, particularly in cases of proximal and distal tibia fractures[46, 47].

Intraoperative fluoroscopy was also challenging in the conventional infrapatellar technique for tibia IMIL nailing as it involves holding the hyperflexed knee due to the fluoroscopy machine's many adjustments[48]. Moreover, when the tibia is longer than 40 cm, the proximal section fluoroscopy image may be difficult to obtain[48]. But in suprapatellar approach, knee positioning in the semi-extended

position facilitates improved access for intraoperative fluoroscopy. Consequently, throughout the surgical process, we can get images in all views with minimal adjustments in fluoroscopy machine[49].

Recently, Ponugoti, N. et al. conducted in a meta-analysis that, "when it comes to knee pain and functional outcomes, suprapatellar approach for IMIL nailing of the tibia did not outperform the intra-patellar technique"[33]. But, a recent RCT done by Q. Sun et al. demonstrated that the suprapatellar approach was superior in view of functional knee outcomes[50]. "According to Leliveld and Verhofstad, 38% of patients who had infrapatellar incisions experienced chronic knee pain as a consequence and there was a substantial and persistent prevalence of iatrogenic injury to the infrapatellar nerve following infrapatellar intramedullary nailing of tibia"[34]. An injury to this nerve seemed to be linked to knee pain following surgery[34]. Where as in suprapatellar technique, the patellar tendon and infrapatellar nerve were not at risk theoretically because the incision will be proximal to patella followed by passing the nail in the trochlear groove.

According to Zhan et al., the suprapatellar technique also useful in prevention of degeneration of knee joint and lowering the occurrence of postoperative knee pain[38]. "Furthermore, with a reported incidence ranging from 10% to 86%, postoperative anterior knee pain is a significant common complication, although not frequent consequence following infrapatellar IMN insertion"[19, 20, 50]. The following explanations have been put forth: Anterior Knee Pain (AKP) may result from intraarticular damage, infra-patellar nerve damage, nail protruding during or after surgery, or the nail insertion point. It may also result from the longitudinal division of

the patellar tendon fibres during the transtendinous technique in infrapatellar nailing[51, 52, 53]. The suprapatellar technique, on the other hand, potentially avoids these possible sources of anterior knee pain because the incision is made proximal to the patella. As it is thought that knee function and the intensity of knee pain are inter-related, suprapatellar technique may promote improved knee function recovery[54].

One main issue with the suprapatellar technique is the intra-articular cartilage injury to the Patello-Femoral joint during insertion of nail trans-articular manner[56, 57]. The incidence, degrees of severity of articular damage with suprapatellar technique is still under investigation. One study done by Jones M, Parry M, Whitehouse M indicated a "22% risk of trochlear articular injury with suprapatellar nailing; however, these patients were early in the series, and the results were attributed to technical errors"[40]. Through cadaveric research, Gaines et al. found that the suprapatellar approach resulted in a less overall incidence of articular structural injury compared to the infrapatellar method[58]. However, "patellofemoral contact pressures were discovered to be higher in the suprapatellar portal in contrast to conventional methods in another recent cadaveric study done by Zamora R, Wright C, Short A, Seligson D"[59]. They found that the pressure applied was less than what was required to cause cartilage degradation. Gelbke et al. studied that although suprapatellar IMIL nailing raises patella-femoral contact pressures, these pressures are still less than those associated with the degeneration of articular cartilage[60]. Chan et al studies showed that "five patients in his suprapatellar group had evidence of chondromalacia patellae at 1year on MRI. But, the findings didn't correlate with either the post-nail or pre-nail insertion arthroscopy, and not even 1 patient in the Suprapatellar nailing group with post-nail insertion arthroscopic changes had Patello-Femoral(PF) joint pain at one

year"[61]. Thus, when transarticular nail insertion was done, patella femoral joint injury could be carefully avoided intraoperatively. For additional research regarding the PF joint pain incidence and severity, more RCT studies with big sample sizes and extended follow-up are required.

Guide wire, Reamers, Instruments, and the nail must travel through the joint during suprapatellar nailing[63]. Hence, the danger of postoperative sepsis in the knee is speculative, particularly in cases of open fractures. Some studies by Mitchell told that treating open tibia fractures with suprapatellar approach showed a low rate of knee sepsis[62]. Marecek et al. conducted a multicenter comparison of SPN versus IPN techiques in the management of open fractures and discovered no discernible variation in both groups' risk of knee infection.

It was crucial to reduce intraoperative blood loss because doing so could speed up recovery and mobilization. There aren't many RCTs that detailed or compared the total blood loss from different surgical options of fractures of tibia shaft. The meta analysis study done by Yang L, Li G, and Sun Y comparing SPN versus IPN for fractures of tibia shaft found that the suprapatellar technique significantly reduced total blood loss[55].

Overall , opinions on whether the suprapatellar technique is better than the infrapatrellar technique are inconsistent. Taking all studies into consideration, we want to study about the rotational malalignment as the most significant complication of the tibia IMIL nailing due to not only its potential to accelerate the degeneration of knee and ankle joint but also many functional and cosmetic abnormalities that could

have detrimental long-term effects on quality of life. The literature that is currently available suggests that supra-patellar nailing is superior to infra-patellar nailing; nevertheless, drawing conclusions is difficult due to substantial limitations in the data. This RCT experiment was carried out to ascertain incidence and degree of rotational malalignment as primary result using suprapatellar compared to infrapatellar insertion of intramedullary nail in tibial diaphyseal fractures in order to provide stronger clinical recommendations.

ANATOMY OF TIBIA SHAFT:

The bigger and medial bone of the leg is called the tibia, or shin bone in Latin. It is comparable to the upper limb's radius. There are two large, flat condyles on its upper end and a prismoid shaped shaft between both ends.

How are sides determined?

1. The lower end's medial side extends below the remainder of the bone. The term "medial malleolus" refers to the projection,
2. The top end is significantly bigger than the bottom end.
3. The shaft's most noticeable and crest-like border is located at the front.

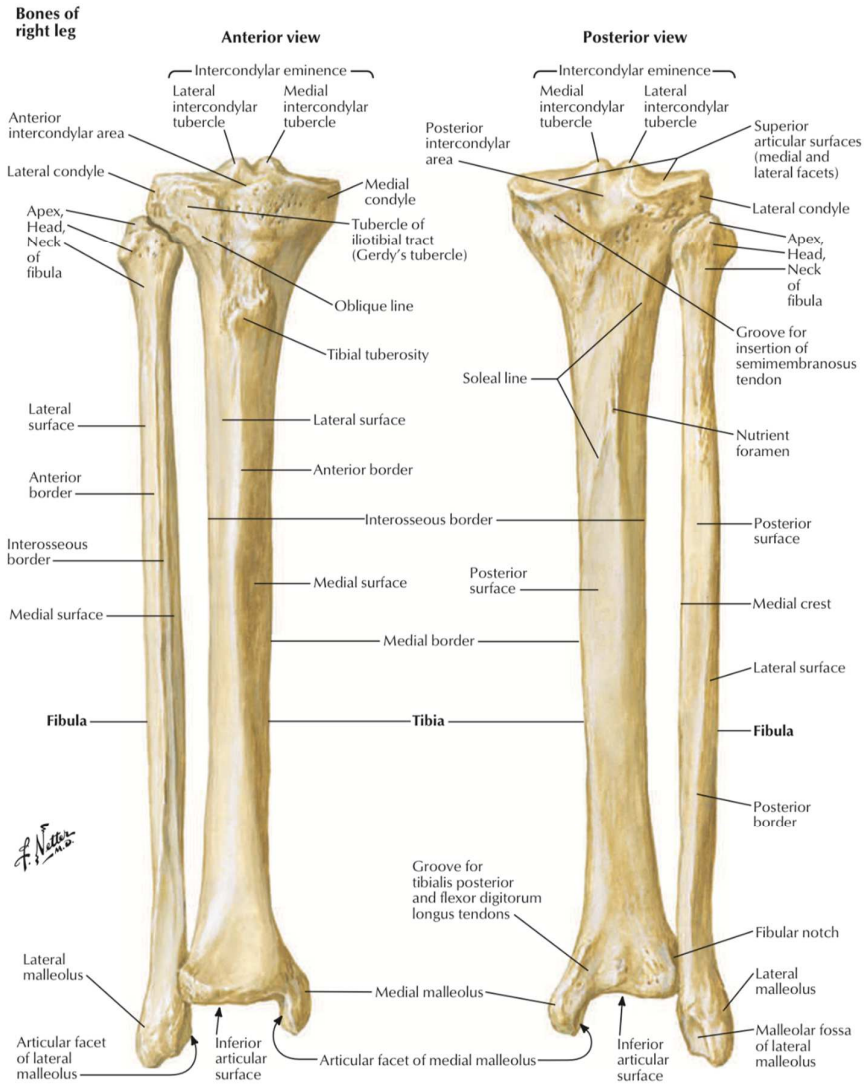


Figure 1 – showing parts of tibia and fibula bones.

The anterior and interosseous borders are separated by the lateral surface. It is concave and oriented laterally in its top three-fourths and forwards in its lower one-fourth.

Between the anterior and medial boundaries is the medial surface.

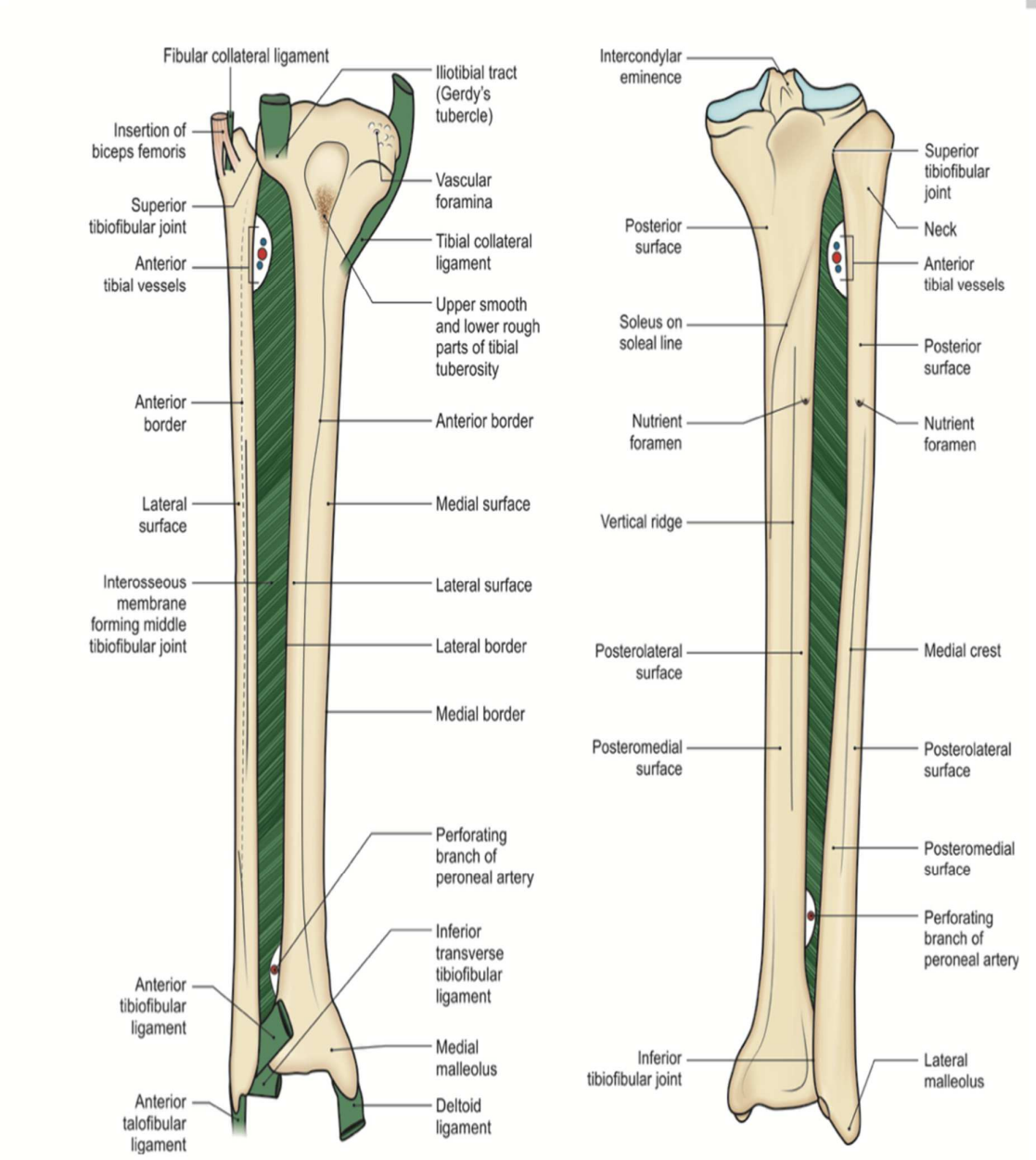


Figure 2:showing various borders and surfaces of tibia and fibiula

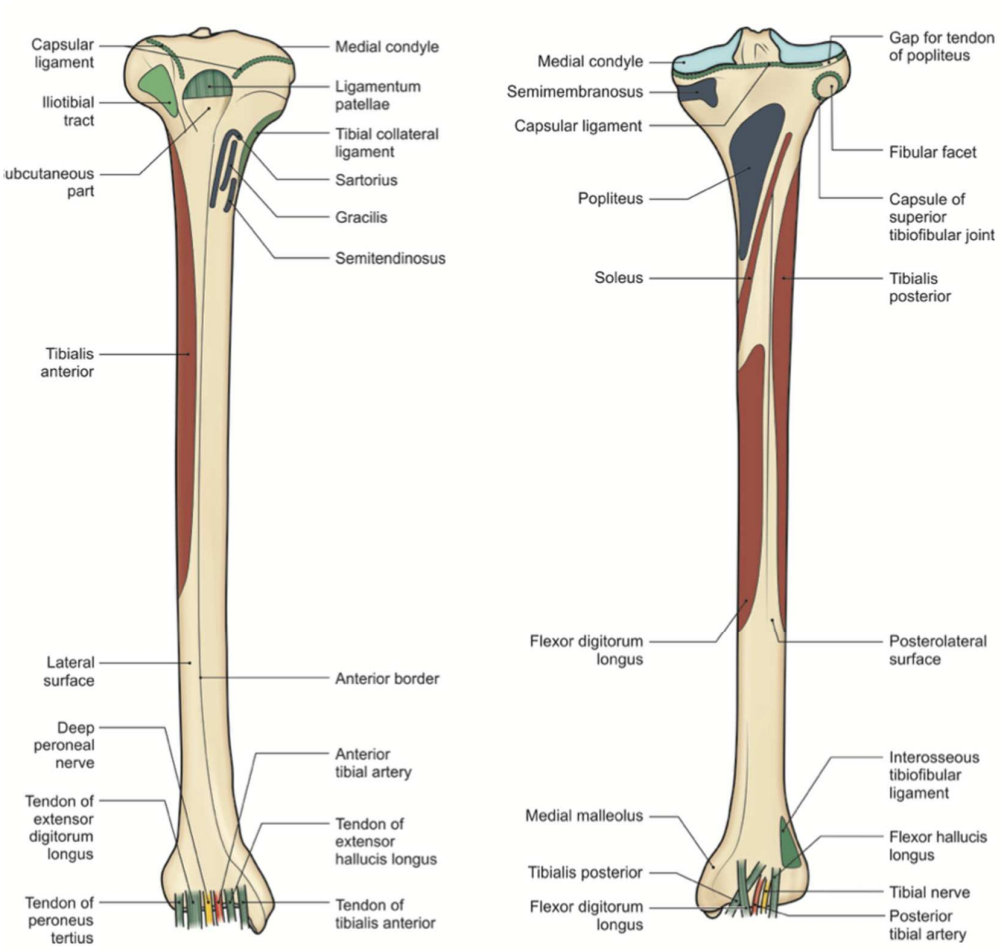


Figure 3 : showing varoius attachements over shaft of tibia

Attachments on the Shaft:

1. The soleus originates from the soleal line. The superficial transverse fascial septum, the fascia covering the popliteus, and the fascia that ovelies soleus is connected to soleal line.

2. The insertions of the sartorius, gracilis, and semitendinosus are received by the top portion of the medial surface, going rearward from before. The tibial collateral ligament attaches to this surface even more posteriorly along the medial boundary.

3. The upper 2/3rd of the lateral surface give birth to the tibialis anterior.
4. The interoosseous tibiofibular ligament is attached to the rough upper portion of the fibular notch.

5. The flexor digitorum longus originates in the medial area of the posterior surface beneath the soleal line, whereas the tibialis posterior originates in the lateral area.

6. The popliteus is positioned on the posterior surface in the triangle area over the soleal line.

7. The lower end of articular surface is where the ankle joint's capsular ligament is joined. The deltoid ligament is attached to the bottom border of the medial malleolus.

8. Situated along the anterior edge of tibia are the leg's deep fascia and the superior extensor retinaculum.

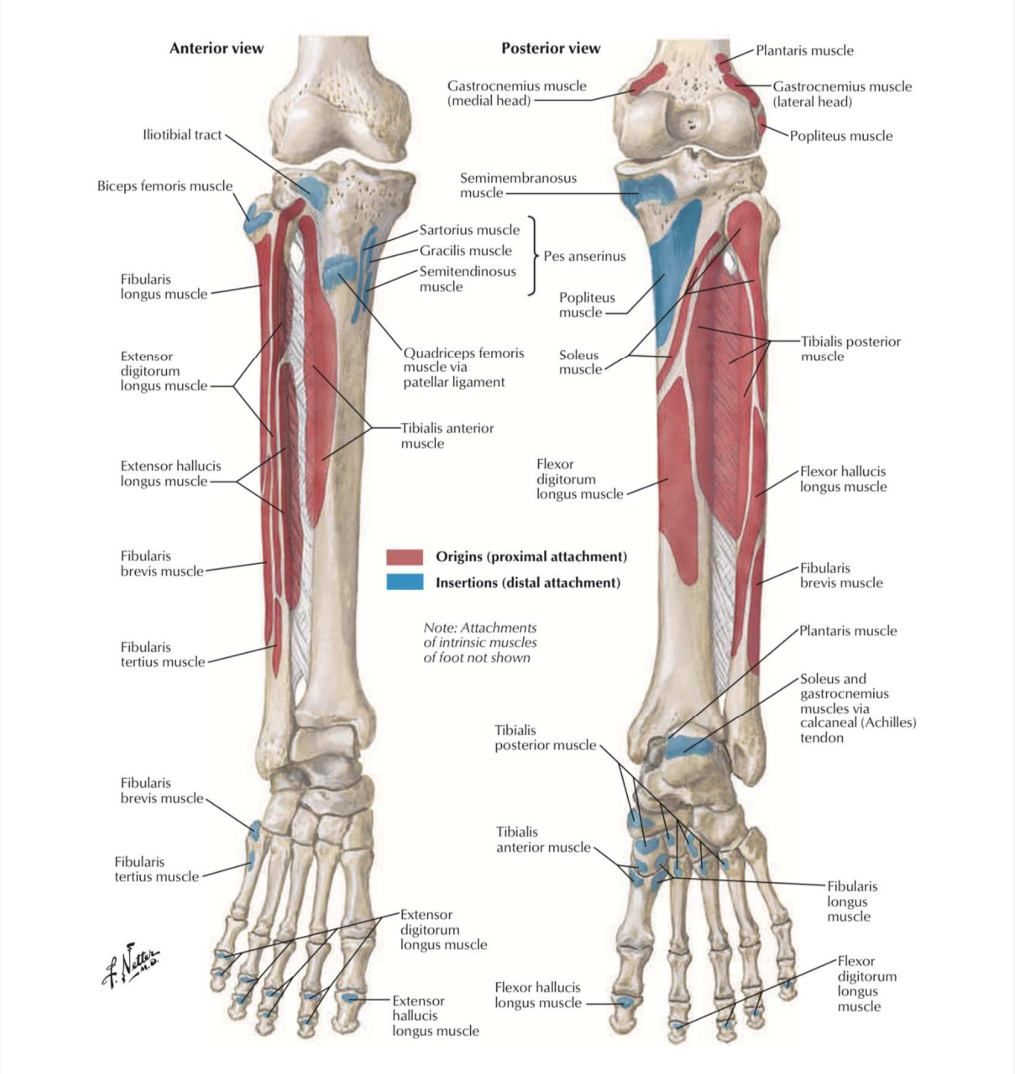


Figure 4: showing muscular origins and insertions on shaft of tibia.

Relations :

1. The Tibialis Anterior (TA), Extensor Hallucis Longus(EHL), the deep peroneal nerve, the anterior tibial artery, the peroneus tertius and the extensor digitorum longus cross the anterior surface of the shaft at its lower part and the lower end`s anterior aspect from medial to lateral side.

2. From medial to lateral side, the Flexor Digitourm Longus(FDL), the tibial nerve, the posterior tibial artery, and the Flexor Hallucis Longus are related to the posterior

surface of the shaft at its lower part and the lower end`s posterior aspect. The tibialis posterior is situated in a groove. On the posterior surface of the medial malleolus, the groove for the tendon of the tibialis posterior extends downward.

3. The great saphenous vein crosses the lowest part of the shaft's medial surface.

Tibia Blood Supply:

The largest nutritional artery in the body supplies Tibia. The proximal end of the vertical ridge on the posterior surface of the bone is where the branch of the posterior tibial artery enters the bone, and it is directed distally from there.

Osteology of tibia:

The tibial diaphysis is incredibly strong and has cross section of triangular shape with thick cortices. More than 80% of the weight in the leg is supported by the tibia, which is the primary weight-bearing bone[64, 65]. Age-related decrease in cortical thickness make the tibia more vulnerable to lower energy damage mechanisms. The distal and proximal metaphyseal bones are comparatively weaker than the tibial diaphysis. Throughout the leg, the fibula is positioned posterior and lateral to tibia, and a thick interosseous membrane connects the two bones. The distal tibial articular surface has an external rotation of approximately 20^0 (mean 21.6 ± 7.6; range 4.8 to 39.5^0) with respect to the proximal articular surface. This phenomenon of tibial torsion is part of normal anatomy[66, 67]. As a result, a standard anteroposterior image of ankle and a standard anteroposterior view of the knee cannot usually be acquired on the same radiograph. The lower extremity's mechanical axis passes just medial to the knee's center, starting at the center of the femur head and ending at the center of the distal tibia at the ankle.

The tibial articular surfaces' proximal and distal surfaces are not quite parallel normally. Generally, the articular surface of distal tibia lies at 90 degrees to the mechanical axis of tibia (LDTA- lateral distal tibial angle = 90^0), while the articular surface of proximal tibia is somewhat slanted medially (MPTA-medial proximal tibial angle= 87^0). These values aid in the assessment and correction of malrotation in tibial fractures as well as in the planning of the correction of multiplanar congenital or post-traumatic abnormalities.

CLASSIFICATIONS OF TIBIA DIAPHYSEAL FRACTURES:

AO/OTA classification which separates fractures into three basic types, these being simple fractures (type A), wedge fractures (type B), and complex fractures (type C). Each fracture type is divided into three groups which denote increasing severity of injury.

As mentioned before, the state of the soft tissues has the most influence on how tibia diaphyseal fractures are treated. As a result, without also classifying the related soft tissue injury, the classification of tibial fractures in clinical practice is meaningless. Closed fractures are categorized using the Tscherne classification, while open fractures are categorized using the Gustilo classification. The primary purpose of these classification is to characterize the soft tissue damage connected to closed and open fractures, respectively.

Type 1	Wound < 1 cm , minimal soft tissue damage and contamination
Type 2	Wound > 1 cm but < 10 cm without extensive soft tissue damage , flap , or avulsion
Type 3a	Opeb segmental fracture , wound > 10 cm with extensive soft tissue damage but adequate soft tissue coverage of perisoteum
Type 3b	Wound > 10 cm with extensive soft tissue damage , significant contamination, inadequare soft tissue to cover periosteum
Type 3 c	Any open fracture with accompanying vascular injury requiring repair

Table 2 : data from Anderson JT, Gustilo RB. Infection prevention in the management of 1,255 open long bone fractures: retrospective and prospective analysis. 1976; 58:453–8; J Bone Joint Surg Am.

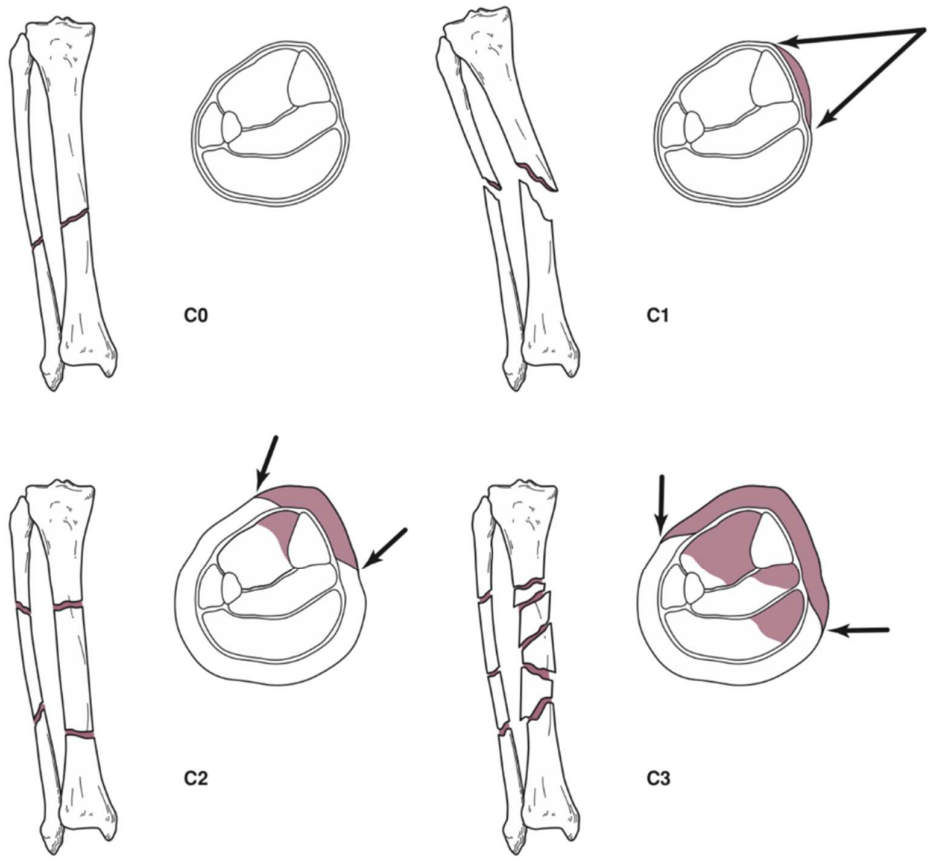


Figure 5 : The closed fractures classification by Tscherne:

C0 - a simple fracture pattern with minimal or nil soft tissue damage;

C1 - fracture pattern of mild to moderately severe or superficial abrasion;

C2 - fracture pattern of moderately severe with substantial skin or muscle contusion combined with deep contamination;

C3 - fracture pattern of severe or in combination with extensive skin contusion or crushing.

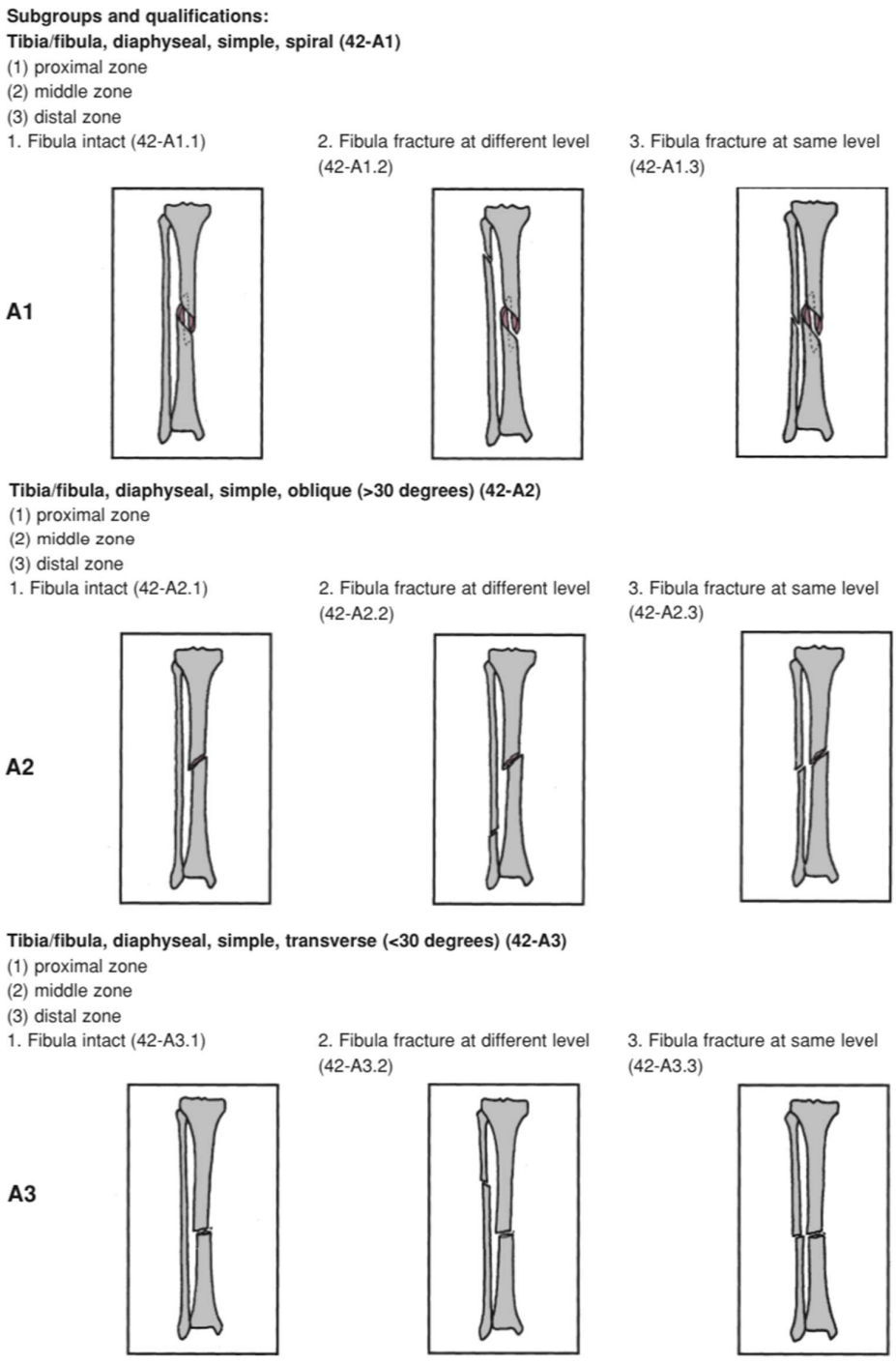


figure 6 : AO/OTA classification for diaphyseal , simple fractures of tibia (42-A).

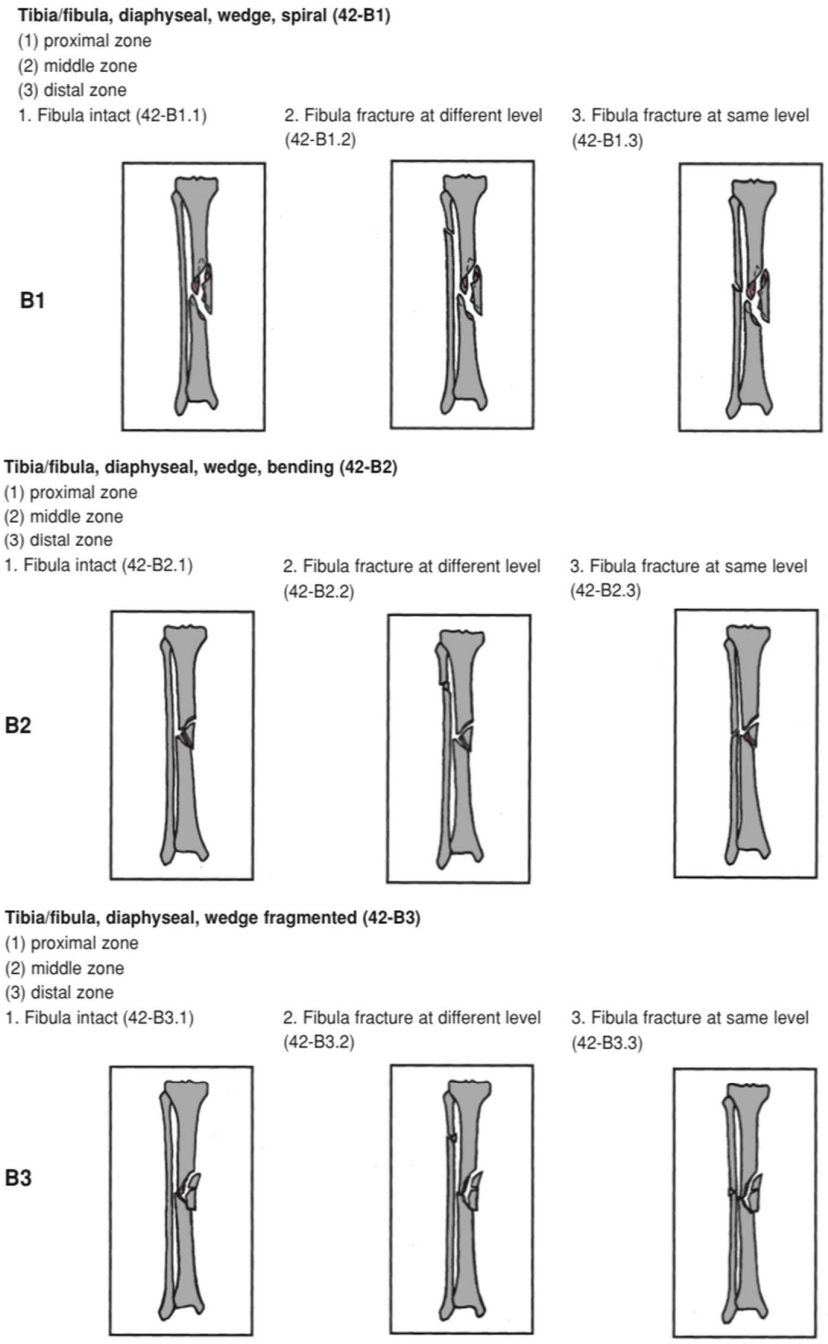


Figure 7 : AO/OTA classification for diaphyseal , wedge fractures of tibia (42-B).

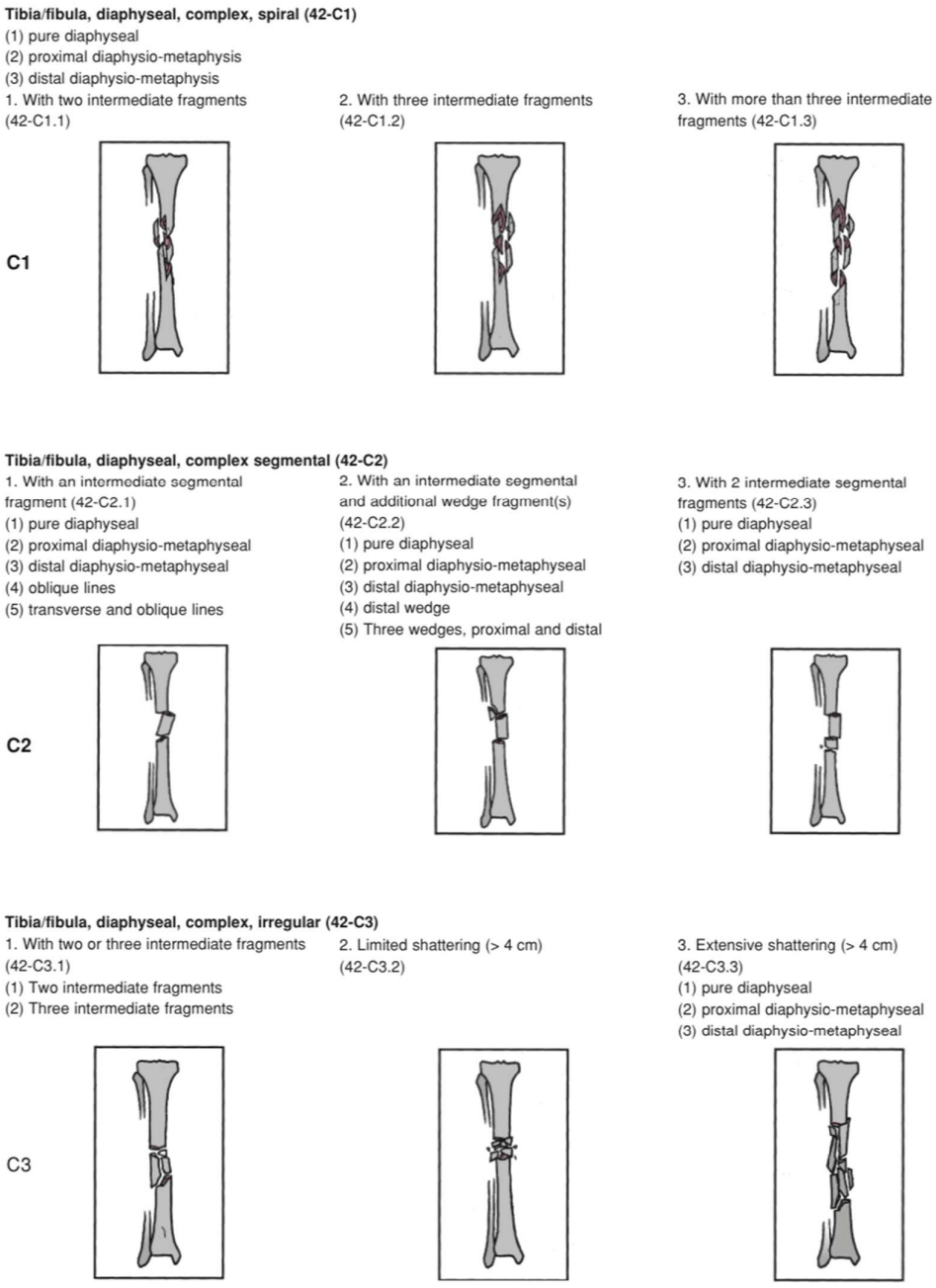


Figure 8 : AO/OTA classification for diaphyseal , complex fractures of tibia (42-C).

MECHANISM OF INJURY:

Tibial fractures are bimodally distributed, with low-energy spiral patterns being common in patients >50 years of age and high-energy transverse and comminuted fractures more common in patients <30 years. Among patients aged ≥65 years tibial fractures are almost three times more prevalent in women than in males[68]. In younger patients, males are roughly twice as likely as females to have high-energy fractures of tibia[69].Low-energy tibial fractures are most frequently caused by sports injuries and falls from a standing height. The corresponding sports events differ according on the population. For instance, according to a British research, up to 80% of sports-related fractures are caused by injuries sustained in soccer[70].

The most frequent cause of high-energy diaphyseal fractures of tibia is road traffic accidents (RTA). According to Court-Brown and McBirnie's research, between 1988 and 1995, road traffic accidents accounted for 37.5 percentage of tibial diaphyseal fractures mostly affecting pedestrians (59.2 percentage of cases), followed by motor vehicle crashes (17.3 percentage) and motorcycle crashes (22.4 percentage). in a research on injuries sustained by pedestrians. According to Burgess et al, 65 percentage of patients had open fractures of Gustilo type III[72,73] and 30 percentage of tibial fractures were bilateral in pedestrians[71]. Other high-energy tibial fracture causes include falls from a height (6.2 percentage) and asualts (4.5 percentage), which usually include a direct blow or a gunshot wound.

Treatment and outcome planning for tibial diaphysis fractures are essentially determined by the extent of the concomitant soft tissue injury, possibly more so than for any other bone. Tibia open fractures are more common with reported rates ranging from 12 – 47 percentage due to its subcutaneous nature, depending on the type of treatment center and patient population[74, 75]. With high-energy mechanisms, open

fractures are considerably more common—up to 63 percentage of cases have been observed in motorbike crashes[70]. Compared to other injury sites, tibia open fractures are more frequently type IIIB fractures that need flap coverage[70].

ASSOCIATED INJURIES:

Compartment Syndrome:

The development of compartment syndrome is more likely in cases with tibial diaphyseal fractures. 1.5% to 11% of tibial fractures have been observed to result in compartment syndrome[76]. Every patient with a tibial fracture should be evaluated for the likelihood of compartment syndrome because a missed diagnosis might have catastrophic effects on limb function or possibly result in renal failure due to rhabdomyolysis.

Ankle Injuries :

Ankle injuries occur in association with approximately one fifth of tibial diaphyseal fractures and can include lateral ligamentous complex disruptions as well as fractures of medial, lateral and even posterior malleoli[77]. Specific surgical treatment of the associated ankle injury is not necessarily recommended in all cases. CT evaluation of the ankle can be helpful to identify undisplaced medial or posterior malleolar fractures prior to surgery to assess the need for clamping or fixation to prevent displacement of these fractures during intramedullary (IM) nailing. Posterior malleolar fractures are reported in association with 8% to 9% of tibial diaphyseal fractures, and there is a high correlation with spiral fractures of tibial distal third (25% to 39%)[78] . The detection rate of these injuries is significantly increased when a protocol is in place for preoperative CT scanning of distal tibial fractures[79].

Floating Knee Injuries:

Floating knee injuries are femur and tibial fractures that occur in ipsilateral limb. Fractures of the femur and tibial diaphyses are classified as type I injuries; type IIA fractures affect the knee joint; and type IIB injuries affect the hip and/or ankle. Usually, these coupled patterns of injury are caused by high-energy mechanisms. Reported rates of associated vascular injury (21%) and open fracture (62%) are higher than expected based on the rates for the two isolated injuries combined[80]. Although the results that have been documented in the past have been relatively poor, internal fixation can produce good to exceptional results when treating both fractures. Severe open tibial fracture or intra-articular involvement of the knee (type IIA) are risk factors for a bad result[81].

Fracture Extension into Tibial Plateau:

Occult proximal extension of tibial diaphyseal fractures into the tibial plateau is rarer than the extension into the tibial plafond or malleoli described above, but is equally important. Preoperative CT scanning of the knee in all proximal one-third tibia fractures is recommended to rule out an associated plateau injury. It is important to recognize intra-articular knee involvement preoperatively as it may influence the choice of implant. A central undisplaced plateau fracture can become widely displaced during IM nail placement and should be stabilized with a clamp or screws prior to IM nailing being undertaken. Alternatively, a lateral plate can be used to avoid intra-operative fracture displacement.

Knee Ligamentous Injury:

Case reports have been published describing ipsilateral knee ligamentous injury, and even knee dislocation, in patients with tibial diaphyseal fractures[82]. In a prospective study using examination under anesthesia, 22% of patients with tibial

diaphyseal fractures were found to have sustained an injury to at least one knee ligament[84]. Although knee ligamentous injuries are more commonly seen in association with femoral diaphyseal fractures and floating knees than with tibial diaphyseal fractures alone[83], some authors advocate routine knee ligament examination in all patients presenting with tibial diaphyseal fractures. However, evaluating the knee ligaments in a patient with an unstable tibia fracture is challenging, and as a result, first presentation of these injuries is likely to result in an underdiagnosis. Examination of knee ligament stability is more straightforward after tibial fixation, but a postoperative diagnosis prevents the surgeon from altering the type or position of the implant to facilitate early ligamentous reconstruction.

Proximal Tibio - fibular Joint Dislocation:

Dislocation of the proximal tibio-fibular joint can occur in isolation and is associated with lateral ligamentous instability and peroneal nerve injury[85]. In rare cases, proximal tibiofibular joint dislocation can occur in association with a tibial diaphyseal fracture, usually when the fibula is intact[85]. Widening of the joint can best be visualized on an internal rotation X-ray following tibial stabilization. Because of the rarity of this combined injury little data are available to guide treatment or predict outcomes.

MEASUREMENT TECHNIQUES OF MALROTATION:

Measuring the foot-thigh angle (TFA) is the most often used approach in clinical assessment of malrotation. The measurements taken along the longitudinal axis of the foot and thigh are compared by the surgeon. The measurement can be done either supine or prone, however the latter is usually chosen. When the patient is in the prone position, their knee should be 90 degrees bent, their ankle should be in a neutral

flexion, and both lower extremity axes—the thigh and the foot—should be measured using goniometry. The rotational difference is found by comparing the thigh foot angles of two limbs.

Rotational malrotation was defined to be significant in the majority of the studies as a torsional differnce between the affected and unaffected limb of more than 10° (range 5–15°)[12].

Using x-rays, patients are radiographically evaluated postoperatively for rotational malalignment. First, the medial and lateral femoral condyles are superimposed to get a true lateral view of the knee. Then a true anterio-posterior (AP) image was obtained by rotating the fluoroscopic device ninety degrees while the leg remains immobile. Now, we must internally rotate the limb for 10 to 15 degrees in order to obtain a mortise view normally. We follow the same technique in the operated limb too. An exact mortise view of the ankle can be obtained by rotating the limb 10 to 15 degrees internally, if the fracture has been accurately reduced. If we need to rotate more than 15 degrees to get a mortise view of ankle , then it is considered as external malrotation and if it was less than 10 degrees, it was considered as internal malrotation.

Patients will be evaluated with computerized tomography also. In a supine position with both lower limbs in full extension with a support to minimize movement during scanning. The proximal and distal transverse axes were determined by CT scanning. The CT images included axial cuts just above the proximal tibiofibular joint and immediately proximal to the tibiotalar articulation of both limbs. Rotation measurements were made from the CT slices taken. The proximal measurement was defined as the angle between the tibia posterior cortex immediately above the fibula head and the transverse axis . In the distal, the measurement was taken as the angle

between the line passing from the fibula and tibia center on the slice taken immediately over the tibiotalar joint and the transverse axis . By comparing with the healthy side, the rotational difference between the two sides was defined. Positive values were evaluated as external malrotation and negative values as internal malrotation. As has been accepted in previous studies on malrotation in literature, more than 10 degrees between the two extremities was accepted as a rotational difference

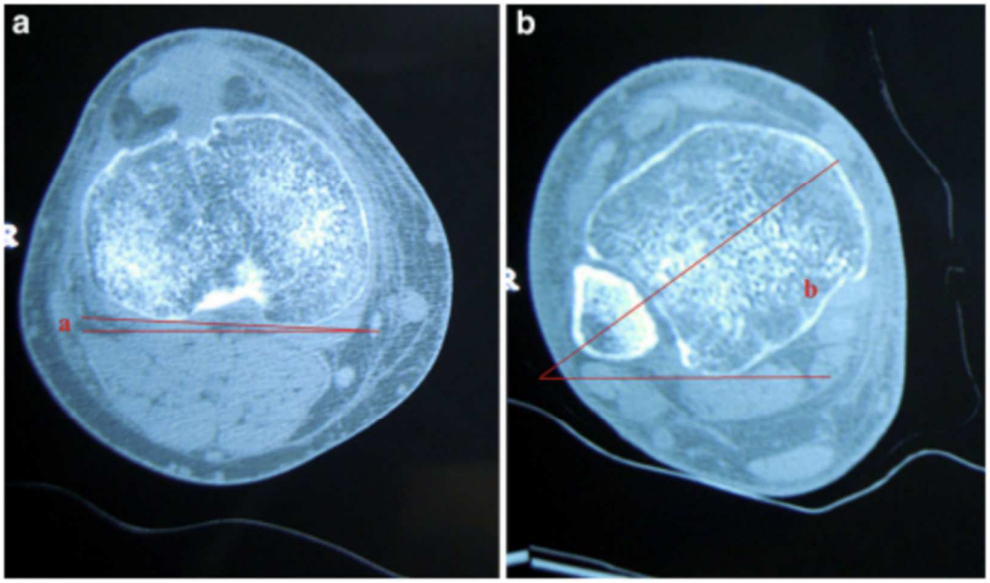


Figure 9: Tibial rotation is measured using CT slices in two ways: (a) the angle ‘a between the tibia's posterior cortex and the transverse axes on the proximal slice, and (b) the angle b’ between the transverse axis on the distal slice and the line that passes through the center of the fibula and tibia. The leg's rotation was measured (a+b), and the rotational difference was calculated by comparing it to the healthy side.

PRINCIPLES OF MANAGEMENT:

Non-operative treatment of all tibial diaphyseal fractures has been obscured long time back. In the current developed world, the majority of adult tibial fractures are treated surgically. The recommended method of surgical treatment varies depending on the location, the age, and the training of the surgeon. A survey of Canadian orthopedic surgeons published in 2008 showed that only 20% of surgeons routinely managed closed tibial diaphyseal fractures nonoperatively compared with 30% of surgeons surveyed at the Orthopaedic Trauma Association Meeting in 1997[86]. "When it comes to nonunion, malunion, return to work, outcome scores, or time to union, numerous studies have shown that nonoperative management is linked to worse outcomes than IM nails"[87].

Current indications include patients with very high anesthetic risk or fractures with excellent initial alignment that will require little or no reduction to obtain adequate alignment. Relative contraindications for closed treatment include anything that prevents effective cast or fracture brace application or any factor that requires operative treatmentPatients who are not compliant are less suitable for nonoperative treatment because closed treatment necessitates periodic follow-up to monitor for displacement. When treated properly, displaced tibial fractures without a fibular fracture require extra caution and close monitoring since they are prone to go into varus without surgical intervention.

Very proximal or distal fractures that approach the metaphysis can be difficult to maintain in acceptable alignment with closed means, so these patterns are also a relative contraindication. Patients at risk of compartment syndrome, particularly ICU patients who cannot provide pain information or participate in the physical

examination, should be considered carefully as casts and splints can limit access to the limb to evaluate swelling of the leg compartments.

Tibial diaphyseal fractures should only be treated nonoperatively if adequate alignment can be obtained with closed reduction. However, there is very little evidence to say how much malalignment is too much[88]. Instead, what we have is a general consensus on threshold values for closed treatment of a tibial diaphyseal fractures. These values are based largely on the criteria used in a series of 1,000 fractures treated with functional bracing[89], discussed below, that demonstrated positive outcomes including a nonunion rate of only 1.1% with only 2.4% failing this treatment because of progressive angulation.

Because of the orientation of the knee and ankle joints varus or valgus malalignment is thought to be more detrimental than apex anterior or posterior alignment as the knee and ankle can compensate for some degree of sagittal plane deformity. There is thought to be little threshold for rotational malalignment as this would cause a mismatch between the axis of the knee and ankle and impede ambulation. However, humans may compensate for rotational lower limb deformities better than previously thought[90].

There is significant variability in published standards for acceptable angulation, shortening, and rotation of tibial diaphyseal fractures. This can make comparisons between studies misleading and interpretation of study results challenging. Parameters for alignment that are acceptable for fractures of tibia diaphysis have not been rigorously tested, nor are the effects of malalignment on long-term function well studied. Limited animal and cadaveric data suggest that tibial varus or valgus malalignment of <10 degrees does not result in significantly abnormal cartilage contact pressures or cartilage degeneration in the ankle or knee[91,92].

Alignment parameters	Acceptable malalignment
VALGUS	$< 5^0$
VARUS	$< 5^0$
APEX ANTERIOR/POSTERIOR ANGULATION	$< 5\text{-}10^0$
ROTATION	$<0\text{-}10^0$
SHORTENING	<10-20 mm

Table 3: Acceptable malalignment in tibial diaphyseal fractures:

From Wright PE, Hutchins WC, Anderson LD, et al. treating bt casts and transfixing pins for tibia and fibula fractures. Bridgman SA, Baird K. Clin Orthop Relat Res. 1975;105:179–191. What constitutes a successful outcome in the audit of closed tibial fractures? 1993; 24 (2): 85–89; Karlstrom G, Olerud S. Treatment options for tibial shaft fractures are critically assessed. Nicoll EA, Clin Orthop Relat Res. 1974;105:82–115. fractures involving the tibia. a review of 705 instances. Sarmiento A, Latta LL. J Bone Joint Surg Br. 1964;46:373–387. Bracing for fracture that works. 1999;7(1):66–75; Tornetta P, Finkemeier CG, Schmidt AH. J Am Acad Orthop Surg. treating fractures of the closed tibia. Closed unstable tibial fractures, Trafton PG, Instr Course Lect. 2003;52:607–622. 1988;230:58–67 Clin Orthop Relat Res

Techniques—Closed management of Tibial Diaphyseal Fractures:

The initial closed treatment of tibial diaphyseal fractures involves the use of closed reduction maneuvers as required and then the application of a long leg splint or cast . Some surgeons perform this procedure under conscious sedation or even full general anesthesia to promote patient comfort and improve the chances of obtaining

the best fracture reduction possible. A long leg splint is initially used to control rotation. Soft material that has some capacity to expand, such as web roll surrounded by plaster, or bivalving of a fiberglass cast is preferred as these injuries are associated with significant swelling, and compartment syndrome may occur. Casts, splints, and any circumferential dressing can increase intercompartmental pressure, so these should be removed immediately in any patient suspected of developing compartment syndrome.

Failure to achieve an adequate initial reduction, is an indication for operative treatment or further attempts at closed reduction. However, unlike nonoperative treatment of humeral diaphyseal fractures, tibial diaphyseal fracture alignment does not tend to improve during non-operative treatment. Therefore, if the initial alignment is not adequate, non-operative treatment should be abandoned in favor of operative treatment.

Nonoperative management of fractures of tibia diaphysis is done with either immobilization by cast or functional bracing. Both treatment methods involve initial stabilization in a long leg cast or a well-moulded splint for 2 to 4 weeks until the soft tissue swelling reduces and callus formation begins[93, 94]. The long leg cast or splint is then changed to a short leg patellar tendon-bearing (PTB) cast or a fabricated functional brace[93]. The advantage of a functional brace over a PTB cast is that it allows ankle motion in addition to knee motion.

The theory behind how bracing and cast immobilization maintain tibial alignment centers around the hydraulic pressure exerted on the fracture by circumferential forces on the noncompressible fluid-based tissues of the leg. Therefore, a tight, well-contoured fit is required for the successful maintenance of fracture reduction. Appropriate moulding is employed at the time of initial cast or brace application and

subsequent adjustments can be made by reforming the brace or wedging the cast to correct fracture alignment. A central theory in the nonoperative treatment of tibia fractures is that stimulation of fracture healing occurs through functional activity of the limb[93].Therefore, early weight bearing is encouraged and ipsilateral injuries that prevent weight bearing are a relative contraindication to nonoperative treatment of the tibia with functional bracing[93,94].

Outcomes:

Although nonoperative treatment of tibial diaphyseal fractures may be less popular today, Sarmiento has published extensively on the nonoperative treatment of tibial diaphyseal fractures with his initial descriptions of the technique dating back to the 1960[93,95]. Sarmiento reported a "1.1% nonunion incidence in the biggest series, a retrospective investigation of 1,000 closed tibial diaphyseal fractures treated conservatively, with 95% of fractures healing with ≤12 mm of shortening and 90% with ≤6 degrees of angulation"[95]. Average final shortening (4.3 mm) correlated strongly with average initial shortening (2.5 mm) demonstrating that for closed, diaphyseal tibial fractures initial shortening is not increased through functional bracing and weight bearing. Similarly, this correlation also suggested that improvement in initial shortening achieved by closed reduction was not maintained through bracing, and therefore unacceptable initial shortening should be viewed as a contraindication to conservative treatment. The study was limited by its retrospective nature and a lack of validated outcome scores.

The most compelling outcome data against closed treatment of tibial fractures comes from studies comparing closed treatment to IM nail fixation. A retrospective cohort study[96] and several RCTs comparing the outcomes of non-operative treatment versus IM nail fixation[97], favored nail fixation over closed treatment in terms of

outcome. A study of conservative therapy versus plating and internal fixation (IM nail fixation) for closed tibial diaphyseal fractures was published by Littenberg et al. in 1998. The reported nonunion rates (ranging from 0% to 13%) with nonoperative treatment were similar to those with operative treatment. However, when comparing nonoperative treatment to surgical fixation[98], the biggest difference was observed in the odds ratio of 0.21 for time to union beyond 20 weeks. The risk of superficial infection was higher with surgical therapy, and functional results and malunion rates could not be compared because to data pooling from several studies.

"Closed therapy exhibited higher rates of nonunion, malunion, and infection than surgical treatment with plates or nails, according to a systematic review of the literature that examined 13 RCTs"[99]. It should be mentioned, though, that depending on the study, reoperation rates following operational treatment varied from 4.7% to 23.1%[99].

Operative Treatment of Tibia Shaft Fractures Indications/Contraindications:

"Failure to acquire adequate closed reduction of farcture , open contaminated fractures, associated vascular injury, a soft tissue envelope that prevents the administration of a cast, a patient who is not cooperative for closed management, and patient preference to avoid wearing a cast are among the indications for operative therapy"[12]. Tibial nailing is appealing to many patients and clinicians because it allows for immediate mobilization of patient and knee and ankle range of motion, less frequent follow-up, and the ability to immediate weight bearing. This is especially true since "the results of RCTs have shown that operative fixation is preferable to closed treatment in terms of nonunion, malunion, complications, and time to return to work"[99]. Currently, the majority of displaced tibial diaphyseal fractures are best

treated surgically, with intramedullary nailing being the most often performed procedure[100].

INTRA MEDULLARY NAILING

"The most typical course of treatment for tibial diaphyseal fractures is IM nailing. Surgeons favored nail fixation for 96% of closed fractures and lower grade open fractures, according to an international survey"[101]. "Numerous prospective randomized trials and a comprehensive assessment of the literature demonstrating the superiority of nail fixation over closed therapy lend credence to this practice trend"[87,97,99].

PREOPERATIVE PLANNING:

The main preoperative planning step unique to tibial nailing is determining if the fracture pattern is suitable to nail fixation. Adequate imaging must be obtained to determine that the fracture is not too proximal or distal to nail. Often, this requires a CT scan in addition to x-rays. Simple fracture lines that enter the knee or ankle joint may not preclude nailing, but the surgeon should know of this beforehand so that the surgery can be modified as required to address this component of the fracture.

Some surgeons routinely perform CT scans of fractures in the distal one-fourth of the tibia as intra-articular fractures have been observed in up to 43% of the cases, with coronal shear fractures into the posterior malleolus being the most common fracture pattern[102]. "Undisplaced fractures can be difficult to appreciate on plain radiographs and 14% of articular involvement is missed"[102]. It is advantageous to know about these articular fractures prior to surgery so that clamp placement or screw fixation can be performed to avoid displacing the fracture during nailing.

Further preoperative considerations include the surgeon ensuring that the medullary canal isn't small for the sizes of nails that are available. Companies will differ in the size of their smallest nail and rare sizes may not be stocked in your hospital. Typical smaller nail diameters are 9 mm or 8.5 mm. Similarly, patients who are significantly shorter or taller than population norms may also require nail lengths not routinely kept in stock. Finally, the surgeon should make sure there are no other factors that might make nailing difficult such as pre-existing knee stiffness, a previous tibial fracture that might have caused a significant tibial deformity or obliterated the medullary canal, a total knee arthroplasty, or a large contaminated knee wound.

Tibial nailing is typically performed on a table that allows imaging from the knee to the ankle. To help stop the limb's innate tendency to spin externally at the hip, the patient is put supine with a bump under the ipsilateral hip. A radiolucent triangle is placed under the knee and position can be changed during the procedure to allow different degrees of knee flexion. Tibial nailing also can be performed effectively on a fracture table. In this setup the knee is hyperflexed over a bump, and a traction pin can even be used distally to help reduce the fracture. This technique is effective but has become less popular as some studies raised concerns regarding an increased risk of compartment syndrome secondary to elevated intracompartmental pressures during nailing with traction. This effect is thought to be related to either traction itself or compression of venous outflow with the flexed knee on a bolster. The clinical significance of this increase in pressure during nailing is less clear.

IM nailing of the tibia uses fluoroscopy throughout the case. The C-arm is typically placed opposite the limb, but some surgeons prefer to place the C-arm ipsilaterally to move the base of the machine away from the medial side of the leg where the surgeon typically stands to place the medial to lateral interlocking screws.

This is an option that should be kept in mind particularly if the contralateral upper extremity is being operated on at the same time.

Tourniquets are typically not used by some surgeons for procedures that involve reaming for fear of thermal necrosis, although this has only been described in case reports[103]. Although the evidence for the association between tourniquet use and thermal necrosis is not strong and thermal necrosis probably occurs as a result of reaming small IM canals up to a much larger size, most surgeons do not typically use tourniquets when reaming the tibia. If a tourniquet is needed for debridement of an open fracture, the tourniquet can be placed in the sterile field and lower on the thigh so as to reduce the risk of the surgeon forgetting that the tourniquet is inflated when it is time to ream the tibia.

INFRAPATELLAR TIBIAL NAILING :

There are two surgical approaches for doing the infrapatellar nailing of tibia including, the parapatellar approach and patellar tendon splitting approach

Parapatellar approach :

Medial parapatellar approach is commonly used. A lateral parapatellar approach is used by some surgeons for proximal fractures or in patients in whom preoperative fluoroscopy indicates that the ideal starting point appears to be more easily accessed through this approach. Usually, the skin incision is made 1 cm medial for a medial parapatellar approach, or in the center above the knee. Beginning at the patella's midline, the incision extends outward to almost the same length as the patella (figure 10). A longitudinal incision is made along the patella's length, and dissection is resumed to determine its medial border. The approach should stay in the fat pad and not enter the knee joint.

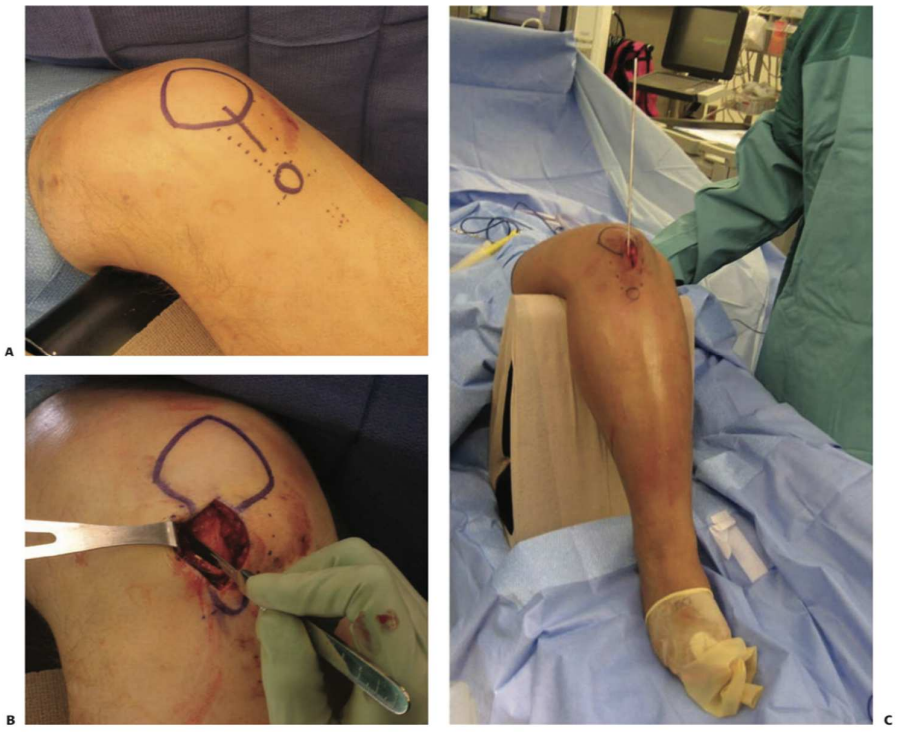


Figure 10 : (A) an incision is made midline, positioned above patella's inferior pole. (B). Next, an incision is made medially to patellar tendon.(C) The guide wire is then inserted.

The usual issue with the medial parapatellar approach is establishing a beginning position that is adequately lateral, as the patella and patellar tendon tend to force the starting wire too medially.

A valgus deformity can arise from an excessively medial starting point in cases of proximal tibia fractures(figure 11). Some patients also have anatomy that makes obtaining the ideal starting point through this approach difficult. One advantage of the limited medial parapatellar approach is that it can be extended up to a full medial parapatellar approach used, which is commonly used for operations such as total knee arthroplasty. This is usually not required but it allows for complete subluxation of the patella and straightforward placement of the starting point regardless of the patient anatomy.

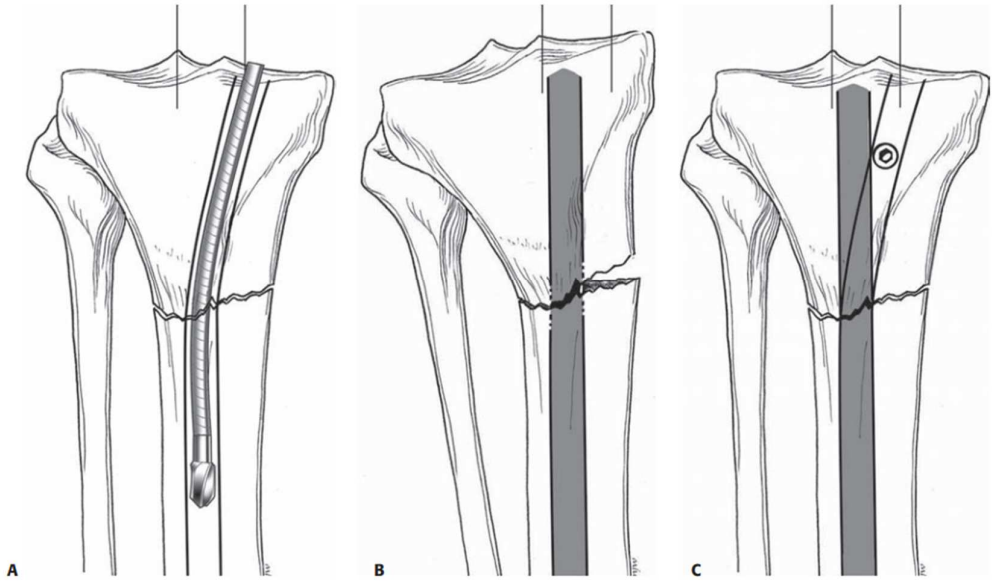


Figure 11: (A) If the starting point is too medial remaining creates an oblique proximal channel in the bone. (B) that causes a valgus deformity once the nail is placed. (C) subsequent placement of blocking screw and reaming a correct path corrects the deformity

Patellar Tendon Splitting approach:

The patellar tendon split is a frequently employed method that gets rid of the challenge of inserting the guidewire sufficiently lateral using the medial parapatellar tendon approach. A longitudinal split is produced in the tendon once the incision is lowered to the tendon. Throughout the procedure, precautions are made to keep the tendon safe. While some surgeons contend that breaking the patellar tendon has no clinical significance, others object to the potential harm it could produce.

Since the starting wire passes through the patellar tendon, it is unable to sublux the patella away from it, making the patellar tendon split technique rather challenging in achieving the optimal starting angle—which is crucial in proximal tibia fractures. The beginning wire may tend to tilt posteriorly as a result. In proximal

fractures, this can result in an apex anterior deformity, while in distal fractures, it is less significant.

Technique:

The patient should be positioned supine and one of the two approaches described above are chosen. A starting guide wire is placed at the starting point. . The ideal starting point of guide wire should be just medial to the lateral spine on a true AP radiograph of the knee as demonstrated by the lateral border of the tibial plateau bisecting the fibular diaphysis. The lateral starting point is just off the articular surface and should parallel the tibial anterior surface. This wire placement is aimed slightly posterior and would be acceptable for distal fracture patterns but might be less ideal for a very proximal pattern. (figure 12,13)

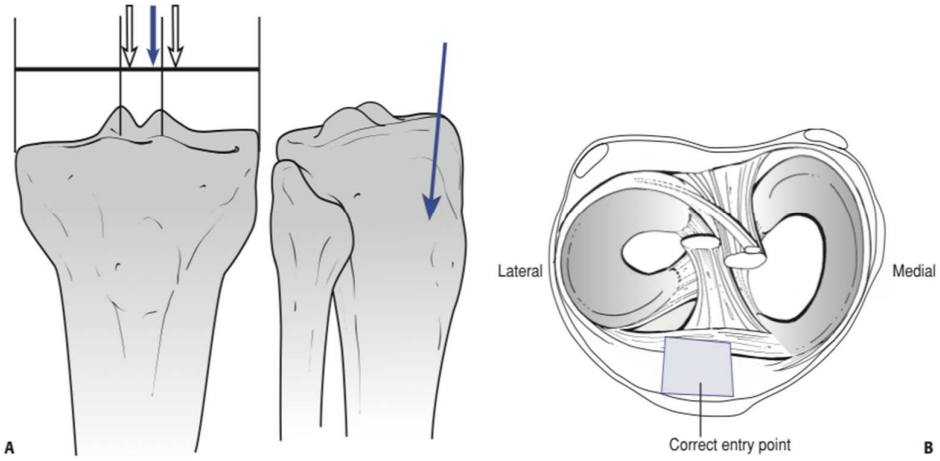
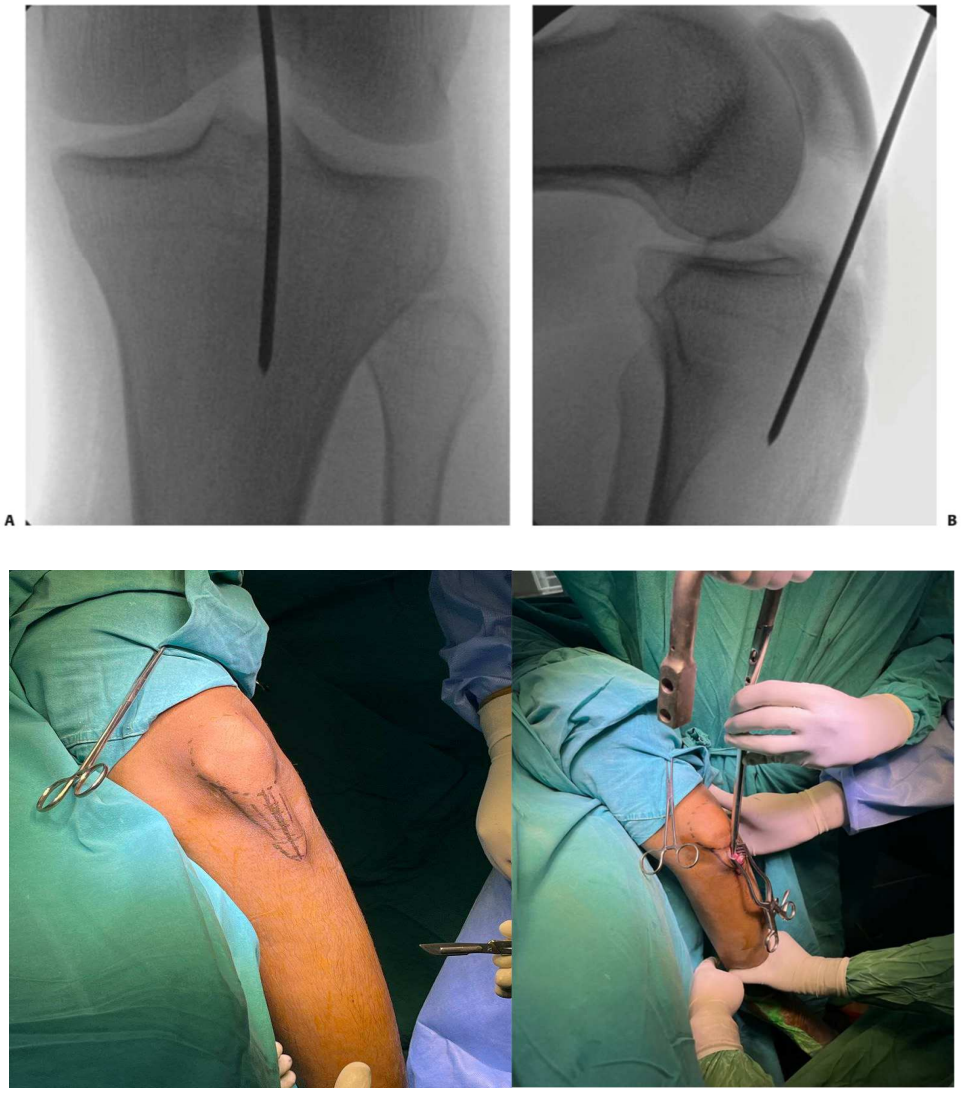


Figure 12 : A: A diagram demonstrating that the correct starting point for a tibial nail is medial to the lateral tibial spine on the AP radiograph and just anterior to the lateral surface on the lateral radiograph. B: The correct nail starting point is anterior to the important structures in the knee.



C D

Figure 13 : (A) and lateral (B) radiographs of the knee demonstrating the placement of a starting wire (C) hyperflexed position of knee during infrapatellar nailing (D) hyperflexed positioning while passing the nail.

Since it has been demonstrated that tibial rotation can alter the appearance of the guidewire position by up to 15 mm, care should be taken to ensure that accurate entry pont is determined from a correct AP radiograph. As such, it is crucial to establish the beginning point using a "true" AP of the knee. To acquire this image, make sure that the lateral side of the tibia at the joint bisects the fibula. Because of the

proximal bend of modern nails, the best place to start is between the tibial tubercle and the joint line. It is important to use caution when choosing the beginning point to avoid damaging the menisci too close or risking reamed away of the tibial tubercle.

Once the starting point is correctly placed the starting wire must be advanced in the appropriate direction. In the Anteroposterior plane this is in line with longitudinal axis and in the lateral plane it is in line with the anterior cortex . Once the starting wire has been placed in the correct position and alignment, a reamer is used to open a path through the proximal tibial metaphysis. Take care to protect the patellar tendon during this step using a soft tissue protector or retractors. There is a tendency for the starting wire to be too far posterior (except if using the suprapatellar approach) because the patella tends to make it difficult to keep the guidewire in line with anterior cortex. If fracture is in diaphysis this may be less important, but for proximal fractures this will induce an apex anterior deformity once the nail is passed into the tibia.

After the initial reamer has been passed into the IM canal, a ball-tipped guidewire is placed into the canal. Typically, a small bend is placed in the distal few centimeters of the guidewire using pliers or a similar instrument. Larger bends will allow for more control to position of the wire and will facilitate the passage of the wire across the fracture site, but they can make it more difficult to get the wire out of the nail.

The guidewire is inserted from the fracture's proximal to distal side. This step is usually trivial in open fractures as the surgeon has direct access to the fracture, but it can be more challenging in closed fractures. There are a number of techniques to facilitate closed reduction of fracture to allow easy passage of guide wire. By rotating guidewire, the direction of its advancement can be controlled because of the bend in

the distal guidewire. Once the wire has passed across the fracture site, it is placed distally at about the level of the metaphyses.

Once the wire is in place, the nail length can be measured. A nail length shorter than the measured length is selected. For closed fractures, Intramedullary canal reaming is usually utilized because it facilitates the insertion of a larger nail and speeds up healing without requiring much more time. Reaming open fractures has historically raised concerns since it may have also affected the periosteal blood supply in addition to momentarily damaging the endosteal blood supply. There is minimal difference between the results of these two procedures, with reamed nailing having a modest advantage, according to a large prospective RCT on the subject.

The reamers are passed over the guidewire, typically starting at 9.5 mm and progressing in increments of 0.5 mm or 1 mm. The reaming progresses to 1.5 mm greater than the nail size. Once some “chatter” is noted, reaming is adequate. It is important to know what diameter nails are available for the system you are using, as well as how the size of the inter- locking bolts is affected by nail diameter. Most systems have nail diameters down to 8.5 or 9 mm, and humeral nails exist that are even smaller and have a contour that can be used reasonably in the tibia, although of course these nails are not designed for this application. The nail will follow the path you reamed for it, take care while reaming to keep the fracture well reduced to avoid eccentric reaming that leads to malalignment once the nail is passed. After reaming, the nail is passed into the tibia over the guidewire.

Proximal interlocking screws are placed through a guide arm, typically from medial to lateral. Remember to remove the guidewire before attempting to place the interlocking screws as this will prevent screw placement. Multiple interlocking screws

should be positioned in more proximal fracture patterns in order to prevent loss of reduction and enhance mechanical stability; three screws should be positioned in the most proximal patterns[96].

Some modern nails do not use medial and lateral interlocking screws but instead use obliquely placed screws. If this is the case any anteromedial to posterolateral screw should be placed with care as damage to the common peroneal nerve, as it passes around the proximal fibula, is possible.

Distal interlocking screws are placed with a free hand technique that utilizes a C-arm and the so called "perfect circles" technique. Recently, a nail system has emerged that uses a computer-guided technique for distal interlocking without fluoroscopy but this system awaits validation. Distal fracture patterns should have two or more interlocking screws to increase stability and decrease the risk of loss of reduction or nonunion.

Unlike femoral nailing where only static locking is used, there is some controversy regarding whether dynamic locking may be advantageous in tibial nailing. Fluoroscopy should be used to confirm that all interlocking screws are properly through the nail, particularly those interlocking screws that have been placed with a free hand technique. There is some recent biomechanical evidence in nails for "angle stable" inter- locking for proximal or distal fractures that are more difficult to maintain reduction, but this technique has yet to be verified clinically.

Distraction at the fracture site is undesirable because it is thought to lead to increased risk of nonunion. In axially stable fracture patterns, compression can be obtained at the fracture site with locking the nail distally 1st and then "back slapping" the nail to compress the fracture site before locking proximally. Some nail systems

also have an internal compression device for this same purpose. Once the hardware is in place, sterile radiographs of the entire length of the tibia can be obtained while closing to make sure the alignment is adequate. Followed by closure of wounds and strile dressing.

SUPRAPATELLAR TIBIAL NAILING:

Suprapatellar approaches for tibial nailing have gained significant interest recently with several studies being published on the topic. The relative ease of attaining fracture reduction, the ease of acquiring anteroposterior fluoroscopic images with the knee less flexed, and the ease of obtaining the beginning point are the claimed advantages of the strategy. These are all of particular benefit in proximal fractures. Theoretical concerns involve damage to the patello- femoral joint and converting a procedure that was outside the knee joint into one that traverses the knee joint and therefore may be at increased risk of a surgical site infection becoming septic arthritis. Studies are underway to address these issues, but the technique is now getting popularity due to the ease of gaining a staring point for fractures of proximal tibia for which it was initially proposed.

Always check laxity of patella in damaged limb (or, alternatively, the unaffected limb) prior to surgery. In cases where patella motion is limited, traditional infrapatellar entrance should be taken into consideration as it could hinder suprapatellar entry instrumentation. Cutting the retinaculum is an alternative to prolong the suprapatellar dissection.

The affected limb is placed with a bolster beneath knee , flexed $20–30^0$, while the patient lies supine(Figure 14). The fluoroscopy machine is on opposite side, and if operating table have on option of leg split, then uninjured leg side is lowered $20\text{-}30^0$ from the horizontal plane compared to injured side. As a result, we may achieve the

best possible fluroscopy in the lateral and anteroposterior views without having to move the affected leg and with only minor C arm adjustments.

The sterile barrier is lowered close to the anesthesiologist to make it easier to insert long guide wires, reamers so that they won't become unsterile. A quick and easy way to manipulate this problem is to cover the fracture with an elastic bandage that is securely stretched. Given that fractures frequently result in malrotated legs, it is always better to draw an outline of all necseeary bony landmarks to help position the guide wire at the proper entrance location (Figure 15).

In the event that this is not feasible, a second deep incision is done into the retinaculum, depending on the amount of laxity of patella. As a result, the patella may subluxate to one side and can be raised to a level suitable for instrumentation. After markings and confirming the proper position of C arm , before strating incision we have to do hydrodilatation i.e., filling the suprapatellar pouch with normal saline which helps in elevating the patella and breaking all the adhesions under the patella and thus providing us enough space to work(figure 16).

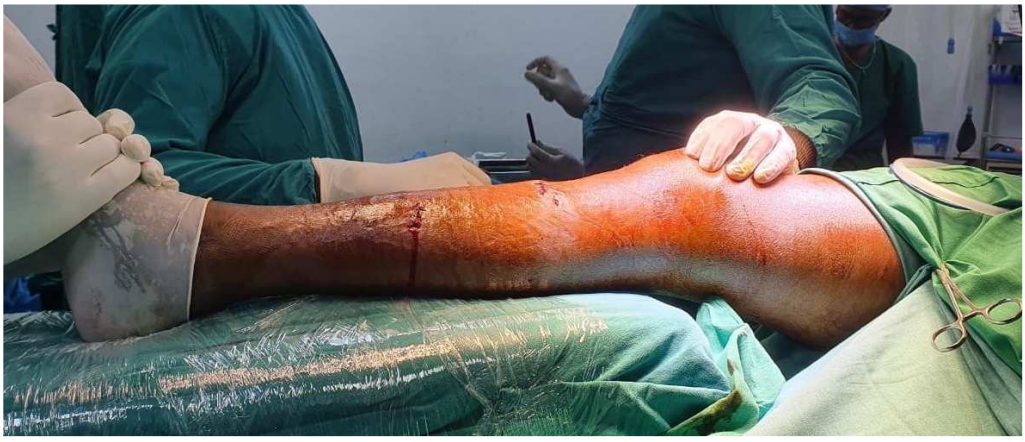


Figure 14 – Patient positioning

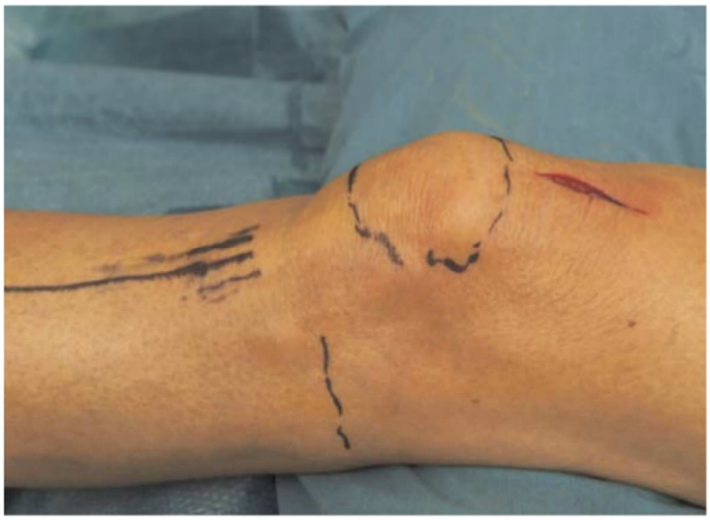


figure 15 – Markings of bony and ligamentous landmarks

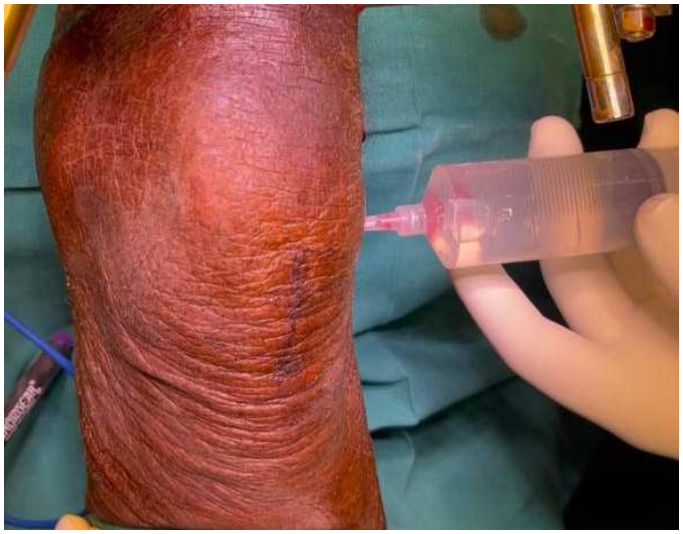
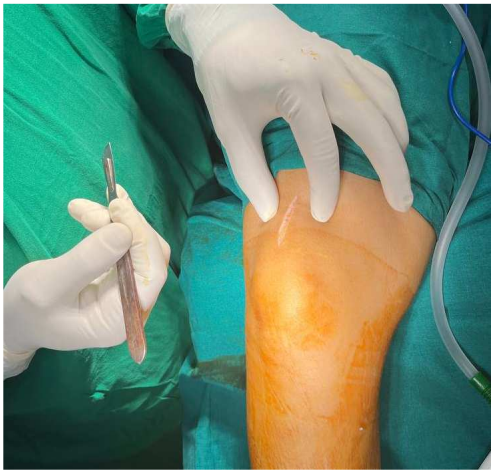


Figure 16 : hydrodilatation – inflating suprapatellar pouch to lift the patella up

An incision of 1.5 - 2 cm is taken on skin longitudinally, 1 cm above the patella's base. Blunt dissection exposes the quadriceps tendon (Fig. 17), and fibres of quadriceps tendon are split in the line of incision(figure 18).

The optimum entrance is one where it is simple to slide a finger under patella and into joint. (Fig. 19).



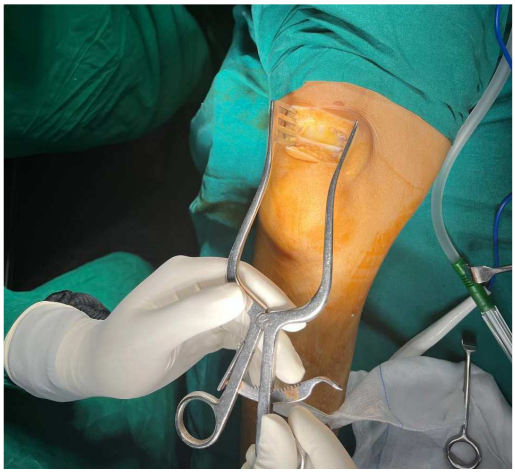


Figure 17: incision of skin and exposing quadriceps.

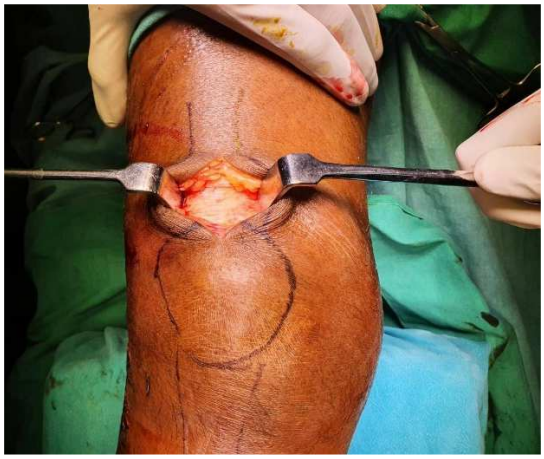


Figure 18 : incising the quadriceps in line of fibres.

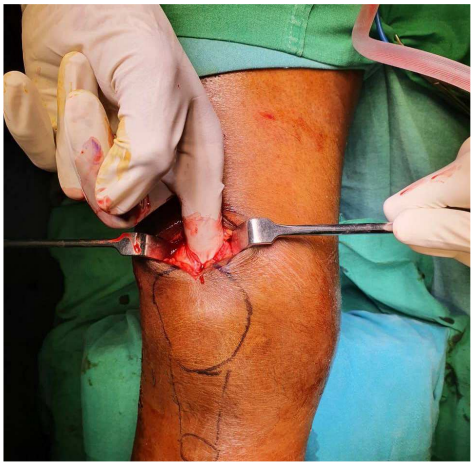


Figure 19: a finger should be able to pass easily which tells us about the space for instrumentation is enough

The protective entrance tube may be placed at this point, depending on the brand and kind of nail. A cannulated bone awl is taken and inserted through the incision. The correct entry point of awl is confirmed under C arm (figure 20,21). Placing the Guidewire with freehand technique is always easier and the guide wire is passed over the cannulated bone awl (Figure 22).

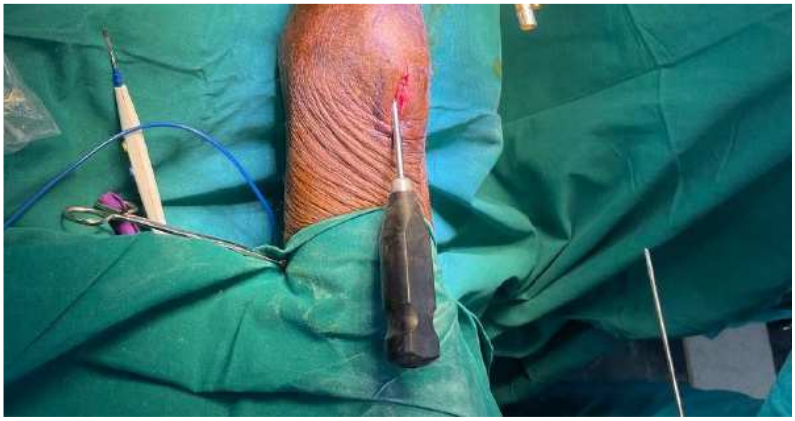


Figure 20: passing the cannulated entry awl

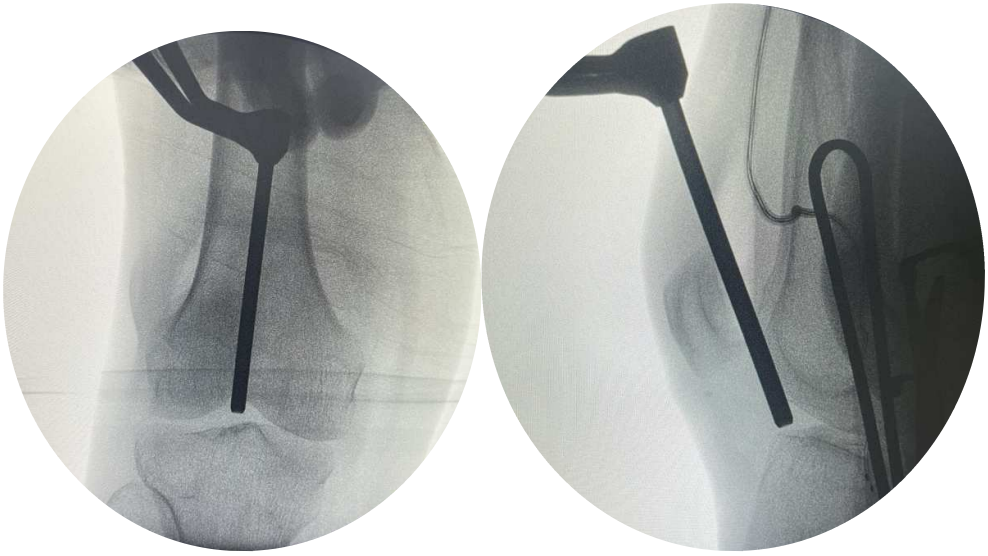


Figure 21: checking the entry point and confirming in both planes

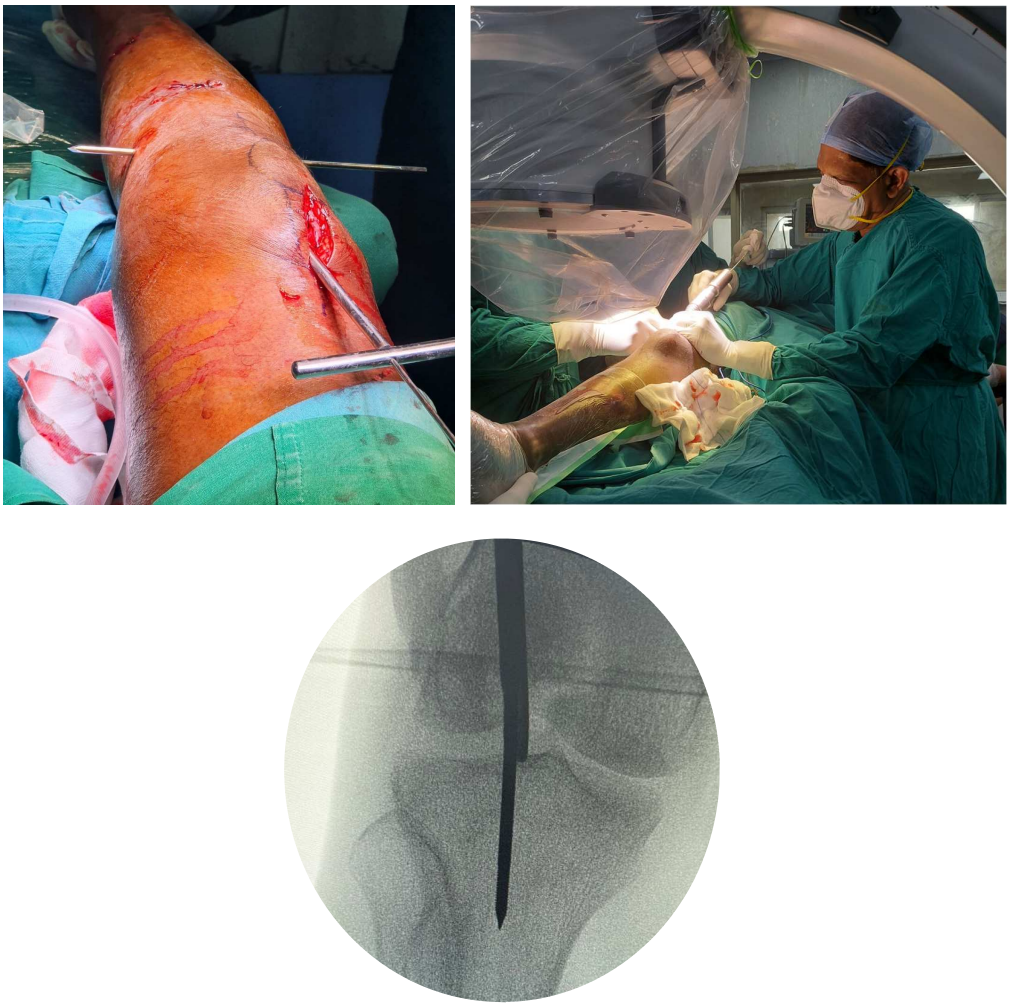


Figure 22: passing the guide wire thorough the cannulated bone awl

The optimal entrance, as illustrated in Figures 22 and 23, is about 9 mm laterally from the tibial plateau's center and somewhat laterally from the tibial tubercle. The entrance site is in front of the front articular border when seen laterally. Guide wire in tibia medulla should be oriented in both planes towards the center and confirm the guide wire under fluoroscopy(figure 23).

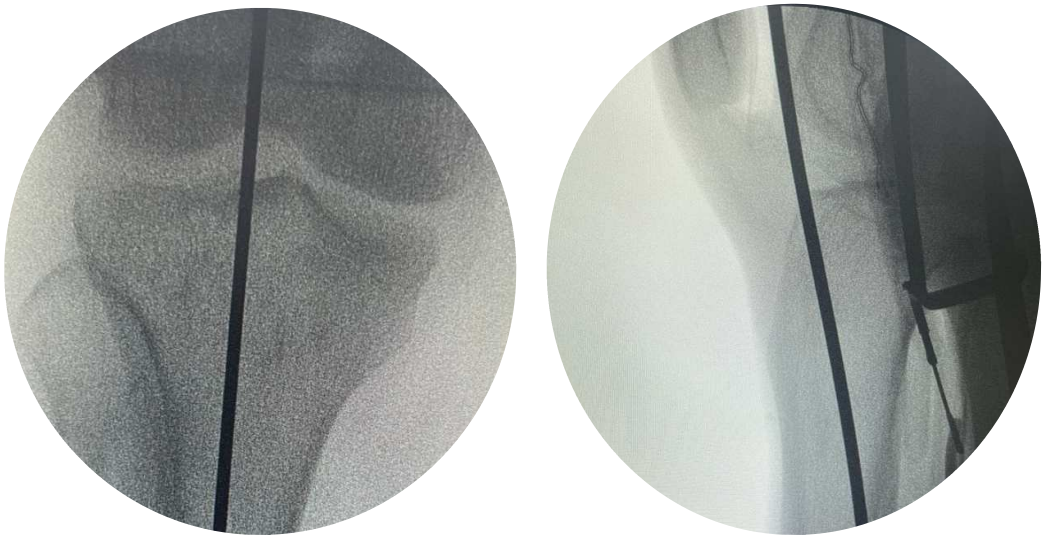


Figure 23: correct placement of guide wire checked under c arm in both planes.

After radiographic imaging in both views validates the exact position of guide wire, the protective sleeve is inserted (Figure 23). Using a blunt trocar, the sleeve can be carefully passes on guide wire, under the patella, and upto tibia surface. During fluoroscopy, it is imperative to ensure that the sleeve "sits" on top of the tibia to prevent injury to the intra-articular structures(figure 24).

One advantage of certain systems is that the sleeve can be fixed to the tibia plateau with additional k wires . This is advantageous since the sleeve can be readily moved upwards during reaming without fixation. It is crucial to often check the location of the sleeve during the reaming process if it is not fastened. Now, using a short reamer, the medullary canal in the proximal tibia is opened to a depth of 4-6 cm through the sleeve over the guide wire(figure 25). The posterior cortex could be punctured if the guide wire is not centered in the canal or if the reaming is too far below.

Figure 24: trocar and drill sleeve along with elastic nail insertion sleeve are inserted over the guide wire.

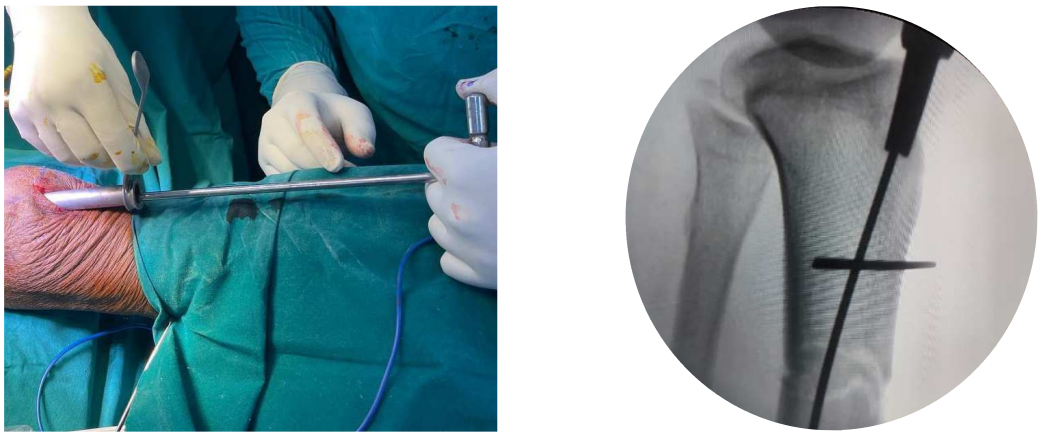


figure 25: entry reaming done with proximal short reamer.

Next the ball-tip guide can be inserted into the medullary canal and advanced past the fracture level and down to the distal tibia. Verify by radiographic imaging in both planes that the wire is within the medullary canal. In metadiaphyseal fractures, it is important to center the wire in the distal fragment in both the anteroposterior and lateral views. Using the appropriate measurement guide, the nail's length is now ascertained (or after the reaming procedure). Take cautious not to calculate the length incorrectly. Mounting an extended end cap is far less difficult than extracting a nail that is sticking out of the knee joint.

In situations where the fracture can be squeezed further, there is a chance that the nail will migrate into the knee joint. If guiding systems are utilized to put the distal locking screws, it is then important for the probe to lock the nail distally first.

The fracture is decreased as usual prior to reaming. During the reaming procedure, a percutaneous reduction clamp may be helpful in decreasing oblique fractures to anatomic or nearly anatomic positions. It is considerably easier to adjust and reposition once the legs are stretched till the nail is placed. In order to prevent intraarticular damage, it is imperative that the reaming be carried out through the protective sleeve. It is also advised that the proper position of the sleeve be radiographically verified multiple times during the procedure.

Be advised that a reamer longer than the infrapatellar entry usually needs to be used at the suprapatellar entry, depending on the length of the tibia. After that, the reaming is done as normal, but to a diameter that is between 1 and 1.5 mm bigger than the nail's diameter(figure 26) .

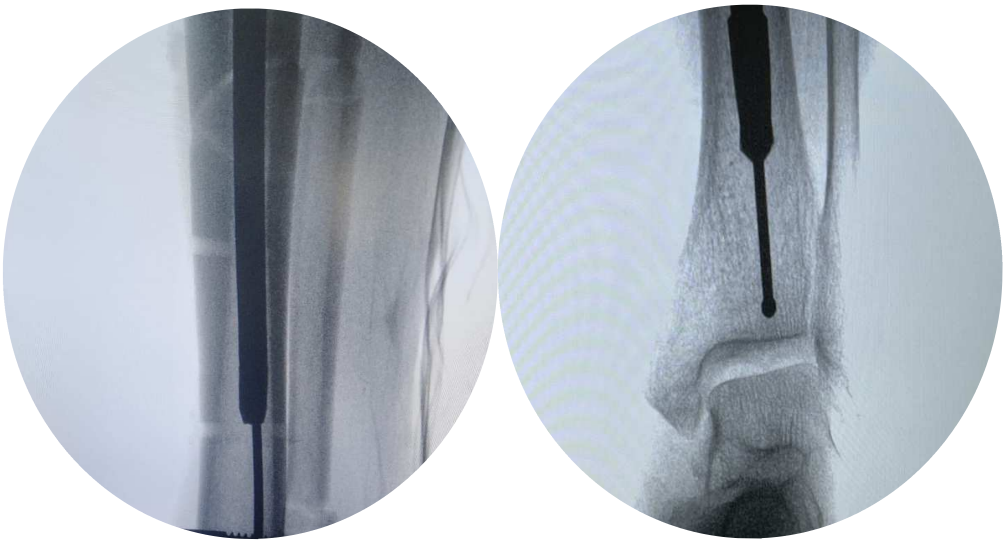
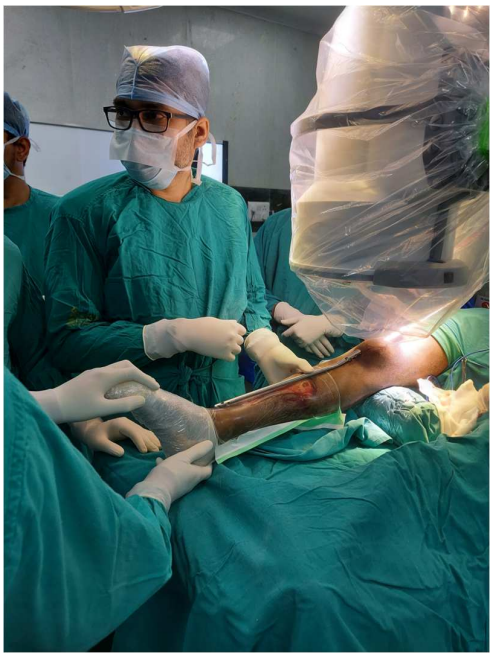
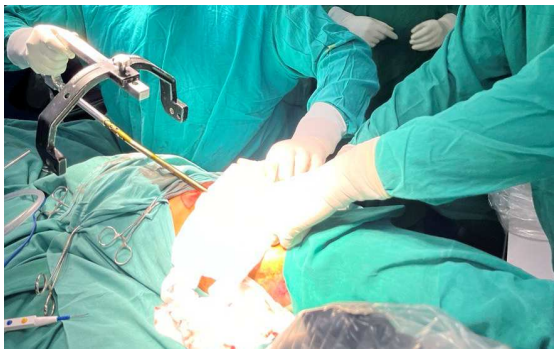
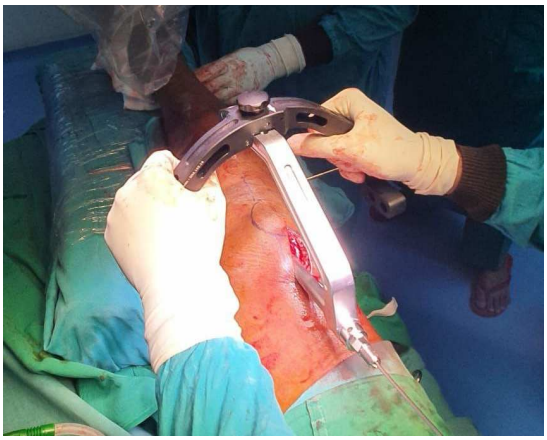


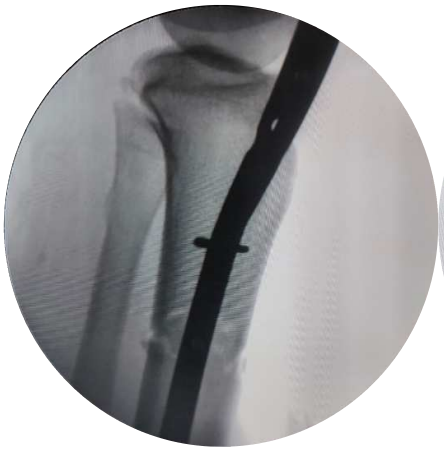
Figure 26: serial reaming done over guide wire







Checking the correct length of nail under C arm guidance



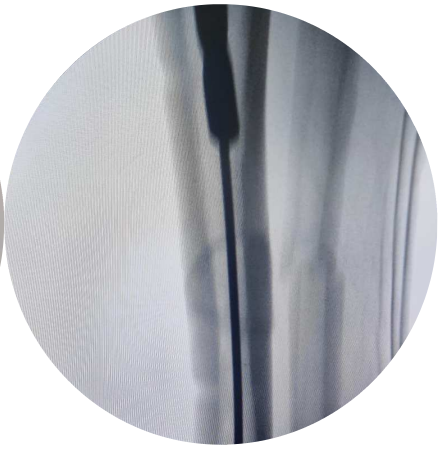
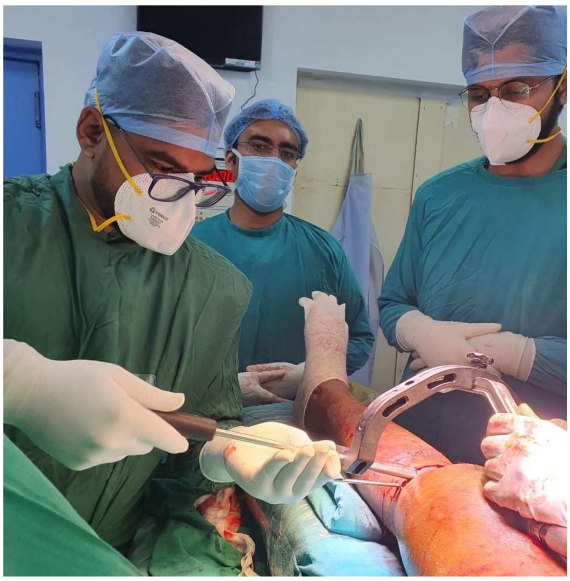


Figure 27:passing the nail over the guide wire

Depending on the nail manufacturer, it is often necessary to remove the inner part of the sleeve protector before inserting the nail and the nail is inserted carefully over he guidewire under C arm guidance. If necessary, blocking screws should be inserted in both planes before nail insertion to allow for fracture repositioning and increased stability(figure 27). The system's targeting mechanism is used to lock the

nail proximally, and freehand technique is used to lock it distally (Figure 28).Additionally, a check is performed with a finger in joint to ensure that the nail is not felt. At the same time, damage to the cartilage can be examined (Figure 29).



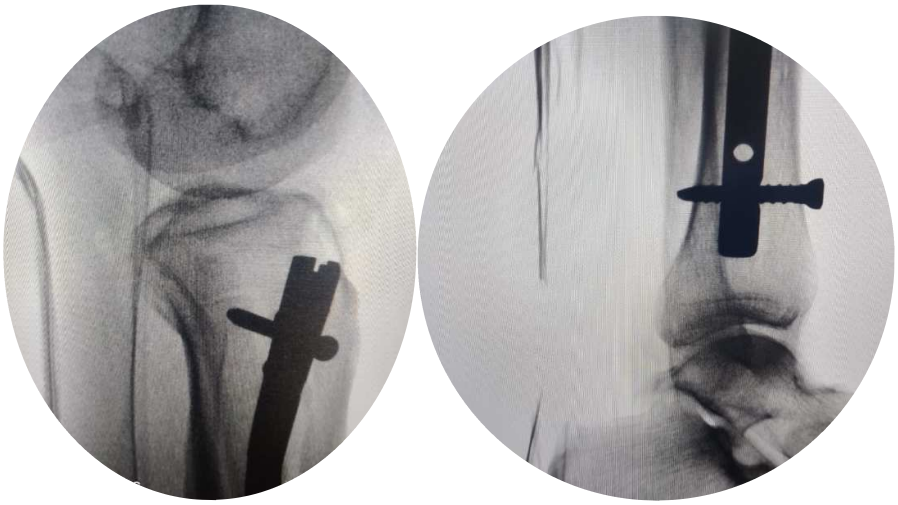
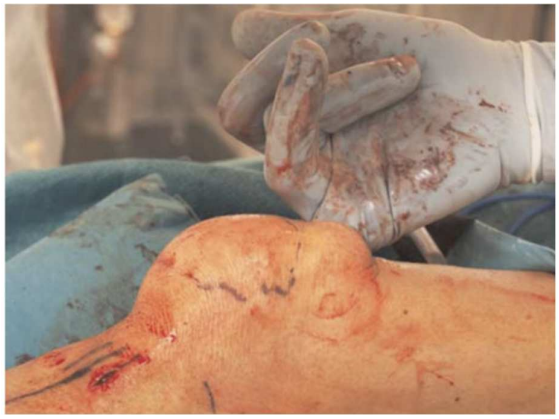


Figure 28 : proximal and distal locking



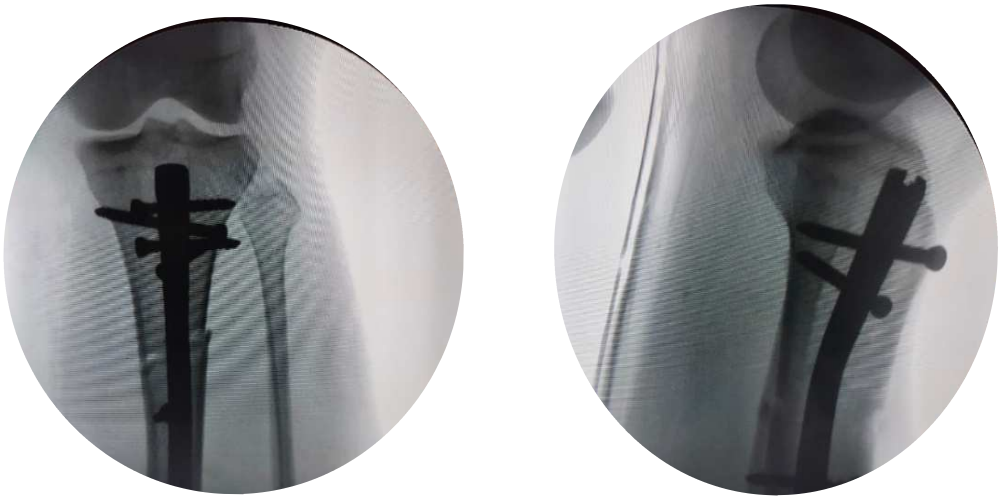


Figure 29 : final checking the under surface of patella with finger to check for damage and final C arm shoots.

Postoperative Care:

There is variation in postoperative care. There is an argument to place patients in a postoperative splint to minimize swelling and to prevent the development of ankle equinus in patients who will have delayed weight bearing. Splinting may also keep the ankle in a near neutral position which may reduce intracompartmental pressures and therefore lessen the likelihood of compartment syndrome. Many surgeons do not use post-operative splints or braces, but if they are used patients are converted from the splint into a removable boot somewhere between the first

postoperative day and the first follow-up visit. The boot is generally discarded once weight bearing has started. The first opportunity to promote knee and ankle range of motion is to begin exercising.

The axial stability of the fracture pattern dictates weight bearing. In cases where non-comminuted diaphyseal fracture patterns demonstrate adequate axial stability, rapid weight bearing to the extent tolerated is typically initiated. When it comes to extremely comminuted patterns, or for fractures that are particularly proximal or distal—where the nail has less mechanical advantage in limiting loss of reduction—weight bearing is frequently restricted to partial weight bearing or non-weight bearing for six weeks.

Patients are typically seen at 2, 6, 12, 26, and 52 weeks from the time of surgery. Radiographs are obtained at each visit after the initial visit. Patients with very proximal or distal fracture patterns may benefit from radiographs at the 2-week mark or more frequent early follow-up as these fracture patterns can lose reduction in the early healing phase.

Pitfalls:

Pitfall no. 1:Proximal Fracture Malalignment:

"It is very difficult to obtain adequate alignment using a tibial nail in proximal tibial fractures. Initial reports on the topic demonstrated malreduction rates of 55% and 85%"[104]. "The high rate of malreduction in very proximal shaft fractures has led some surgeons to recommend percutaneous plating for its relative technical ease in comparison to proximal nailing, and outcomes for plating and nailing of proximal fractures appear to be similar"[105]. "The typical deformity is valgus and apex anterior (procurvatum) deformity. The valgus deformity is due to too lateral starting point that

creates an initial reaming pathway which runs from too medial to lateral. Once the nail is placed, this tips the fracture into valgus. Similarly, the apex anterior deformity is created by the pull of the extensor mechanism and is worsened by an initial reaming path that is angled too far posterior which produces the deformity once the nail is introduced"[28].

For proximal fractures, it's crucial to reduce the fracture before reaming and to choose the optimal starting site and starting wire direction. The surgeon cannot rely on the nail to reduce the fracture as it is introduced. It is difficult to obtain the ideal proximal reaming path because of interference with the patella, which is what leads to the typically incorrect starting point which is too medial and too posterior. One technique to obtain the ideal starting point and reaming path is to extend the incision into a more extensive medial parapatellar arthrotomy and dislocate the patella.

"Other techniques to prevent malreduction include the use of percutaneous clamps or threaded guide wires. Blocking or "Poller" screws are a particularly useful technique to help guide the nail correctly"[106]. With a blocking screw, drill bit, or k-wire, you can press the reamer and nail into the correct position with this technique. If the patient is elderly and has broader tibia and lower-quality bone, leaving the screw in situ may help to promote stability. Usually, the screw is positioned where you wish to keep the nail from going or on the fractures` concave side .

Pitfall no. 2: Staring Wire too Posterior

For proximal fractures, the right beginning point and reaming approach are very crucial. If fracture location is more distal, there is more tolerance for imperfection as the fit of the straight nail in the narrow diaphysis will tend to align the fracture and make up for imperfections in the start- ing pathway. If the starting point is adequate but the starting wire is angled too far posteriorly, a reamer can be

advanced a shorter distance than usual, approximately 1 or 2 cm down the wire. The wire is then removed and a curved hand reamer or a similar device can be used to correct the reamer path bringing it more in line with the anterior cortex. This technique is particularly useful if a patellar splitting approach is used as the patella often makes it difficult to obtain a starting wire that is angled anterior enough.

Pitfall no. 3: Postoperative Knee Pain

"High proportion of patients in many studies have reported postoperative knee pain, with rates ranging from 31% to 73%"[110,111]. Nail removal in some series is as high as 26% to 50%[111]. The etiology of this knee pain is unclear but possibilities include an intra- articular starting point that damages the meniscus, leaving the nail too proud proximally, and differences in the approaches as detailed above. Authors have argued that a correct starting point and burying the nail may reduce but not completely eliminate the rate of knee pain, although various studies have contradicted each other regarding the importance of nail prominence in knee pain. Pain over the proximal inter- locking screws is also common and should be differentiated by physical examination from pain unrelated to the interlocking screw sites. Pain over the interlocking screws can typically be relieved by simply removing the screws without taking out the entire nail. An excessively lengthy interlocking screw may lead to a higher frequency of hardware with symptoms, so care should be made to ensure this does not happen.

Instruments and implants used :

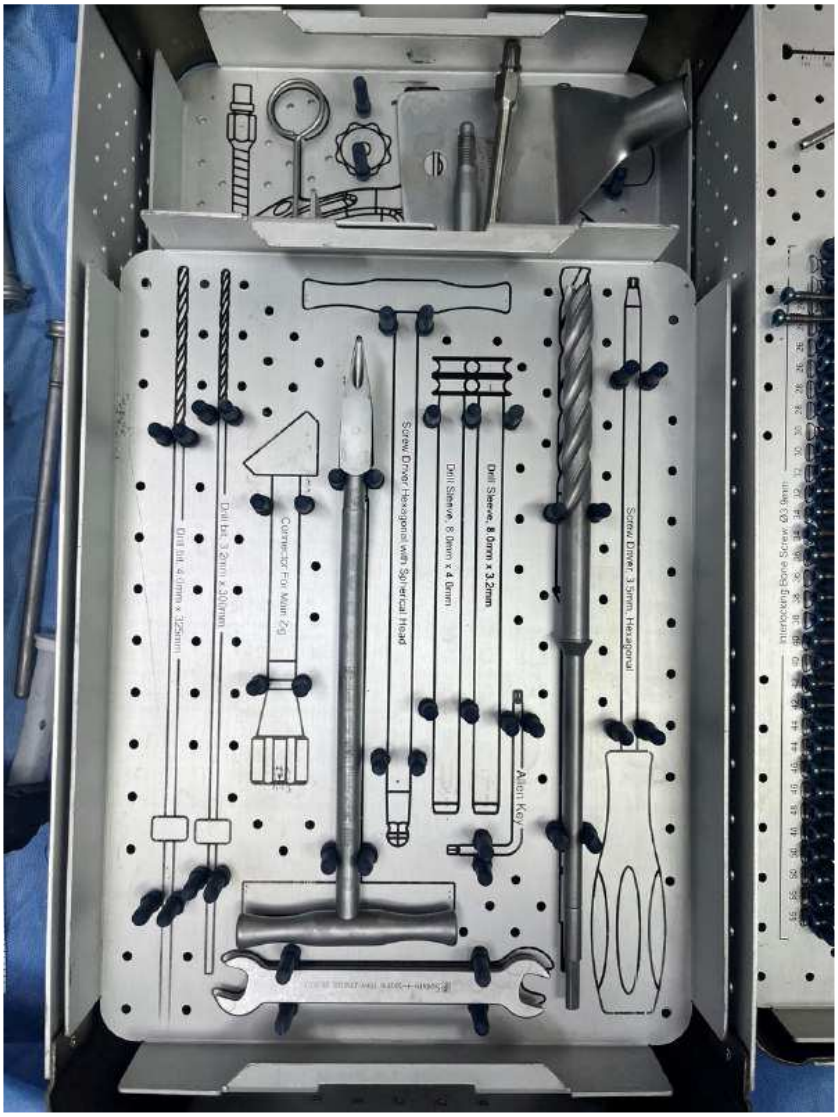


Figure 30 : Bone awl , proximal reamer in SPN set

Figure 31 : different sizes of SPN nails, different sizes of screws – both proximal, distal and sleeves

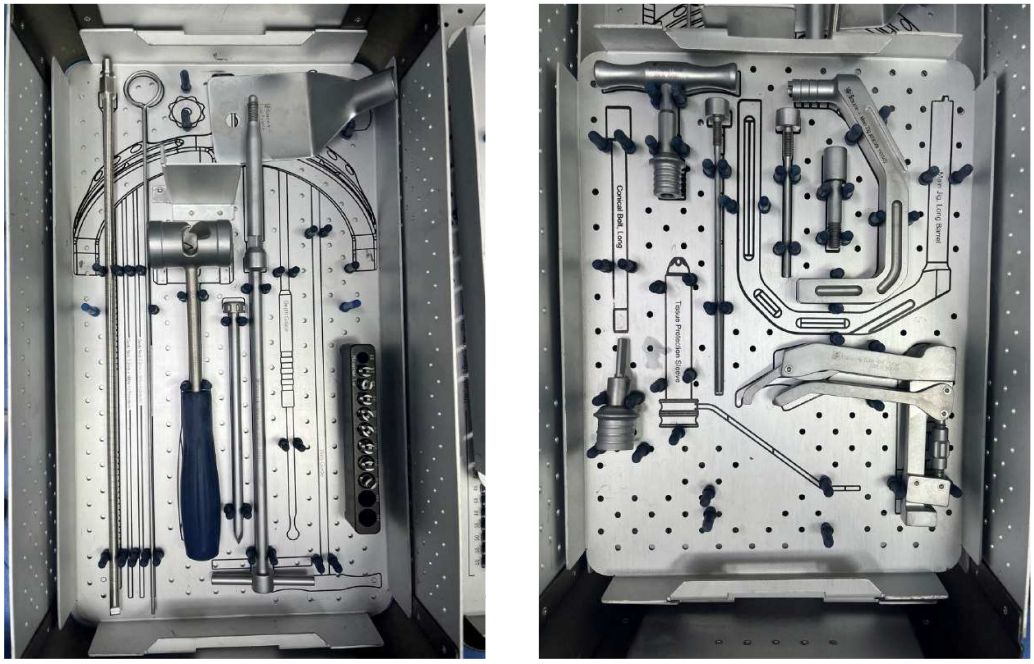


Figure 32 : soft tissue protetctor, mallet, guidewire zig, sleeves for proximal and distal locking

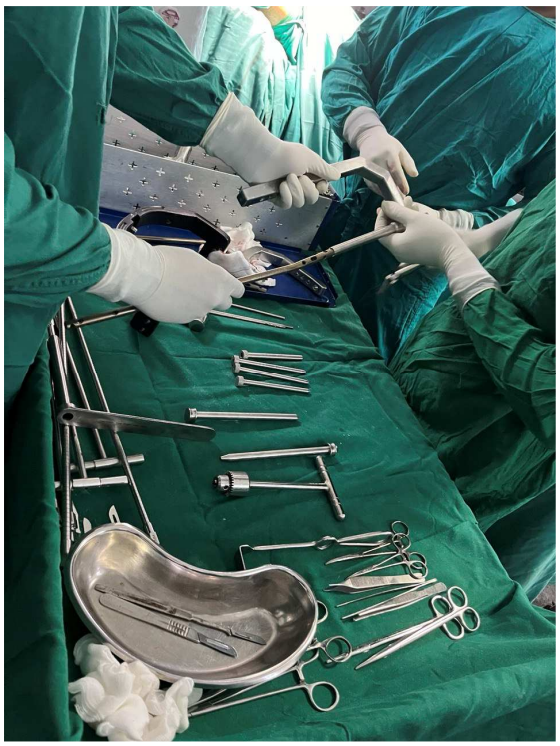


Figure 33: work table showing all instruments used during SPN nailing and also showing the fixing of nail to zig.

MATERIALS AND METHODS

Source of Data:

Data will be collected from patients who came to casualty or outpatient department (OPD) with tibial diaphyseal fractures who will undergo reamed intramedullary nailing with semi extended suprapatellar or standard infrapatellar approach in Dr. Prabhakar Kore Hospital & Medical Research Centre and Charitable Hospital in Belagavi over a period of one year from 01/08/22 to 31/07/23.

Study Design: RCT (Randomized Controlled Trail)

Study Period: 1 year.

Sample Size: There will two groups each with sample size 20.

Sampling technique:

The minimum sample size formula based on mean and standard deviation is

$$n = \frac{(z_\alpha + z_\beta)^2 (s_1^2 + s_2^2)}{(\bar{X}_1 - \bar{X}_2)^2}$$

where zα is linked with the level of significance and zβ is linked with the power of the test. For 5% level of the significance zα =1.96 and zβ =0.84 for 80% power of the test."

Randomisation of patients is done by sealed envelope technique. This is one of the most commonly used randomization technique. Once the patient has consented to enter the study, the sealed opaque envelope will be opened and the patient is offered the allocated treatment regimen.

Inclusion Criteria:

1) AGE FROM : 18 YEARS ONWARDS
2) AO classification – 42A1, A2 , A3 ,43A
3) All patients with fracture of tibial diaphysis that were to undergo reamed intramedullary nail fixation.

Exclusion Criteria:

1) Age less than 18 years.

2) Patients with non-unions, compound type 3 fractures, pathological fractures, comminuted fractures requiring extra stability

fracture of opposite tibia, either recent or old.

3) pregnancy or any other condition that is contraindicated for radiography

4) Fractures with intrarticular extension

5)fracture of opposite tibia, either recent or old

6) Ipsilateral femur fractures.

7) AO41, 43B, 43C fractures.

8) Severe osteoarthritis of the knee.

Study protocol:

All patients who came to casualty or outpatient department (OPD) with tibial diaphyseal fractures who will undergo reamed intramedullary nailing randomly with semi extended suprapatellar or standard infrapatellar approach at KLEs Dr. Prabhakar Kore Hospital & Medical Research Centre and Charitable Hospital, Belagavi over a period of one year.

All patients who are eligible in inclusion criteria will be advised to undergo post operative clinical examination, appropriate x-rays and computerized tomography.

Data collection procedure:

Patients with tibial diaphyseal fractures who undergone reamed intramedullary nailing with semi-extended suprapatellar or standard infrapatellar approach to be evaluated and studied over a period of 1 year in selected patients at KLEs Dr. Prabhakar Kore Hospital and Medical Research Centre, Belagavi.

All the patients will be reviewed postoperatively using clinical examination , x-rays and computerized tomography scan. The most widely utilized method in clinical assessment is the foot-thigh angle (TFA) measurement. The operator compares the measurements between the longitudinal axis of the thigh with the longitudinal axis of the foot. This can be performed with the patient supine or prone, however the latter is most commonly preferred. In prone, the patient should have their knee flexed to 90 degrees and the ankle at neutral flexion and the foot axis and thigh axis of both lower extremities are measured by goniometry. The difference between the two is determined as the rotational difference.

All patients will be assessed postoperatively for rotational alignment using x-rays. "First, a true lateral of the knee is obtained by superimposing the medial and lateral femoral condyles. With the leg held stationary, the fluoroscopic unit is rotated 90 degrees, which provided a true anterio-posterior (AP) view. If the tibial fracture is accurately reduced, rotation of an additional 10 to 15 degrees provided an accurate mortise view of the ankle"[134]. If it was more than 15 degrees, it is taken as external malrotation and if it was less than 10 degrees, it was declared internal malrotation.

Patients will be evaluated with computerized tomography also. In a supine position with both lower limbs in full extension with a support to minimize movement during scanning. The proximal and distal transverse axes were determined by CT scanning. The CT images included axial cuts just above the proximal tibiofibular joint and immediately proximal to the tibiotalar articulation of both limbs. Rotation measurements were made from the CT slices taken. The proximal measurement was defined as the angle between the tibia posterior cortex immediately above the fibula head and the transverse axis . In the distal, the measurement was taken as the angle between the line passing from the fibula and tibia center on the slice taken

immediately over the tibiotalar joint and the transverse axis . By comparing with the healthy side, the rotational difference between the two sides was defined. Positive values were evaluated as external malrotation and negative values as internal malrotation. As has been accepted in previous studies on malrotation in literature, more than 10 degrees between the two extremities was accepted as a rotational difference.

Data processing and analysis/statistical analysis:

The rotational maalignment mean difference between the afflicted and unaffected sides in the IP and SP groups is the parameter taken into consideration.

Cornal plane:

$\bar{X}_1$ is the mean of first group (mean difference in alignment in coronal plane after suprapatellar

nailing)is 3.2 and $\bar{X}_2$ is mean for the second group (mean difference in alignment in coronal plane after infrapatellar nailing is 5.7.

The first group's standard deviation (s1) is 1.1, and the second group's standard deviation (s2) is 1.8.

The sample size that results from using these settings is 6.

Saggital plane:

$\bar{X}_1$ is the mean of first group (mean difference in alignment in after suprapatellar nailing) is 2.9 and $\bar{X}_2$ is mean for the second group (mean difference in alignment in after infrapatellar nailing is 5.5.

The first group's standard deviation (1) is denoted by s1, and the second group's standard deviation (2.3) is represented by s2.

The sample size that results from using these settings is 7.

The study will have a larger sample size (20) in order to increase confirmatory power.

There will two groups each with size. 20.

Does the study require any investigations or interventions to be conducted on patients or other humans or animals? If so, please describe briefly.

1) x-ray knee joint with full length tibia – true anteroposterior and lateral view

2) x-ray ankle mortise view

3) Computerized tomography of both tibia

-Other relevant investigations will be done as required.

-Animals are not involved in this study.

Budget analysis:

1)DIRECT COST:

A) Personal: 5000/-

B) Equipment's: NIL PER PATIENT

C) Investigations: NIL

2) INDIRECT COST:

A)Printing and copying supplies: Rs. 5000/-

B)Data collection and Transport: Rs.2000/-

C)Meeting and other expenses: NIL

3) MISCELLANEOUS: Rs.5000/-

Data analysis:

"Data is analysed using statistical software R version 4.4.0. and Microsoft Excel. Categorical variables given in the form of frequency tables. Continuous variables given in Mean ± SD / Median (Min, Max) form. Chi square test is used to check the association of categorical variables with groups. Normality of variable is checked by Shapiro Wilk test and QQ plot. If data follows normal distribution, parametric tests will be used. Otherwise, non-parametric tests will be used. Two sample t test/Welch's t test are used to compare the mean of variables over groups. Mann Whitney U test is used to compare the distribution of variables over groups. P-value less than or equal to 0.05 indicates statistical significance".

RESULTS

Study have measurements of 40 patients that are divided into IPN group and SPN group of 20 subjects each. The following table gives the comparison of demographical details over groups.

*Abbreviation: t – Two sample t test, MC – Chi square test with Monte Carlo simulation, * indicates statistical significance.*

Table 4: Comparison of demographical details over groups.

Demographic data	**subclass**	**IPN**	**SPN**	**overall**	**p-value**
Age (years)	Mean ± SD Median (Min, Max)	32.8 ± 13.63 28 (17, 60)	45.05 ± 18.07 40.5 (20, 83)	38.92 ± 16.97 33.5 (17, 83)	**0.0204^{t*}**
Gender	Female	3 (15%)	4 (20%)	7 (17.5%)	0.9999^{MC}
	Male	17 (85%)	16 (80%)	33 (82.5%)	

The mean age of subjects in the IPN group is 32.8 ± 13.63 years, with a median age of 28 years (ranging from 17 to 60). In the SPN group, the mean age is significantly higher at 45.05 ± 18.07 years, with a median age of 40.5 years (ranging from 20 to 83). From two sample t test, it is observed that, the difference in age between the groups is statistically significant (p-value = 0.0204).

Gender distribution shows that the IPN group consists of 3 (15%) females and 17 (85%) males, while the SPN group includes 4 (20%) females and 16 (80%) males. The gender distribution between the groups is not statistically significant according to the results of the Chi square test.(p-value = 0.9999).

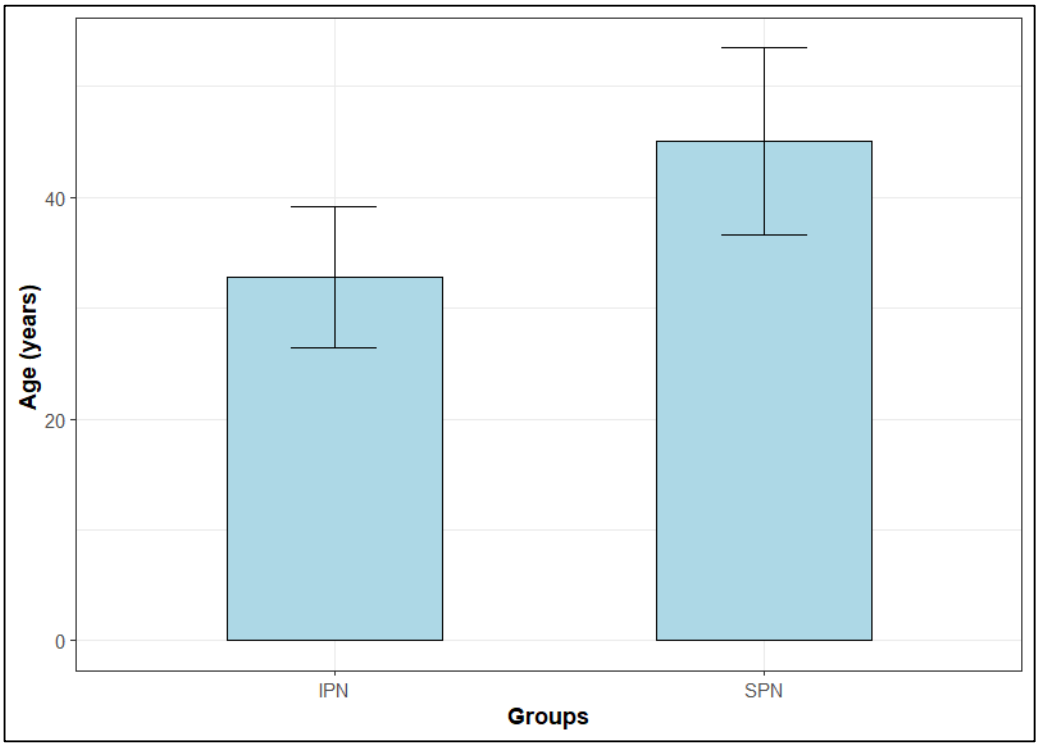


Figure 34: Mean plot of age over groups..

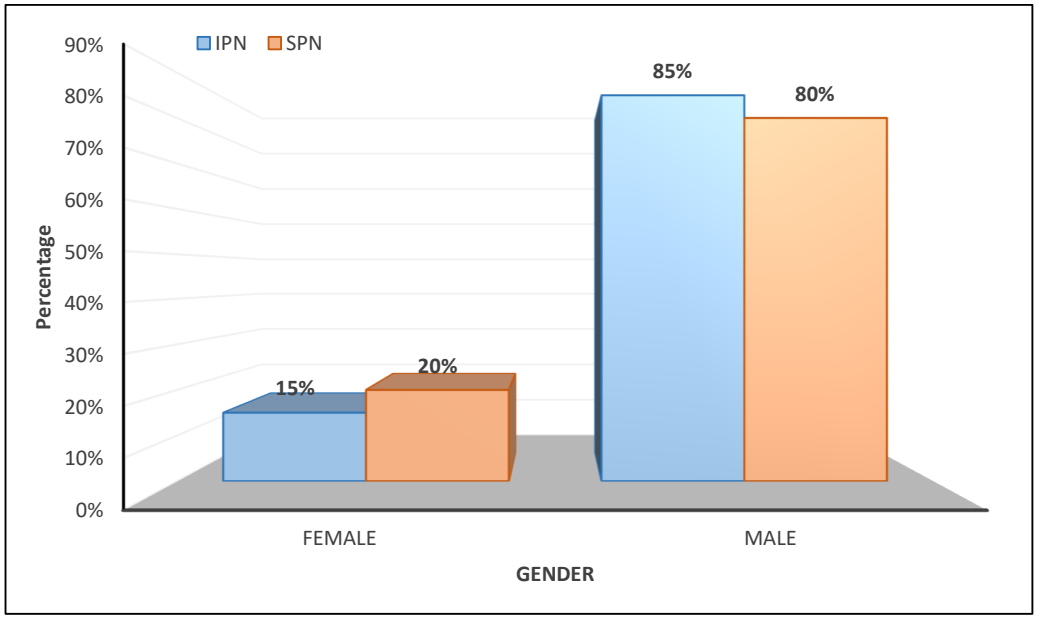


Figure 35: Distribution of gender over groups.

The following table gives the comparison of mode of injury over groups.

Table 5: Comparison of mode of injury over groups.

Mode of Injury	IPN	SPN	Total	p-value
Assault	2 (10%)	0 (0%)	2 (5%)	
Fall	2 (10%)	5 (25%)	7 (17.5%)	
Injury	1 (5%)	0 (0%)	1 (2.5%)	0.2469^{MC}
RTA	14 (70%)	15 (75%)	29 (72.5%)	
Sports	1 (5%)	0 (0%)	1 (2.5%)	

Our research indicates that the distribution of injury modes among groups does not significantly differ.

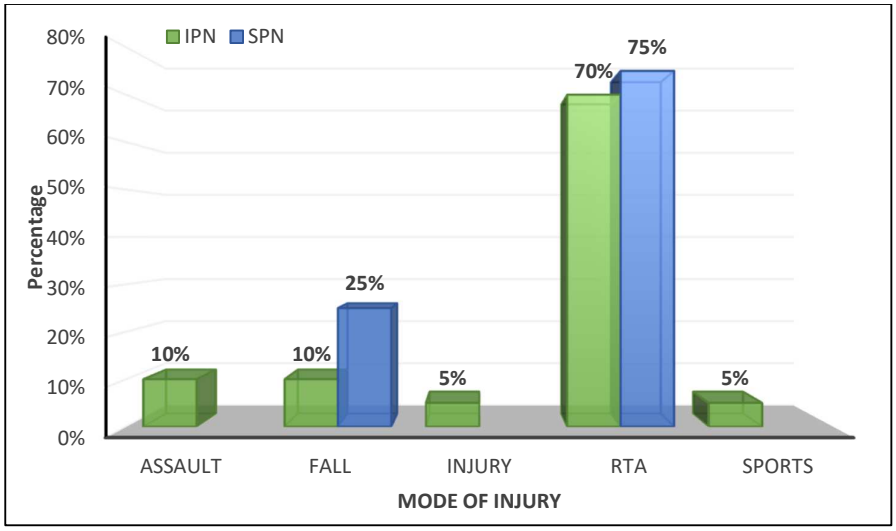


Figure 36: Distribution of mode of injury over groups.

The following table gives the comparison of diagnosis over groups.

Table 6: Comparison of diagnosis over groups.

Diagnosis	IPN	SPN	Total	p-value
Tibia distal third fracture	3 (15%)	3 (15%)	6 (15%)	0.9999[MC]
Tibia midshaft fracture	9 (45%)	9 (45%)	18 (45%)	
Tibia proximal third fracture	5 (25%)	4 (20%)	9 (22.5%)	
Tibia segmental complex fracture	3 (15%)	4 (20%)	7 (17.5%)	

Both groups show identical distributions for certain diagnoses: 3 (15%) cases of tibia distal third fractures and 9 (45%) cases of tibia midshaft fractures each. The IPN group has 5 (25%) cases of tibia proximal third fractures, whereas the SPN group has 4 (20%) cases. Additionally, there are 3 (15%) cases of tibia segmental complex fractures in the IPN group and 4 (20%) cases in the SPN group. The distribution of diagnoses among groups does not significantly differ, according to the results of the Chi square test.

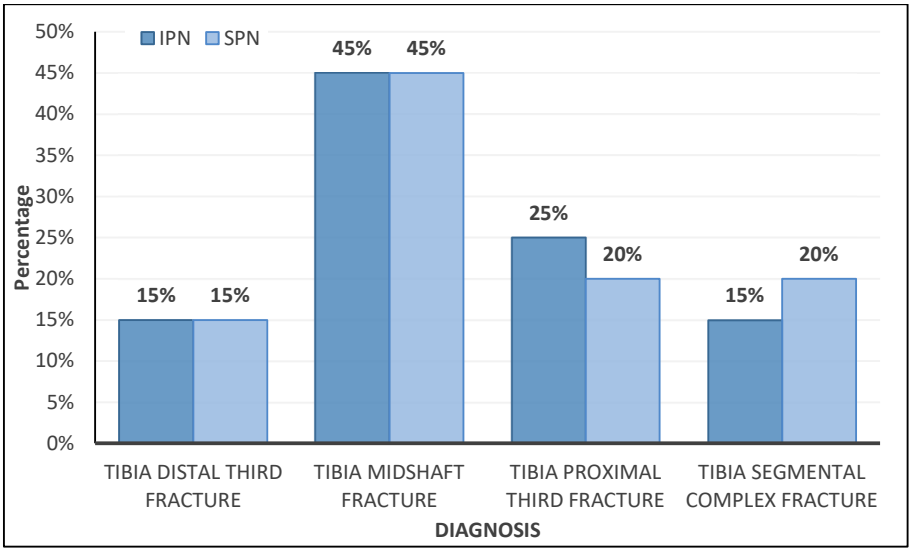


Figure 37: Distribution of diagnosis over groups.

The following table gives the comparison of side of injury over groups.

Table 7: Comparison of side of injury over groups.

Side	IPN	SPN	Total	p-value
Left	5 (25%)	10 (50%)	15 (37.5%)	0.1025[C]
Right	15 (75%)	10 (50%)	25 (62.5%)	

Abbreviation: C – Chi square test.

In the IPN group, 5 (25%) injuries occurred on the left side and 15 (75%) injuries on the right side. In the SPN group, 10 (50%) injuries on the left side and 10 (50%) injuries on the right side. The distribution of side of injury across groups does not significantly differ, according to the results of the Chi square test.

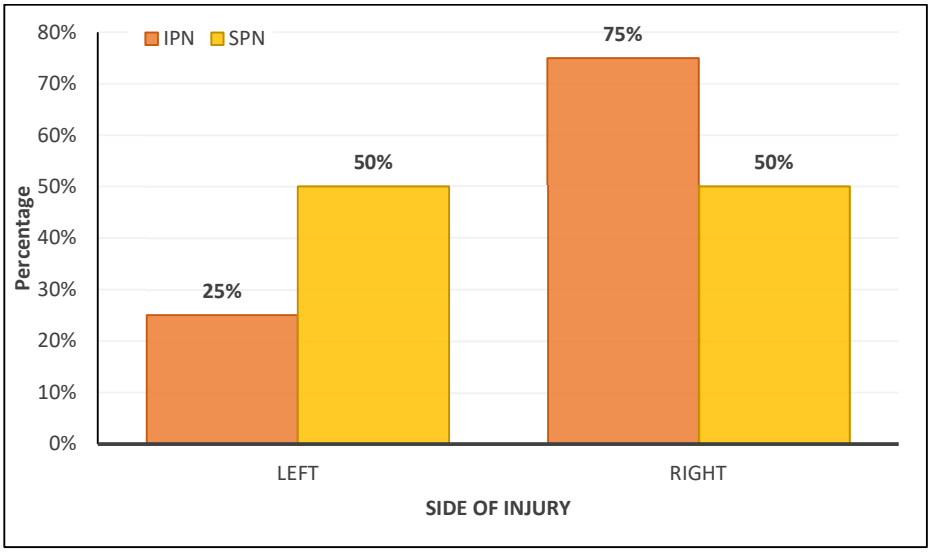


Figure 38: Distribution of side of injury over groups.

The following table gives the comparison of type of fracture over groups.

Table 8: Comparison of type of fracture over groups.

A O Type	IPN	SPN	Total	p-value
AO 42 A1	4 (20%)	3 (15%)	7 (17.5%)	
AO 42 A2	4 (20%)	4 (20%)	8 (20%)	
AO 42 A3	5 (25%)	4 (20%)	9 (22.5%)	
AO 42 B1	1 (5%)	1 (5%)	2 (5%)	
AO 42 B2	2 (10%)	1 (5%)	3 (7.5%)	0.9999^{MC}
AO 42 B3	1 (5%)	2 (10%)	3 (7.5%)	
AO 42 C2	2 (10%)	2 (10%)	4 (10%)	
AO 42 C3	1 (5%)	2 (10%)	3 (7.5%)	
AO 43 C1	0 (0%)	1 (5%)	1 (2.5%)	

The distribution of side of injury across groups does not significantly differ, according to the results of the Chi square test.

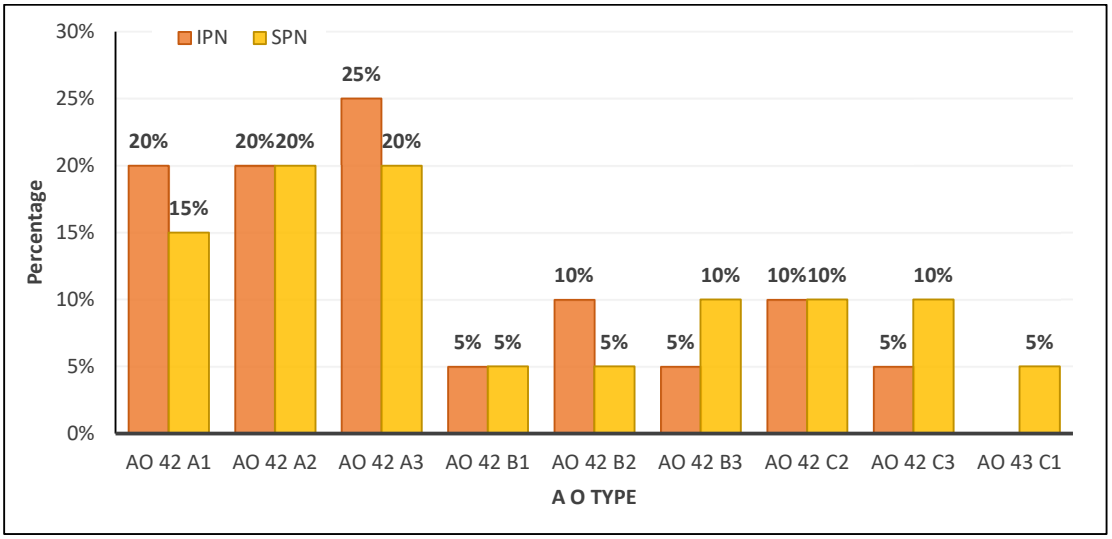


Figure 39: Distribution of type of fracture over groups.

The following table gives the comparison of nature of fracture over groups.

Table 9: Comparison of nature of fracture over groups.

Nature of Fracture	IPN	SPN	Total	p-value
Complex irregular	1 (5%)	2 (10%)	3 (7.5%)	
Complex segmental	2 (10%)	2 (10%)	4 (10%)	
Complex spiral	0 (0%)	1 (5%)	1 (2.5%)	
Simple Oblique	4 (20%)	4 (20%)	8 (20%)	
Simple spiral	4 (20%)	3 (15%)	7 (17.5%)	0.9999[MC]
Simple transverse	5 (25%)	4 (20%)	9 (22.5%)	
Wedge bending	2 (10%)	1 (5%)	3 (7.5%)	
Wedge fragmented	1 (5%)	2 (10%)	3 (7.5%)	
Wedge spiral	1 (5%)	1 (5%)	2 (5%)	

The distribution of side of injury across groups does not significantly differ, according to the results of the Chi square test.

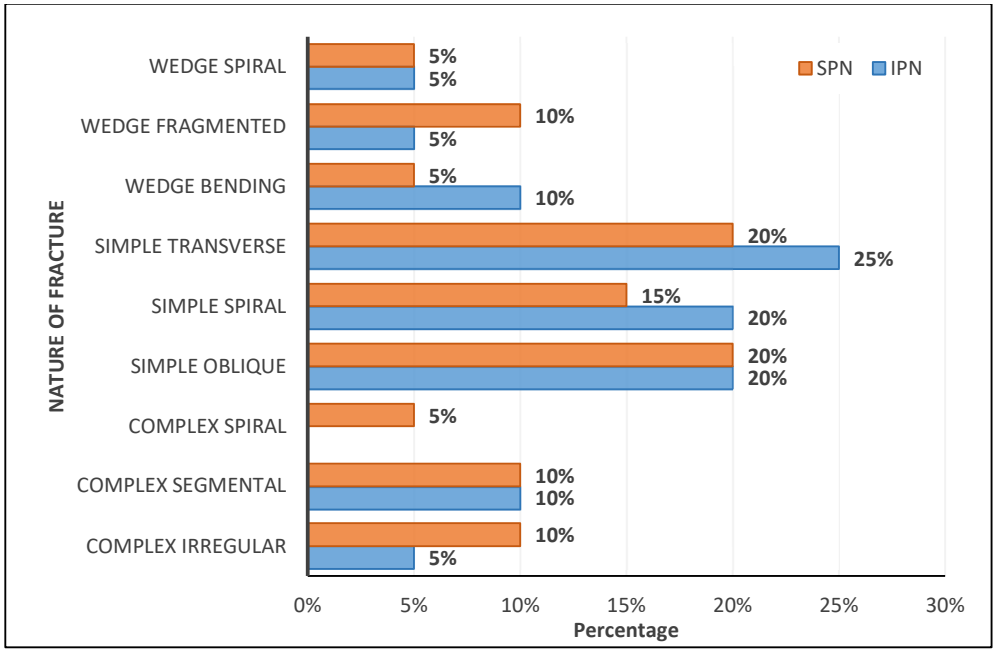


Figure 40: Distribution of nature of fracture over groups.

The following table gives the comparison of rotational malalignment with thigh foot angle over groups.

Table 10: Comparison of rotational malalignment with thigh foot angle.

Variate	Subclass	IPN	SPN	overall	p-value
TFA Rotational Difference	<10	15 (75%)	19 (95%)	34 (85%)	0.1934[MC]
	≥10	5 (25%)	1 (5%)	6 (15%)	
	Mean ± SD Median (Min, Max)	6.7 ± 3.8 6 (0, 14)	4.3 ± 3.06 4 (0, 12)	5.5 ± 3.62 4 (0, 14)	**0.0340[t]***
INT or EXT	External	13 (65%)	13 (65%)	26 (65%)	0.5672[MC]
	Internal	6 (30%)	4 (20%)	10 (25%)	
	NIL	1 (5%)	3 (15%)	4 (10%)	

In IPN group, 15 (75%) had rotational difference <10 degrees and 5 (25%) had rotational difference ≥10 degrees. In SPN group, 19 (95%) had rotational difference <10 degrees and 1 (5%) had rotational difference ≥10 degrees. The distribution of side of injury across groups does not significantly differ, according to the results of the Chi square test. (p-value = 0.1934).

The IPN group has a mean rotational difference of 6.7 ± 3.8 degrees, with a median of 6 degrees (ranging from 0 to 14 degrees). The SPN group shows a lower mean rotational difference of 4.3 ± 3.06 degrees, with a median of 4 degrees (ranging from 0 to 12 degrees). The TFA Rotational difference across groups shows a significant difference, according to the results of the two sample t test (p-value = 0.0340).

Regarding the type of rotational malalignment, both groups have the same percentage of external rotation cases (65%). The IPN group has 6 (30%) internal

rotation cases and 1 (5%) case with no malalignment, whereas the SPN group has 4 (20%) internal rotation cases and 3 (15%) cases with no malalignment. The distribution of side of injury across groups does not significantly differ, according to the results of the Chi square test.

(p-value = 0.5672).

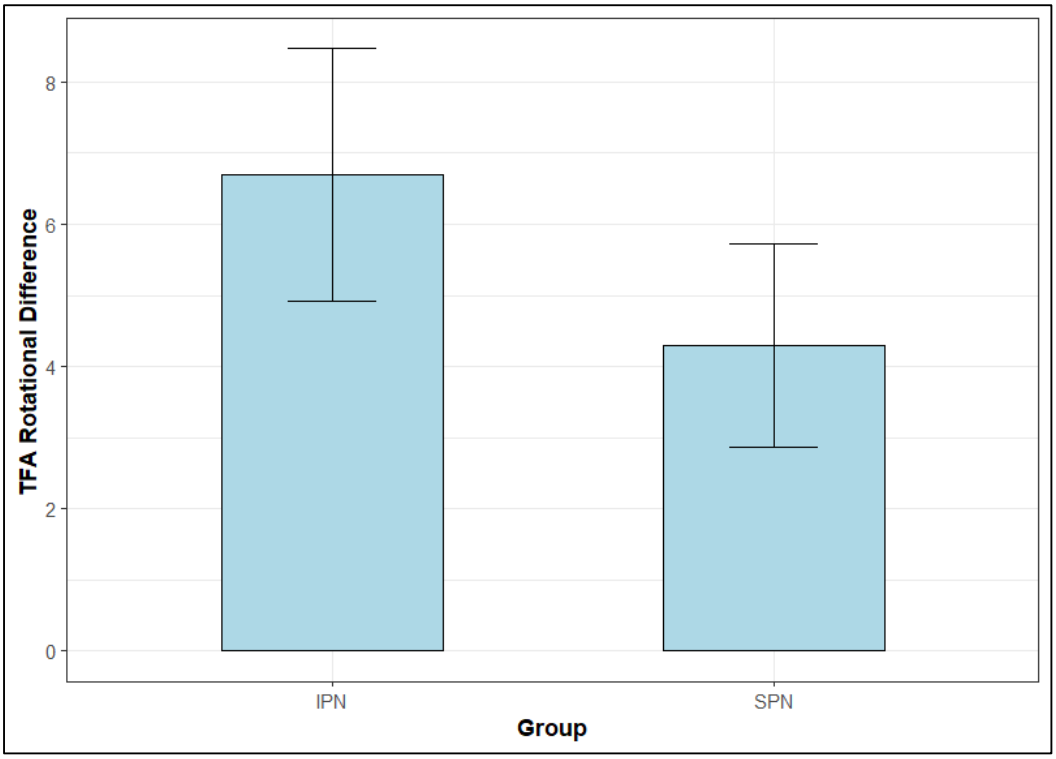


Figure 41: Mean plot of rotational malalignment with thigh foot angle over groups. The following table gives the comparison of rotational malalignment with X-ray over groups.

Table 11: Comparison of rotational malalignment with X-ray over groups.

Variate	Subclass	IPN	SPN	overall	"p-value"
X-ray Rotational Difference	<10	14 (70%)	19 (95%)	33 (82.5%)	0.1044[MC]
	≥10	6 (30%)	1 (5%)	7 (17.5%)	
	Mean ± SD	6.5 ± 4.35	4 ± 3.04	5.25 ± 3.91	**0.0417[t]***
	Median (Min, Max)	6 (0, 14)	3 (0, 12)	4 (0, 14)	
INT or EXT	External	12 (60%)	13 (65%)	25 (62.5%)	0.9999[MC]
	Internal	6 (30%)	5 (25%)	11 (27.5%)	
	NIL	2 (10%)	2 (10%)	4 (10%)	

In IPN group, 14 (70%) had rotational difference <10 degrees and 6 (30%) had rotational difference ≥10 degrees. In SPN group, 19 (95%) had rotational difference <10 degrees and 1 (5%) had rotational difference ≥10 degrees. However, the distribution across groups does not significantly differ, according to the results of the Chi square test (p-value = 0.1044).

The IPN group has a mean X-ray rotational difference of 6.5 ± 4.35 degrees, with a median of 6 degrees (ranging from 0 to 14 degrees). The SPN group shows a lower mean X-ray rotational difference of 4 ± 3.04 degrees, with a median of 3 degrees (ranging from 0 to 12 degrees). From two sample t test, this difference in rotational malalignment is statistically significant (p-value = 0.0417).

For rotational malalignment observed in X-rays, the IPN group has 12 (60%) cases of external rotation, 6 (30%) cases of internal rotation, and 2 (10%) cases with no malalignment. The SPN group has 13 (65%) cases of external rotation, 5 (25%) cases of internal rotation, and 2 (10%) cases with no malalignment. The results of the Chi square test show that there is no statistically significant difference in the type of rotational malalignment (p-value = 0.9999).

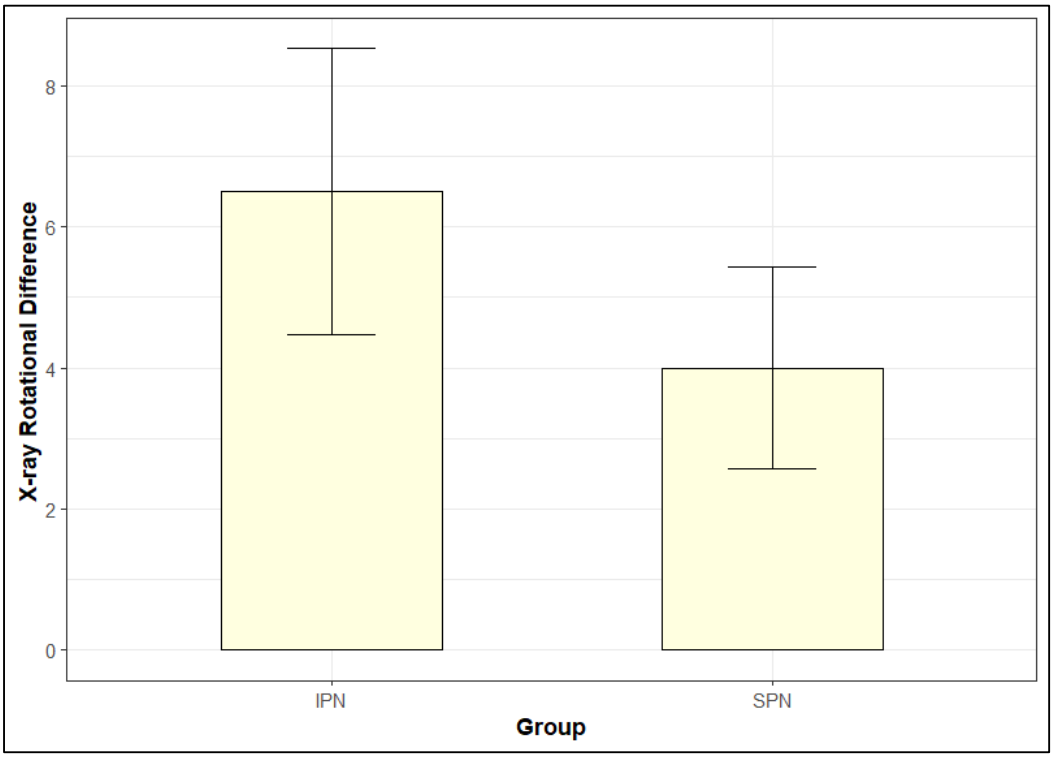


Figure 42: Mean plot of rotational malalignment with X-ray over groups.

The following table gives the comparison of rotational malalignment with CT over groups.

Table 12: Comparison of rotational malalignment with CT over groups.

Variables	**Sub Category**	**IPN**	**SPN**	**Total**	**p-value**
CT Rotational Difference	<10	13 (65%)	19 (95%)	32 (80%)	0.0510[MC]
	≥10	7 (35%)	1 (5%)	8 (20%)	
	Mean ± SD Median (Min, Max)	8.21 ± 4.73 6.3 (1.2, 17.7)	4.87 ± 2.96 3.95 (1.2, 13.9)	6.54 ± 4.25 5.7 (1.2, 17.7)	**0.0199[MW*]**
INT or EXT	External	14 (70%)	13 (65%)	27 (67.5%)	0.7357[MC]
	Internal	6 (30%)	7 (35%)	13 (32.5%)	

In IPN group, 13 (65%) had rotational difference < 10 degrees and 7 (35%) had rotational difference ≥10 degrees. In SPN group, 19 (95%) had rotational difference <10 degrees and 1 (5%) had rotational difference ≥10 degrees. However, The distribution between the groups does not significantly differ, according to the results of the Chi square test (p-value = 0.0510).

The IPN group has a mean CT rotational difference of 8.21 ± 4.73 degrees, with a median of 6.3 degrees (ranging from 1.2 to 17.7 degrees). The SPN group shows a lower mean CT rotational difference of 4.87 ± 2.96 degrees, with a median of 3.95 degrees (ranging from 1.2 to 13.9 degrees). The difference in CT rotational malalignment between the groups is shown to be statistically significant based on the Mann Whitney U test (p-value = 0.0199).

Regarding the type of rotational malalignment, in the IPN group, 14 (70%) cases show external rotation, and 6 (30%) cases show internal rotation. In the SPN group,

13 (65%) cases show external rotation, and 7 (35%) cases show internal rotation. It can be seen from the Chi square test that there is no statistically significant difference between the groups' rotational malalignment types.

(p-value = 0.7357).

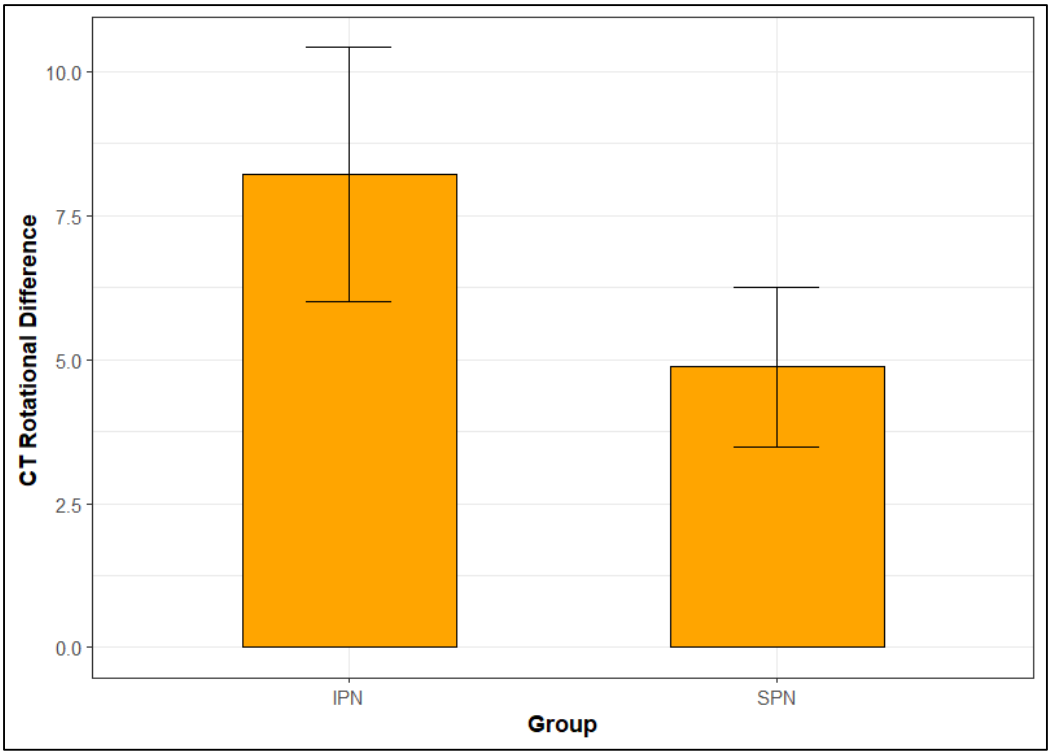


Figure 43: Mean plot of rotational malalignment with CT over groups.

The following table gives the comparison of Intraoperative time over groups.

Table 13: Comparison of Intraoperative time over groups.

Variables	IPN	SPN	Total	p-value
Intraoperative time	102.45 ± 6.89 102.5 (92, 120)	82.1 ± 7.49 81 (71, 99)	92.28 ± 12.51 94 (71, 120)	**< 0.001^{t*}**

*Abbreviation: t – Two sample t test, * indicates statistical significance.*

The IPN group has a mean intraoperative time of 102.45 ± 6.89 minutes, with a median time of 102.5 minutes (ranging from 92 to 120 minutes). In contrast, the SPN group has a significantly shorter mean intraoperative time of 82.1 ± 7.49minutes, with a median time of 81 minutes (ranging from 71 to 99 minutes). The intraoperative time across groups differs significantly, according to the results of the two sample t test. (p-value < 0.001).

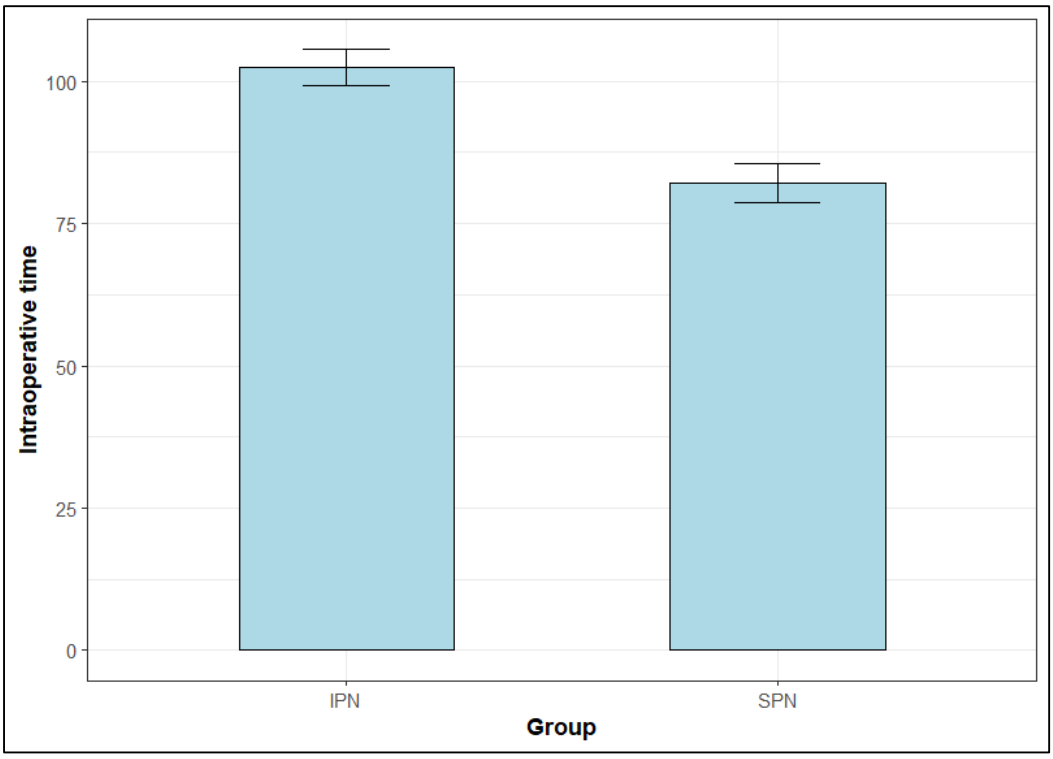


Figure 44: Mean plot of intraoperative time over groups.

The following table gives the comparison of Intraoperative blood loss over groups.

Table 14: Comparison of Intraoperative blood loss over groups.

Variables	IPN	SPN	Total	p-value
Intraoperative blood loss	65.3 ± 4.86 64 (58, 78)	48.6 ± 8 48.5 (37, 62)	56.95 ± 10.68 60 (37, 78)	**< 0.001^{WT*}**

*Abbreviation: WT – Welch's t test, * indicates statistical significance.*

The IPN group has a mean blood loss of 65.3 ± 4.86 mL, with a median of 64 mL (ranging from 58 to 78 mL). In contrast, the SPN group has a significantly lower mean blood loss of 48.6 ± 8 mL, with a median of 48.5 mL (ranging from 37 to 62 mL). From Welch's t test, it is observed that, there is significant difference in intraoperative blood loss over groups (p-value < 0.001).

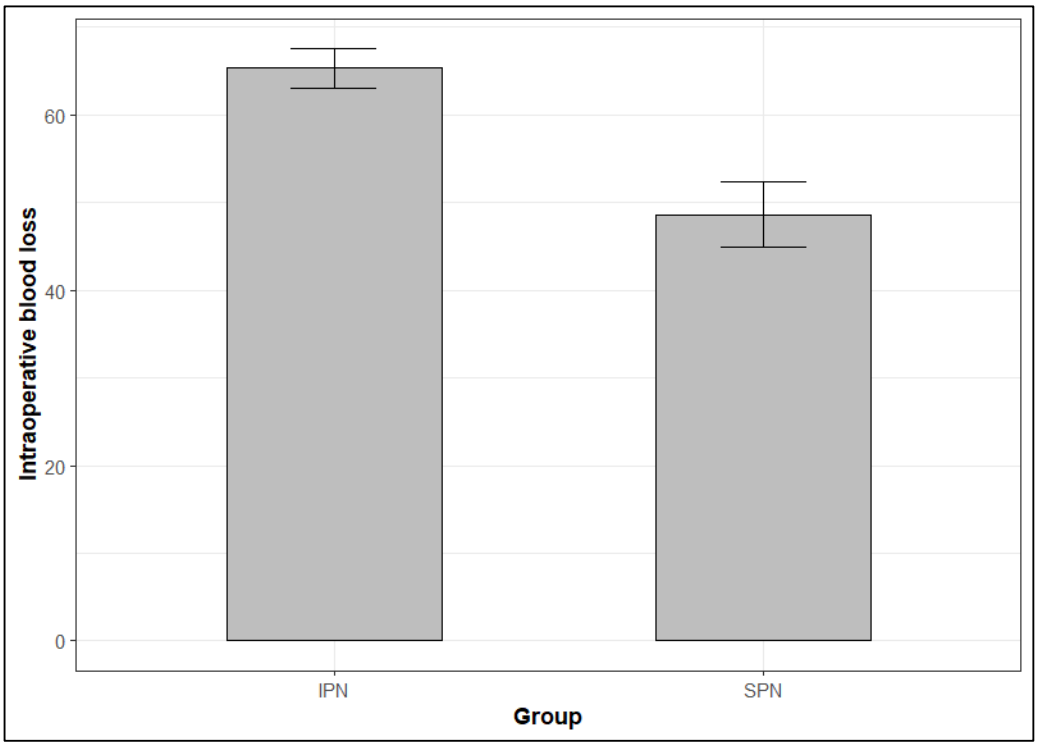


Figure 45: Mean plot of intraoperative blood loss over groups.

The following table gives the comparison of Intraoperative time over groups.

Table 15: Comparison of Fluoroscopy Time over groups.

Variables	IPN	SPN	Total	p-value
TRD/FT	119.75 ± 10.57 119 (101, 140)	90.5 ± 5.23 91 (80, 102)	105.12 ± 16.94 101.5 (80, 140)	**< 0.001^{WT*}**

*Abbreviation: WT – Welch's t test, * indicates statistical significance.*

The IPN group has a mean TRD/FT of 119.75 ± 10.57, with a median of 119 (ranging from 101 to 140). On the other hand, the SPN group exhibits a significantly lower mean TRD/FT of 90.5 ± 5.23, with a median of 91 (ranging from 80 to 102). There is a statistically significant difference in the TRD/FT across groups, as shown by Welch's t test (p-value < 0.001).

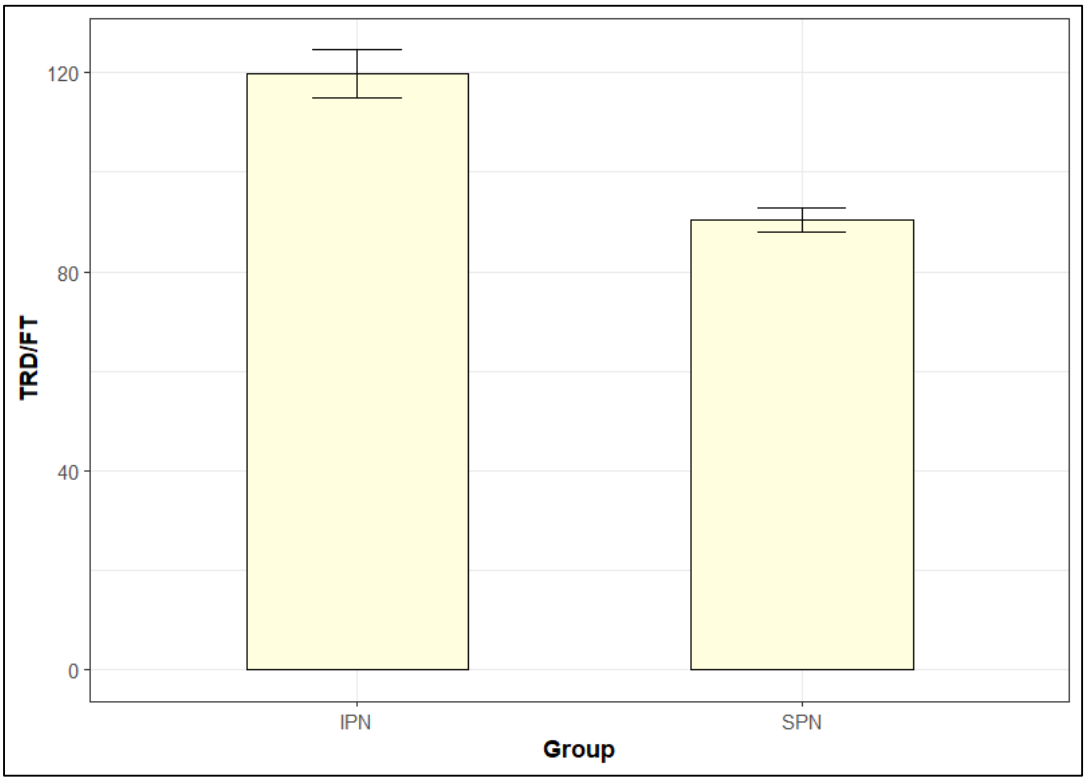


Figure 46: Mean plot of Fluoroscopy Time over groups.

The following table gives the comparison of Intraoperative blood loss over groups.

Table 16: Comparison of Kujala score over groups.

Variables	IPN	SPN	Total	p-value
Kujala	60.15 ± 5.68 59.5 (51, 68)	73 ± 4.76 73.5 (63, 79)	66.58 ± 8.31 67.5 (51, 79)	**< 0.001t***

*Abbreviation: t – Two sample t test, * indicates statistical significance.*

The IPN group has a mean Kujala score of 60.15 ± 5.68, with a median of 59.5 (ranging from 51 to 68). Conversely, the SPN group demonstrates a significantly higher mean Kujala score of 73 ± 4.76, with a median of 73.5 (ranging from 63 to 79). The results of the two sample t test show that Kujala score differs significantly from the other groups (p-value< 0.001).

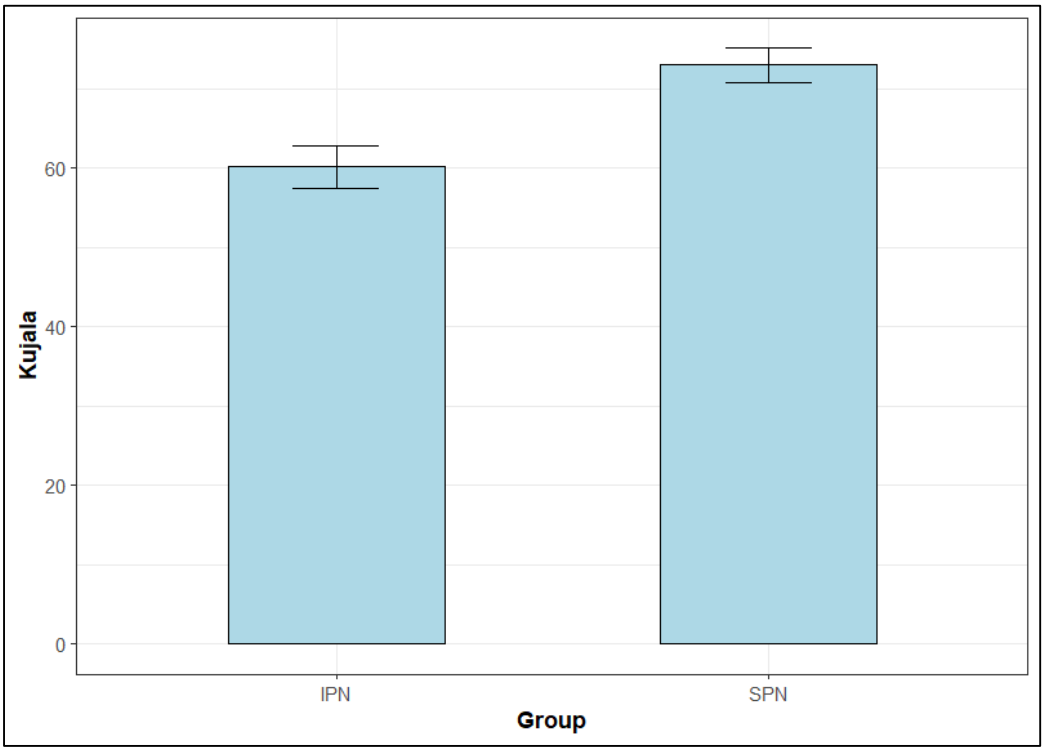


Figure 47: Mean plot of Kujala score over groups.

The following table gives the comparison of Anterior knee pain with VAS score over groups.

Table 17: Comparison of Anterior knee pain with VAS score over groups.

Variables	**IPN**	**SPN**	**Total**	**p-value**
VAS score	4.65 ± 1.27 4 (3, 7)	3.7 ± 1.3 3.5 (2, 6)	4.18 ± 1.36 4 (2, 7)	**0.0323^{MW*}**

*Abbreviation: MW – Mann Whitney U test, * indicates statistical significance.*

In the IPN group, the mean VAS score is 4.65 ± 1.27, with a median of 4 (ranging from 3 to 7). On the other hand, the SPN group shows a lower mean VAS score of 3.7 ± 1.3, with a median of 3.5 (ranging from 2 to 6). The distribution of VAS scores among groups shows a significant difference, as determined by the Mann Whitney U test (p-value = 0.0323).

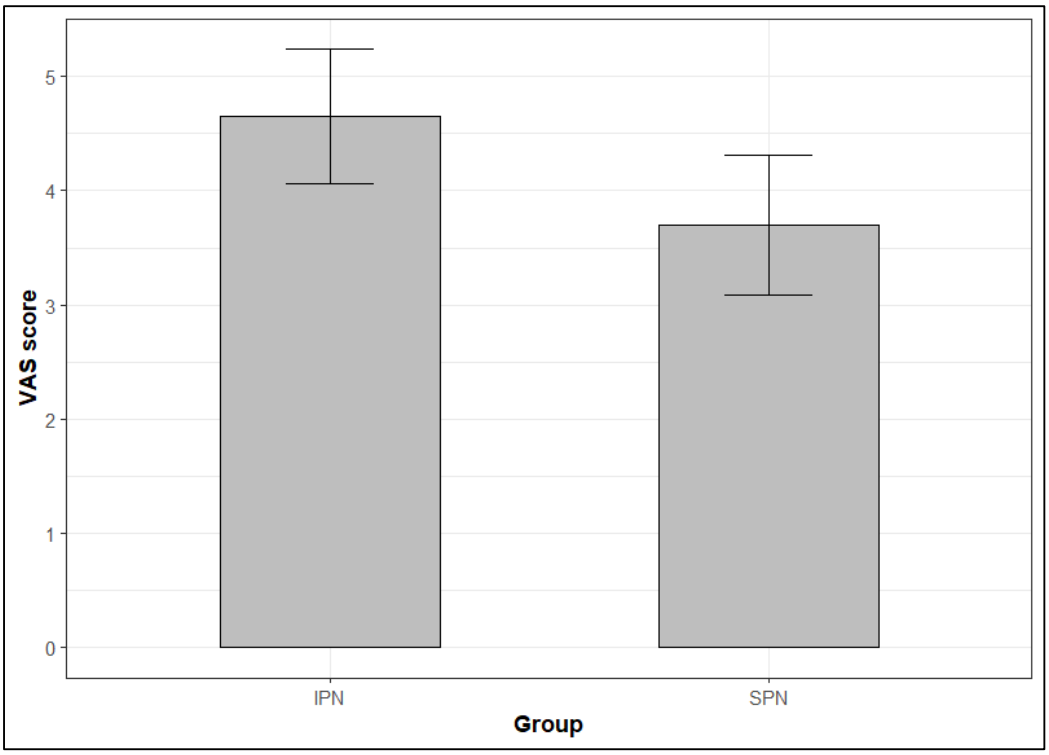


Figure 48: Mean plot of anterior knee pain with VAS score over groups.

The following table gives the comparison of Lower Extremity Functional Score (LEFS) over groups.

Table 18: Comparison of Lower Extremity Functional Score (LEFS) over groups.

Variables	IPN	SPN	Total	p-value
Lefs score	69.35 ± 2.46 69 (65, 73)	74.65 ± 1.66 75 (72, 77)	72 ± 3.39 73 (65, 77)	**< 0.001^{MW*}**

In the IPN group, the mean LEFS score is 69.35 ± 2.46, with a median of 69 (ranging from 65 to 73). Conversely, the SPN group exhibits a significantly higher mean LEFS score of 74.65 ± 1.66, with a median of 75 (ranging from 72 to 77). The distribution of Lefs scores among groups shows a significant variation, according to the Mann Whitney U test (p-value < 0.001).

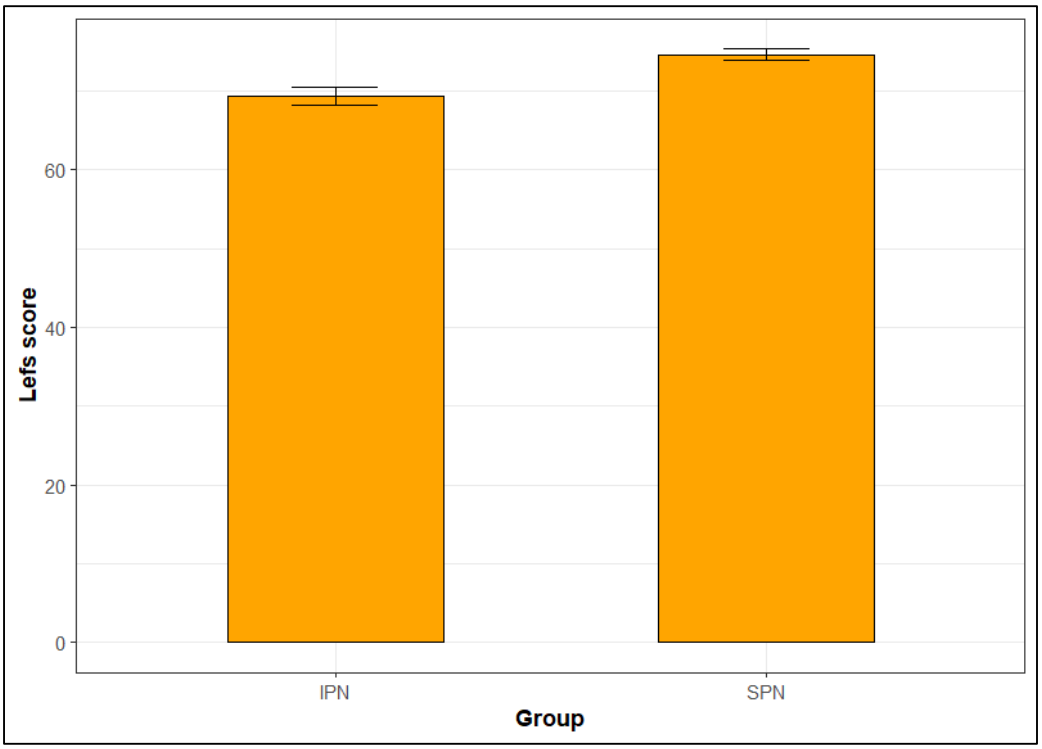


Figure 49: Mean plot of Lower Extremity Functional Score (LEFS) over groups.

The following table gives the comparison of time to union over groups.

Table 19: Comparison of time to union over groups.

Variables	IPN	SPN	Total	p-value
Time to union	6.15 ± 1.23 6 (4, 8)	5 ± 1.03 5 (4, 7)	5.58 ± 1.26 5 (4, 8)	**0.0041^{MW*}**

In the IPN group, the mean time to union is 6.15 ± 1.23 weeks, with a median of 6 weeks (ranging from 4 to 8 weeks). In contrast, the SPN group shows a significantly shorter mean time to union of 5 ± 1.03 weeks, with a median of 5 weeks (ranging from 4 to 7 weeks). The distribution of time to union across groups shows a significant difference, according to the Mann Whitney U test (p-value = 0.0041).

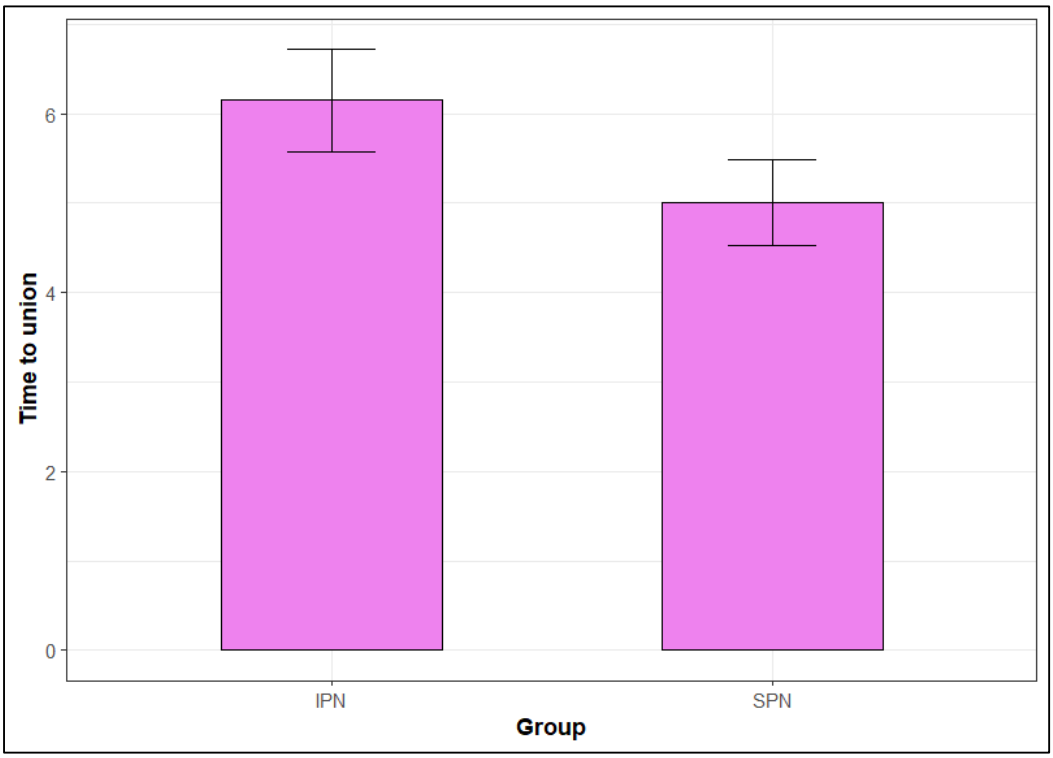


Figure 50: Mean plot of time to union over groups.

DISCUSSION

The most popular and recommended course of treatment for tibia diaphyseal fractures is intramedullar nailing. Nonoperative treatment for tibial diaphyseal fractures should only be pursued if closed reduction is unable to achieve sufficient alignment. Among the reasons for surgical management are insufficient closed reduction of the fracture, open contaminated fractures, related vascular damage, a soft tissue envelope that makes a cast impractical, a patient unwilling to comply with closed management, and the patient's desire to not wear a cast. Many patients and physicians find tibial nailing to be appealing due to its quick post-operative mobility knee & ankle, reduced need for follow-up visits, and immediate ability to bear weight.

This is particularly relevant given that many RCT results have demonstrated that, “in terms of nonunion, malunion, comorbidities, and delay to return to work, operative fixation is preferable to closed treatment”[99]. There are often complications occurring after surgeries, and IMIL nailing is no exception. When IMIL nailing is used for tibial fractures, there have been high documented occurrences of malrotation, malunion, and nonunion. Despite being a commonly performed treatment, intramedullary nailing of the tibia lacks a standard technique, as stated in the literature. It is conceivable to assume that this lack of standardization contributes to the reported issues.

“Despite being the standard of care, infrapatellar tibial nailing (IPN) is still technically challenging due to the numerous adjustments made during intraoperative imaging and the proximal fracture fragment displacement with knee flexion caused by the quadriceps and extensor complex”[40]. Because this technique requires the user to insert the nail with their knee flexed, it is more difficult to use in proximal one-third fractures due to the quadriceps muscle's action, which pushes the proximal fragment

into extension and causes abnormalities in rotation and angulation[18]. A novel method was devised to mitigate the disadvantage of infrapatellar nailing by positioning the knee in a semi-extended posture. This was initially shown in 2000 and then changed to the suprapatellar nailing technique[21]. A method of tibia nailing in a semiextended position of knee[41] was invented by Tornetta et al. to prevent the proximal fragment from going into extension deformity. This approach was later developed by several authors. This technique lessens fracture susceptibility, removes the problem of hyperflexion resulting in fragment misalignment, and simplifies radiographic imaging.

While the results of suprapatellar nailing were still being investigated, the outcomes of infrapatellar nailing were clearly recorded in numerous investigations. For tibia diaphyseal fractures, we compared semiextended suprapatellar nailing and conventional infrapatellar nailing in our study. Over the course of a year, data is gathered from patients who visited the emergency or outpatient department (OPD) with tibial diaphyseal fractures and had reamed intramedullary nailing using either the usual infrapatellar approach or the semi-extended suprapatellar technique. Two study groups of twenty patients each were randomly assigned to comprise the total of forty participants. Traditional infrapatellar nailing (IPN) was performed on one group, while semi-extended supratellar nailing (SPN) was performed on the other.

Rotational malalignment is potentially serious adverse effect of tibia IMIL nailing. In addition to aesthetic problems, torsional anomalies can result in several functional abnormalities, including lower limb arthrosis. Currently, little is known about the degree of rotation that matters, the exact incidence of malrotation following IMIL nail fixation of the tibia, and the necessity of correction. While numerous studies estimate an incidence ranging from 0 to 6 percentage27, the incidence of

malrotation following tibia IMIL nailing has been observed to be as high as 30% in practice[12,29,30]. Malrotation between various types of tibia IMIL nailing is rarely documented in the literature. Therefore, the 1^0 aim of our RCT is to see standard infrapatellar entrance techniques with suprapatellar semi-extended approaches in order to ascertain the prevalence and degree of rotational malalignment in tibial diaphyseal fractures. Additionally, our study examined the differences between suprapatellar and infrapatellar nailing procedures for tibia diaphyseal fractures in terms of intraoperative time, blood loss, fluoroscopy time at the time of surgery, and kujala score, vas score, lefs score, and union time in the final follow-up.

Malrotation can be assessed clinically and with radiography both intraoperatively and postoperatively. In a clinical setting, this is accomplished by taking the TFA (Thigh Foot Angle) of the affected and unaffected limbs and comparing them. Using lateral and anteroposterior views got after surgery, radiographic outcomes were measured in terms of the tibia's anatomic alignment. IPN is a technically challenging procedure that has historically presented challenges in avoiding muscle stress and getting adequate reduction in the lateral plane for both proximal and distal tibia fractures.

. Tibia shaft fractures in the hyperflexion posture often cause malreduction and an apex-anterior deformity in the sagittal plane[36].

If there is a doubt of malalignment during or after surgery, computerized tomography is the recommended imaging technique since it is effective, dependable, and independent of observer bias. “Malalignment in the sagittal, coronal and axial planes may be seen in tibial fractures. Generally, more than 1 cm shortness and more than 5^0 rotational or angular deformity are accepted as malunion”[114]. “In most of the studies malrotation was defined to be greater than 10 degrees” [12,16,29,30]. “Tibial

malrotation findings are minimal and usually patients have no clinical sign of tibial malrotation. By the patient noticing a difference in the cosmetic appearance of the foot, or asymmetry between legs, tibial malrotation may be determined"[12,29]. Bonnevialle et al. reported "no clinical sign of tibial malrotation though the values were 22 external and 31 internal malrotation"[113]. "The most accurate measurement technique of tibial rotation is anthropometric measurements made on autopsy samples. However, this technique is not possible in clinics"[112]. "The indirect measurement of tibial rotation can be determined in the clinic by measuring the TFA and the thigh-transmalleolar angle"[115]. In our study we measured the rotational malalignment with the help of TFA in prone and hip and knee at 90 degrees and comparing the operated limb with the healthy limb.

When measuring rotational difference clinically with thigh foot angle, significantly our findings suggest that the IPN group has a mean rotational difference of 6.7 ± 3.8 degrees, with a median of 6 degrees (ranging from 0 to 14 degrees). The SPN group shows a lower mean rotational difference of 4.3 ± 3.06 degrees, with a median of 4 degrees (ranging from 0 to 12 degrees). The TFA Rotational difference across groups shows a significant difference (p-value = 0.0340).

In most of the studies torsional variation of more than 10° (range 5–15°) is significant with respect to the unaffected limb was considered malrotation[12]

In IPN group, 15 (75%) had rotational difference <10 degrees and 5 (25%) had rotational difference ≥10 degrees. In SPN group, 19 (95%) had rotational difference <10 degrees and 1 (5%) had rotational difference ≥10 degrees.

Regarding the type of rotational malalignment, both groups have the same percentage of external rotation cases (65%). The IPN group has 6 (30%) internal rotation cases and 1 (5%) case with no malalignment, whereas the SPN group has 4

(20%) internal rotation cases and 3 (15%) cases with no malalignment. The type of rotational malalignment among groups does not significantly differ (p-value = 0.5672).

"All the patients were assessed intra-operatively for rotational alignment using the fluoroscopic images of knee and ankle of the same limb, as described in literature[116]. First, a true lateral of the knee was obtained by superimposing the medial and lateral femoral condyles. With the leg held stationary, the fluoroscopic unit was rotated 90 degrees, which provided a true anterio-posterior (AP) view. If the tibial fracture was accurately reduced, rotation of an additional 10 to 15 degrees provided an accurate mortise view of the ankle. If it was more than 15 degrees, it was taken as external malrotation and if it was less than 10 degrees, it was declared internal malrotation.

When measured with radiography (X-rays) , in IPN group, 14 (70%) had rotational difference <10 degrees and 6 (30%) had rotational difference ≥10 degrees. In SPN group, 19 (95%) had rotational difference <10 degrees and 1 (5%) had rotational difference ≥10 degrees."[134]

The IPN group has a mean X-ray rotational difference of 6.5 ± 4.35 degrees, with a median of 6 degrees (ranging from 0 to 14 degrees). The SPN group shows a lower mean X-ray rotational difference of 4 ± 3.04 degrees, with a median of 3 degrees (ranging from 0 to 12 degrees). From two sample t test, this difference in rotational malalignment is statistically significant (p-value = 0.0417).

For rotational malalignment observed in X-rays, the IPN group has 12 (60%) cases of external rotation, 6 (30%) cases of internal rotation, and 2 (10%) cases with no malalignment. The SPN group has 13 (65%) cases of external rotation, 5 (25%) cases of internal rotation, and 2 (10%) cases with no malalignment. There is no

statistically significant difference in the type of rotational malalignment between the groups (p-value = 0.9999).

The use of CT in radiological measurements was first described by Jacob et al. One study "done at a trauma center looking at the sequelae of tibial malunion on gait mechanics, they noticed that the incidence of rotational malreduction as determined by computed tomography (CT) appeared to be greater than that reported clinically"[12]. "Radiologic assessment, involving CT images of both tibiae, was used to quantify accurately the degree of tibial rotation based on a standard technique similar to those previously described in the literature"[112,117,118]. In order to reduce movement during scanning, the patient must be placed in a supine position with their legs fastened to an adjustable support.

"Proximal and distal transverse axes are determined with CT scanning . The angle is defined by the 2 transverse axes defines the tibial torsion. The CT images included a number of axial cuts (usually 2 or 3) taken 2 mm apart just above the proximal tibiofibular joint and then again just proximal to the tibiotalar articulation. The proximal reference line is determined by drawing a line tangent to the dorsal border of the tibia on the image captured just proximal to the fibular head"[118]. "The distal reference line is the transverse axis through the distal tibia that passes through the center of the fibula and tibia on a slice just above the distal tibial plafond"[112]. "Tibiofibular torsion is defined as the angle between the 2 axes. The contralateral limb was used as a control to the affected limb. Internal rotation deformity is assigned a negative value and external rotation was given a positive value with zero representing the calculated torsion of the normal or unaffected tibia"[12]. At some time following the 1st postop day but before being discharged from the hospital, all patients had scans. "From references in previous literature and for the purposes of this study,

we defined malrotation as a rotational difference of greater than 10° compared with the normal limb"[1,119,120].

When measured with computerized tomography in IPN group, 13 (65%) had rotational difference < 10 degrees and 7 (35%) had rotational difference ≥10 degrees. In SPN group, 19 (95%) had rotational difference <10 degrees and 1 (5%) had rotational difference ≥10 degrees.

The IPN group has a mean CT rotational difference of 8.21 ± 4.73 degrees, with a median of 6.3 degrees (ranging from 1.2 to 17.7 degrees). The SPN group shows a lower mean CT rotational difference of 4.87 ± 2.96 degrees, with a median of 3.95 degrees (ranging from 1.2 to 13.9 degrees). CT rotational malalignment between SPN and IPN is statistically significant (p-value = 0.0199).

Regarding the type of rotational malalignment, in the IPN group, 14 (70%) cases show external rotation, and 6 (30%) cases show internal rotation. In the SPN group, 13 (65%) cases show external rotation, and 7 (35%) cases show internal rotation.The difference in the type of rotational malalignment between the groups is not statistically significant (p-value = 0.7357).

This shows there is a significant association for infrapatellar nailing with both more incidence of malrotation and also greater amount of malrotation than SPN approach when measured clinically with thigh foot angle and radiologically with xrays and computerized tomography. We believe that with infrapatellar technique for a tibial shaft fracture in hyperflexed posistion, the quadriceps muscle pushes the proximal fragment into extension, causing angulation abnormalities and fragment displacement, making this method challenging. In the hyperflexion posture, proximal tibial fractures frequently result in malreduction and an apex-anterior deformity in the sagittal plane[36]. Whereas suprapatellar nailing provides a more precise entry point and

reduction of fracture. This method eliminates the issues of hyperflexion leading to fragment malalignment, reduces fracture easily due to its semi extended position.

"A patient losing blood during any surgery is a concern for both the surgeon and anesthetist. Precise estimation of blood loss is crucial because underestimation may lead to significant complications, and overestimation and unnecessary transfusion may increase complications and mortality"[12,122]. "There are many methods for intraoperative blood loss estimation, e.g., gravimetric, photometry, and visual estimation, but the most used method is visual estimation. Other methods are not widely used due to their unavailability, impracticality, or time consumption, e.g., gravimetric method, as the gauze must be weighed pre and post-use"[122,123]. In our study we used visual estimation method to assess blood loos

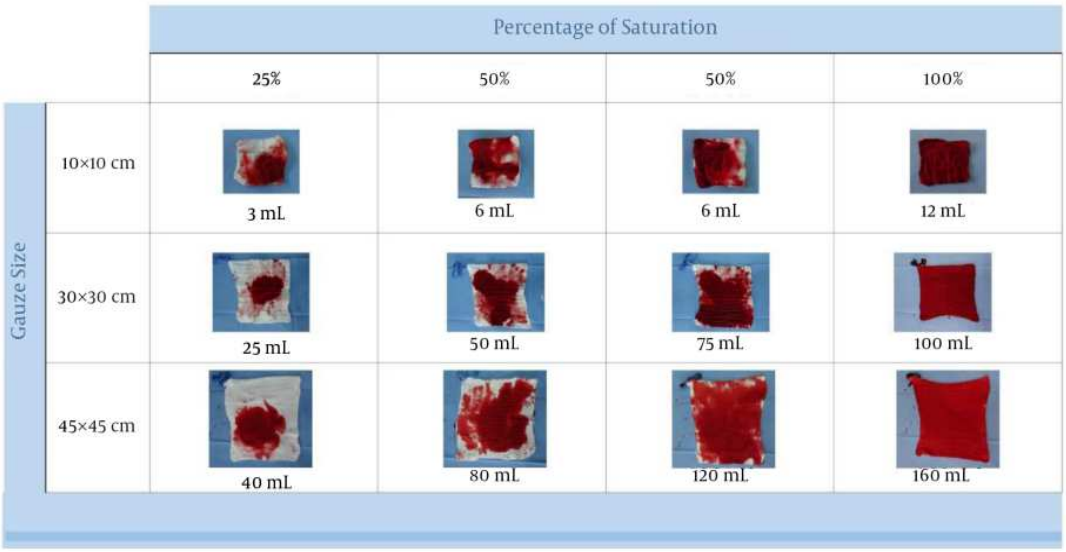


Figure 51 : Visual Guide for Determining Blood Loss for Three Different Sizes of Gauze. There was a 25% increase in total absorptive capacity when the gauze was dripping (supersaturated) and a 25% decrease in each category when the gauze was wet

The IPN group has a mean blood loss of 65.3 ± 4.86 mL, with a median of 64 mL (ranging from 58 to 78 mL). In contrast, the SPN group has a significantly lower mean blood loss of 48.6 ± 8 mL, with a median of 48.5 mL (ranging from 37 to 62 mL). There is significant difference in intraoperative blood loss over groups (p-value < 0.001).

"Two recent meta-analyses show a decreased operative time with the SP approach"[124,125]. Xu et al[125] "comparing 7 studies (3 randomized; 4 clinical controlled trials), found the IP approach to be more time consuming than the SP approach (*P*=.01)". Chen et al "evaluated 7 randomized controlled trials (RCT) and originally found no significant difference in operative time (*P*=.88); however, sensitivity analysis excluding an outlier study did show a significant reduction in operative time with the SP approach (*P*=.002)"[124].

Due to this confusion we compared the intraoperative time between both groups. The IPN group has a mean intraoperative time of 102.45 ± 6.89 minutes, with a median time of 102.5 minutes (ranging from 92 to 120 minutes). In contrast, the SPN group has a significantly shorter mean intraoperative time of 82.1 ± 7.49minutes, with a median time of 81 minutes (ranging from 71 to 99 minutes). The intraoperative time varies significantly between the groups (p-value < 0.001).

"The semi-extended position of the knee in the suprapatellar approach allows for quicker Patient positioning time and is not demanding in maintaining fracture reduction/position. In comparison, the infrapatellar approach requires at least 90° of knee flexion or hyperflexion to introduce the entry guide-wire and subsequent tibial nail"[126]. "Various techniques are adopted by surgeons to maintain the flexed position of the knee, which involve additional attachments, supports and manual fracture reduction, optimal patient positioning for the infrapatellar approach can be time-

consuming"[126]. "Whereas the semi-extended position required for suprapatellar approach is less demanding with a simple set-up"[18]. "The semi-extended position also facilitates maintenance of fracture reduction and reduces the risk of malalignment"[40]. There is minimal evidence in literature comparing patient positioning time in IP tibial nailing vs SP tibial nailing. In our study the IPN group has a mean TRD/FT of 119.75 ± 10.57, with a median of 119 (ranging from 101 to 140). On the other hand, the SPN group exhibits a significantly lower mean TRD/FT of 90.5 ± 5.23, with a median of 91 (ranging from 80 to 102). There is a statistically significant difference in the Fluroscopy Time across groups (p-value < 0.001). These findings tell us that suprapatellar nailing is associated with significant lesser intraoperative fluoroscopy time when compared to infrapatellar nailing.

Chronic anterior knee pain (AKP) is a serious issue after tibia fractures treated with intramedullary nailing. AKP was defined as any pain in front of knee, irrespective of its source—patella, the joint lines, or an incision. In order to avoid missing any individuals who may be experiencing knee pain, we have utilized a broad definition of AKP. One of the most frequent side effects of IMIL nailing is AKP. The specific reason of this pain is uncertain, but it is possible that damage to the knee's articular surfaces and injury o infrapatellar nerve is the primary factor.

According to several estimates, the percentage of patients claiming to have knee discomfort might range from 10% to 86%[124,127].

"Postoperative anterior knee pain can have several causes, such as prominence of nail, damage to intra-articular structures, injury to the patellar tendon or fat pad, injury to the saphenous nerve's infrapatellar branch, and changed biomechanics"[128]. Numerous research have assessed the results of anterior knee pain after applying the

SP and IP techniques. “The SPN group had considerably reduced postoperative pain scores in all five of the most recent meta-analyses”[124,130].

“After one and three months postoperatively, Sun et al. discovered no significant difference in the VAS scores between the IP and SP groups; however, after six, twelve, and twenty-four months, they found significantly lower VAS values in the SP group”[50]. Twelve months after suprapatellar nailing, Sanders et al. assessed forty-one patients and reported that none of them experienced anterior knee pain[42]. “When kneeling at all postoperative time periods, individuals treated with the suprapatellar method were shown to be able to transmit a greater mean proportion of weight through the affected leg compared to the unaffected leg, however MacDonald et al. reported no significant difference in VAS values”[127].

By avoiding the saphenous nerve's branches and protecting the patellar tendon, the suprapatellar approach may reduce the incidence of anterior knee pain[41]. To determine if the knee structure will be harmed by the suprapatellar nailing insertion, Eastman, J.G. and Tseng, S.S. performed a cadaveric study[129]. They discovered that during suprapatellar IMN surgery, the medial meniscus and intermeniscal ligament were most vulnerable, however the damage was limited to 1-2 mm.According to Courtney P. M., the suprapatellar technique provides good protection for the infrapatellar nerve[43].

Although Mark Jones contends that “the mean scores were higher in the infrapatellar group, their study found no difference in knee pain scores between suprapatellar IMN and infrapatellar IMN”[40]. According to our randomized controlled study, knee pain was less common and less severe when the suprapatellar method was used as compared to the infrapatellar insertion. We measured vas score for all patients

at the 6 months followup using vas score scale and compared between the suprapatellar nailing and infrapatellar nailing.

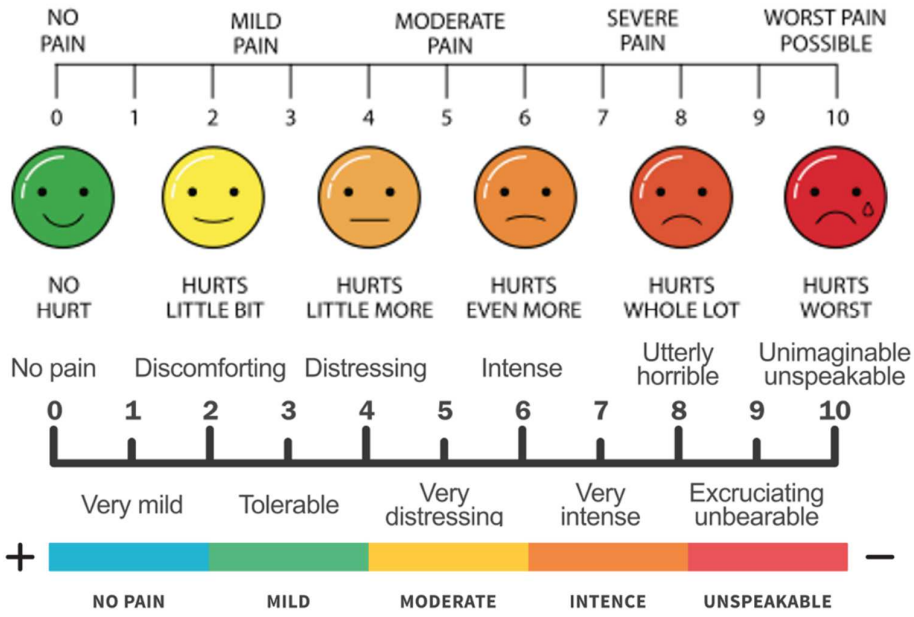


Figure 52 : VAS score pain assessment scale

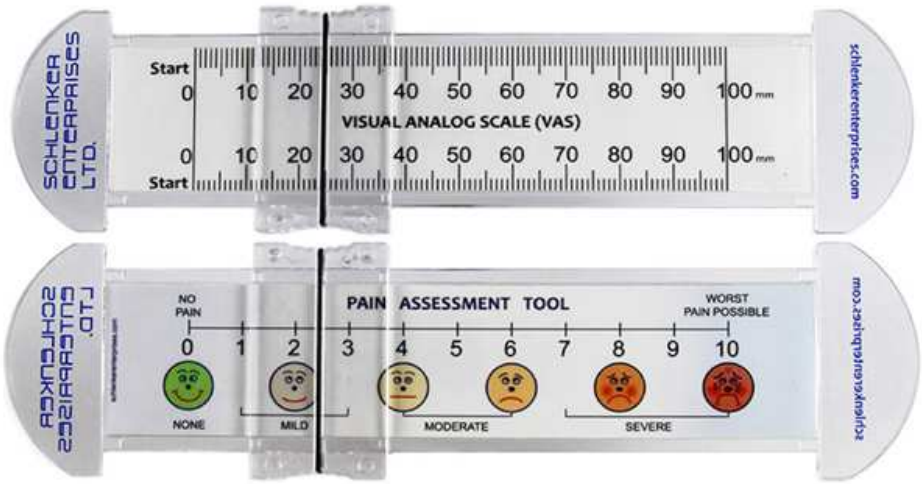


Figure 53 : VAS score pain assessment tool

In the IPN group, the mean VAS score is 4.65 ± 1.27, with a median of 4 (ranging from 3 to 7). On the other hand, the SPN group shows a lower mean VAS

score of 3.7 ± 1.3, with a median of 3.5 (ranging from 2 to 6). The distribution of VAS scores among groups shows a significant difference (p-value = 0.0323).

According to these results we can see the severity of pain is significantly less in suprapatellar nailing group.

The Kujala anterior knee pain scale was identified and also used to study prevalence of Patello Femoral knee pain. The results that follow compare the average postoperative KUJALA scores at the six-month followup.

The Kujala patellofemoral scoring system*

	Score		Score
1. Limp		8. Prolonged sitting with the knees flexed	
a) None	5	a) No difficulty	10
b) Slight or periodical	3	b) Pain after exercise	8
c) Constant	0	c) Constant pain	6
2. Support		d) Pain forces to extend knees temporarily	4
a) Full support without pain	5	e) Unable	0
b) Painful	3	9. Pain	
c) Weight bearing impossible	0	a) None	10
3. Walking		b) Slight and occasional	8
a) Unlimited	5	c) Interferes with sleep	6
b) More than 2 km	3	d) Occasionally severe	3
c) 1-2 km	2	e) Constant and severe	0
d) Unable	0	10. Swelling	
4. Stairs		a) None	10
a) No difficulty	10	b) After severe exertion	8
b) Slight pain when descending	8	c) After daily activities	6
c) Pain both when descending and ascending	5	d) Every evening	4
d) Unable	0	e) Constant	0
5. Squatting		11. Abnormal painful kneecap (patellar)	
a) No difficulty	5	movements (subluxations)	
b) Repeated squatting painful	4	a) None	10
c) Painful each time	3	b) Occasionally in sports activities	6
d) Possible with partial weight bearing	2	c) Occasionally in daily activities	4
e) Unable	0	d) At least one documented dislocation	2
6. Running		e) More than two dislocations	0
a) No difficulty	10	12. Atrophy of thigh	
b) Pain after more than 2 km	8	a) None	5
c) Slight pain from start	6	b) Slight	3
d) Severe pain	3	c) Severe	0
e) Unable	0	13. Flexion deficiency	
7. Jumping		a) None	5
a) No difficulty	10	b) Slight	3
b) Slight difficulty	7	c) Severe	0
c) Constant pain	2		
d) Unable	0	**Total score:**	

*Maximum score= 100

Figure 54 : The KUJALA patellofemoral scoring system.

The IPN group has a mean Kujala score of 60.15 ± 5.68, with a median of 59.5 (ranging from 51 to 68). Conversely, the SPN group demonstrates a significantly higher mean Kujala score of 73 ± 4.76, with a median of 73.5 (ranging from 63 to 79). The results of the two sample t test show that Kujala score differs significantly from the other groups (p-value< 0.001) after six months, with the SPN group scoring higher. "Similar results were observed in a research by Jones et al., where the SP group had higher KUJALA scores than the IP group[40]. "Nonetheless, a related investigation on transpatellar, medial parapatellar, and suprapatellar nailing conducted by Ozcan et al. did not discover a statistically significant difference in KUJALA ratings among the three groups"[132]. "In contrast to our findings, Cicekli et al. reported KUJALA scores of 87.82 and 83.37 in the SP and IP groups, respectively. This difference was not statistically significant (p=0.098)"[131]. Overall, we saw that in our instances, functional outcomes improved after surgery.

	Activities	Extreme Difficulty or Unable to Perform Activity	Quite a Bit of Difficulty	Moderate Difficulty	A Little Bit of Difficulty	No Difficulty
1	Any of your usual work, housework, or school activities.	0	1	2	3	4
2	Your usual hobbies, re creational or sporting activities.	0	1	2	3	4
3	Getting into or out of the bath.	0	1	2	3	4
4	Walking between rooms.	0	1	2	3	4
5	Putting on your shoes or socks.	0	1	2	3	4
6	Squatting.	0	1	2	3	4
7	Lifting an object, like a bag of groceries from the floor.	0	1	2	3	4
8	Performing light activities around your home.	0	1	2	3	4
9	Performing heavy activities around your home.	0	1	2	3	4
10	Getting into or out of a car.	0	1	2	3	4
11	Walking 2 blocks.	0	1	2	3	4
12	Walking a mile.	0	1	2	3	4
13	Going up or down 10 stairs (about 1 flight of stairs).	0	1	2	3	4
14	Standing for 1 hour.	0	1	2	3	4
15	Sitting for 1 hour.	0	1	2	3	4
16	Running on even ground.	0	1	2	3	4
17	Running on uneven ground.	0	1	2	3	4
18	Making sharp turns while running fast.	0	1	2	3	4
19	Hopping.	0	1	2	3	4
20	Rolling over in bed.	0	1	2	3	4
	Column Totals:		0	0	0	0

Figure 55 : LEFS scoring system

"The LEFS englobes the sum of 20 different activities scoring up to a maximum of 80 points. The lower the score the greater the disability. The minimal detectable change (MDC) is 9 scale points. The maximum score for 20 related daily

activities was 80. Each activity received a maximum of four points. A score of 70-80 implied an excellent functional outcome. A score of 60-70 indicated a good functional outcome. A score of 40-60 suggested a fair functional outcome. A score of less than 40, had a poor functional outcome[133]. The LEFS score is caluculated at 6 month followup in our study .

In the IPN group, the mean LEFS score is 69.35 ± 2.46, with a median of 69 (ranging from 65 to 73). Conversely, the SPN group exhibits a significantly higher mean LEFS score of 74.65 ± 1.66, with a median of 75 (ranging from 72 to 77). The distribution of LEFS scores among groups shows a significant variation (p-value < 0.001).

"Radiographic evidence of callus in anteroposterior and lateral views of two or more cortices and the absence of pain at the fracture site were regarded as signs that the fracture had healed"[135]. Patients were followed for every 1 month after 3 months postoperatively to confirm union. In the IPN group, the mean time to union is 6.15 ± 1.23 months, with a median of 6 months (4 - 8 months range). In contrast, the SPN group shows a significantly shorter mean time to union of 5 ± 1.03 months, with a median of 5 months (ranging from 4 to 7 weeks). The distribution of time to union across groups shows a significant difference (p-value = 0.0041).

CONCLUSION:

In conclusion, this study presents compelling evidence supporting the efficacy of suprapatellar nailing (SPN) over Infrapatellar nailing (IPN) in the treatment for tibia diaphyseal fractures. The results show notable enhancements in functional, clinical, and radiological outcomes following the surgical procedure. The study confirms previous research that demonstrates favourable outcomes with suprapatellar nailing in terms of less rotational malalignment, which is a potentially overlooked devastating side effect of tibia nailing. The results of this randomized controlled study show significantly reduced intraoperative time, blood loss, fluoroscopy time with SPN which will improve overall surgical outcomes of the patient. Additionally supraptellar nailing is associated with lesser chronic anterior knee pain VAS score and higher KUJALA score than infrapatellar nailing which have an incremental effect on the activities of daily living of the patient. Based on the clinical and functional outcomes of SPN and IPN techniques of tibia nailing obtained, the SPN approach is having better lower extremity functional score than IPN approach. This study also strongly emphasizes the significant difference in the union times with SPN approach having lesser union time than the IPN approach. This study also shows lesser rotational malalignment in proximal and distal one-third fractures particularly. Therefore, suprapatellar is a safer IMN approach that yields excellent functional and radiological results, including much lower rates of malalignment and ease of operation for tibia diaphysis fractures. The SPN technique is now the norm for tibial nailing in our trauma unit as a result of our research. Our study's results also contribute to the body of knowledge already available and highlight the significance of further research on intramedullary nailing methods for tibial diaphyseal fractures. More extensive RCTs with bigger study groups are still needed to add to the ivestigations.

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ANNEXURE - I

ETHICAL CLEARANCE

K.L.E. ACADEMY OF HIGHER EDUCATION AND RESEARCH
(Deemed to be University)
Accredited 'A+' Grade by NAAC in (3rd Cycle) Placed in Category 'A' by MHRD (GoI)
JNMC INSTITUTIONAL ETHICS COMMITTEE
JAWAHARLAL NEHRU MEDICAL COLLEGE,
NEHRU NAGAR, BELAGAVI-590010 (KARNATAKA-INDIA)
Website: http//www.jnmc.edu
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Principal: 2471701
Fax No. +91 (0)831 – 2470759

Ref No.MDC/JNMCIEC/ 239 Date: 7/10/2022

To,

REG. NO: BL0121006
PG Student in Orthopaedics,
J. N. Medical College,
BELAGAVI.

Sub: Institutional Ethical Clearance for the study.

With reference to the above, we wish to inform you that your proposed research project titled **"ROTATIONAL ALIGNMENT IN TIBIAL DIAPHYSEAL FRACTURES WITH THE SUPRAPATELLAR SEMI- EXTENDED VERSUS STANDARD INFRAPATELLAR ENTRY TIBIAL NAILING TECHNIQUES"** is ethical and justifiable. The proposed research project has been cleared by the JNMC Institutional Ethics Committee.

(Dr. Smita Sonoli)
Member Secretary
JNMC Institutional Ethics Committee
J.N.Medical College, Belagavi.

(Dr. Harsha Hegde)
Chairman,
JNMC Institutional Ethics Committee
J.N.Medical College, Belagavi

ANNEXURES – II

"ROTATIONAL ALIGNMENT IN TIBIAL DIAPHYSEAL FRACTURES WITH THE SUPRAPATELLAR SEMI –EXTENDED VERSUS STANDARD INFRAPATELLAR ENTRY TIBIAL NAILING TECHNIQUES – A RANDOMIZED CONTROLLED TRIAL"

Name of Student/Principal Investigator: REGISTRATION NO: BL0121006

Name of Guide/Co Investigators: _____

Objective: To determine incidence and degree of tibial rotational malalignment with suprapatellar semi-extended versus standard infrapatellar entry tibial nailing techniques using post operative clinical examination, x-rays , and computed tomography (CT).

Introduction:

Fractures of the tibia diaphysis are the most common long bone fractures. Displaced and unstable fractures are commonly treated with reamed intramedullary nail fixation, as many studies have shown this to provide superior functional results, and lower complication rates compared to those obtained with open reduction and internal fixation (ORIF), external fixation, unreamed nailing, or cast immobilization. Intramedullary nailing aims to: aid bony union, restore length, alignment, and rotation of the fractured tibia; it has added advantages as it allows minimal surgical dissection - preserving the blood supply to the fracture site, and the implant also acts as a load-sharing device - giving biomechanical fracture stabilization and allowing early patient mobilization. The goal of intramedullary nailing is to attain rapid union with acceptable axial and rotational alignment while preserving the initial bone length.

No surgical procedure is without complication and intramedullary nailing is not exempt; A potentially serious, but often underappreciated complication of this procedure, is rotational malalignment. Malrotation, in particular, has a high impact

physically and psychologically on the patient, making it an important complication to address in improving patient outcomes. Besides presenting problems cosmetically, torsional deformities may lead to lower extremity arthrosis and other functional complications .Currently, there is little known about the true incidence of tibial malrotation following intramedullary nail fixation, the degree of rotation that is significant, or the indications for correction.

Tibial torsion is the anatomical twist of the proximal versus distal articular axis of the tibial bone in the transverse plane around the longitudinal axis. Any change in the tibial torsion, either in the internal or in the external direction, is considered a mal-rotation and can be seen after fixation of the tibial shaft fractures by closed intramedullary (IM) nailing. Tibial malrotation is calculated as a torsion difference between the affected and unaffected tibia. Recent concerns were raised concerning the reported high prevalence of malrotation following intramedullary nailing of the tibia.

In most of the studies, rotational malrotation was defined as torsional difference of greater than 10° (range 5–15°) compared to the unaffected limb.

Original studies demonstrated a very low prevalence ranging from 0% to 6%, but, with the advent of more accurate techniques to measure tibial malrotation, the prevalence observed in recent studies has ranged from 23% to 36%.

In many studies, tibial malrotation has been measured clinically and the incidence is reported to be 0-6%; whereas such incidence is reported to be 22-36% by using other measurement methods such as computerized tomography (CT) scanning. One study found an incidence of 30% of rotational mal-alignment.

Traditional infrapatellar approach for tibia IMN is a popular surgical procedure used in the treatment of tibial shaft fractures. However, IMN insertion through infrapatellar (IP) approach remained technically challenging due to quadriceps muscle

force resulting in proximal fracture fragments displacement with the knee in flexion, and an increased risk of valgus and procurvatum deformities following tibial nailing. To overcome these issues, the semi extended approach for tibial IMN insertion was first described by Tornetta et al, and later modified to a suprapatellar (SP) approach using a midline quadriceps tendon insertion site by Cole et al. This new approach suggests that valgus and procurvatum malalignment has been more easily avoided when the knee is maintained in extension and also allows for easier anteroposterior and lateral imaging of the tibia.

The classic infrapatellar approach to intramedullary nailing involves placing the knee in hyperflexion over a bump or radiolucent triangle and inserting the nail through a longitudinal incision in line with the fibers of the patellar tendon. Deforming muscle forces often cause proximal-third tibial fractures and segmental fractures to fall into valgus and procurvatum. Semi-extended suprapatellar approach will facilitate intraoperative imaging, allow easier access to starting site position, and counter deforming forces. Although outcomes of traditional infrapatellar nailing have been well documented, there is a paucity of literature on outcomes of using a suprapatellar approach.

In this study we will determine the rotational alignment in tibia diaphyseal fractures with the suprapatrellar semi-extended versus standard infrapatellar entry tibial nailing techniques as primary oucome and other secondary outcomes include intra-operative time and blood loss, fluoroscopy time, knee functional scores and time to union.

Explanation of procedure: If you consent to be in this study, the relevant data will be done on clinical thigh foot angle, x-ray of affected leg AP, Lateral views and CT.

Withdrawal from participation in the study: Participation in this study is voluntary. You will be free to decide whether to participate in this study or continue participation once enrolled. In case you decide to withdraw your participation, you are free to do so. However, please convey the decision to the principal investigator.

Possible benefits from participating in the study: You will/will not have nor get any benefits by participating in this study. The data gathered will help the population at large.

Possible risks from participating in the study: There are no risks involved in participating in this study.

Privacy and confidentiality: The information collected from you will be coded, to prevent any person from identifying you. Your identity will never be revealed. The data collected from you will be kept confidential and only processed or aggregated data will be used for publication.

Financial incentives: You will not receive any payment for participating in this study.

Authorization for publication of aggregated data: Results obtained after processing of the aggregated data will be published for scientific purposes and or presented to scientific groups. However, your identity will never be revealed.

Questions: In case of any questions with regard to this study, you are free to contact:

REGISTRATION NO: BL0121006
Post- graduate resident
Department of Orthopaedics,
J.N. Medical College,
K.A.H.E.R, Belagavi-10

Dr. _____
PROFESSOR,
Department of Orthopaedics.
J.N. Medical College,
K.A.H.E.R, Belagavi-10

If you have any question or complaints with regard to your right as study participant you may contact Dr Harsha Hegde, Chairperson, Ethical committee of JNMC, 0831-2473777, Extension 4052.

Legal rights: By signing this consent form, we are not waving any of your legal rights.

CONSENT STATEMENT

I am making a voluntary decision to participate in the study "**ROTATIONAL ALIGNMENT IN TIBIAL DIAPHYSEAL FRACTURES WITH THE SUPRAPATELLAR SEMI –EXTENDED VERSUS STANDARD INFRAPATELLAR ENTRY TIBIAL NAILING TECHNIQUES – A RANDOMIZED CONTROLLED TRAIL**". My signature below indicates that I have decided to participate and I have read the information provided above or the information provided above has been read to me in the language that I understand best. I was given the opportunity to ask questions and that they have been answered to my satisfaction.

Name of the participant:

Signature or left thumb impression of the participant:

Name of the witness:

Signature or left thumb impression of the witness:

Name of the investigator:

Signature of the investigator:

ANNEXURES - III

PROFORMA

CASE NO.:

Name :

Age / Sex :

Occupation :

IP number :

Address :

Contact Number :

HISTORY :

1. **Mode of injury:** Road traffic accident / Fall at home / Fall from height / Assault

2. **Presenting complaints:**

- Pain–site/duration
- Swelling – site / extent
- Deformity
- Disturbances in function – movements
- Other associated injuries – head injury / limb injuries / spine injuries

3. **Comorbidities:**

- Diabetes mellitus
- Hypertension
- Thyroid disorders
- Tuberculosis
- Bronchial asthma
- Epilepsy

4. **Drug history:** Steroids / Disease modifying anti-rheumatoid drugs Immunosuppressants

5. **Past history:**

Any similar injuries

Previous surgeries or hospitalizations

Any major illnesses

6. **Personal history:**

Sleep:

Appetite:

Bowel/ Bladder:

Smoking:

Alcohol consumption:

7. **Family history:**

CLINICAL EXAMINATION:

General examination:

Built: Well/ Moderate/ Poor

Pallor/ Icterus/ Cyanosis/ Clubbing/ Lymphadenopathy/ Edema

Vitals:

1. Pulse :

2. BP :

3. Respiratory rate :

4. Temperature :

Systemic examination :

Cardiovascular system :

Respiratory system :

Per Abdomen :

Central Nervous System:

Local Examination:

Date of Admission :

Date of Surgery :

Date of Discharge :

FINAL DIAGNOSIS:

SIDE OF FRACTURE

AO TYPE :

NATURE OF FRACTURE :

TYPE OF NAILING DONE :

THIGH FOOT ANGLE OF NORMAL LEG:

THIGH FOOT ANFLE OF OPERTAED LEG:

ROTATIONAL DIFFERENCE (CLINICAL) :

INTERNAL / EXTERNAL :

MEASUREMENT ON X-RAYS ON NORMAL SIDE:

MEASUREMENT ON X-RAYS ON AFFECTED SIDE:

ROTATIONAL DIFFERENCE (X-RAYS) :

INTERNAL / EXTERNAL :

PROXIMAL MEASURMENT OF NORMAL LEG ON CT:

DISTAL MEASURMENT OF NORMAL LEG ON CT:

PROXIMAL MEASURMENT OF OPERATED LEG ON CT :

DISTAL MEASURMENT OF OPERATED LEG ON CT :

ROTATIONAL DIFFERENCE (CT) :

INTERNAL / EXTERNAL :

INTRAOPERATIVE TIME:
INTRAOPERATIVE BLOOD LOSS:

FLUOROSCOPY TIME:

KUJALA SCORE (at 6 months follow-up):

VAS SCORE (at 6 months follow-up):

LEFS SCORE (at 6 months follow-up):

TIME TO UNION :

IMPRESSION:

ANNEXURE III

CLINICAL PHOTOGRAPHS OF PATIENTS

PREOPERATIVE PHOTOGRAPHS:

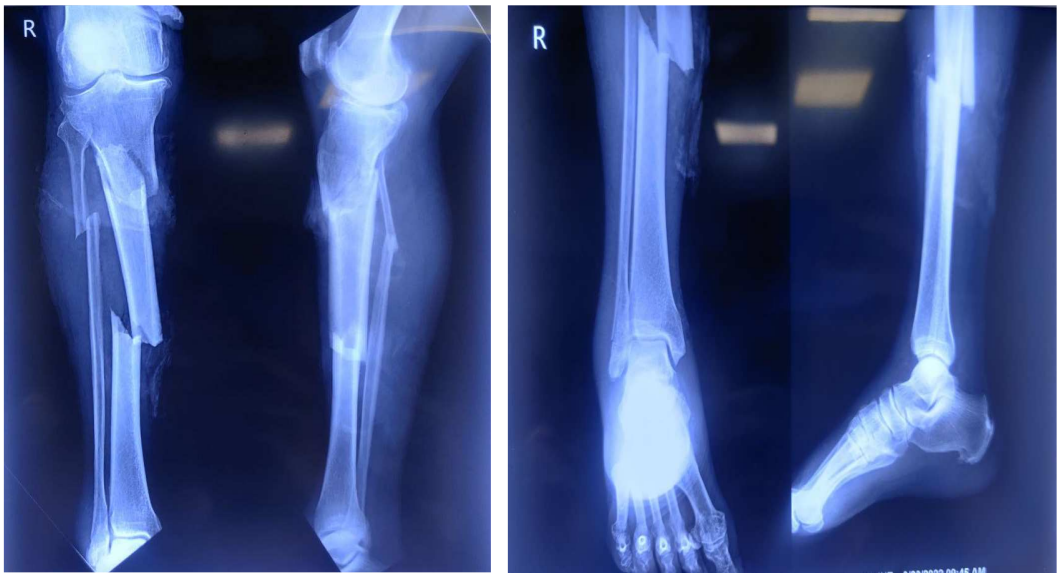


Figure 56 : showing right tibia segemental fracture AO 42 C2

INTRAOPERATIVE SETUP:

Figure 57: showing position of C arm during SPN nailing

INTRAOPERATIVE PHOTOS:

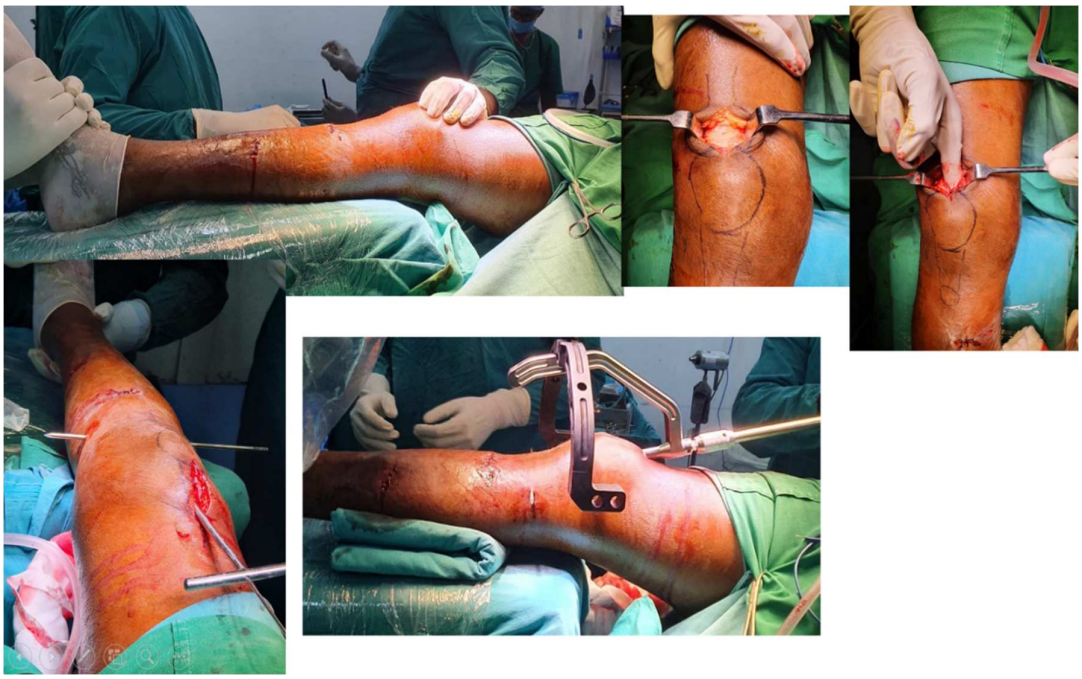


Figure 58 : showing intraoperative images of SPN nailing- position, incision , guide wire and nailing

POSTOPERATIVE IMAGING:

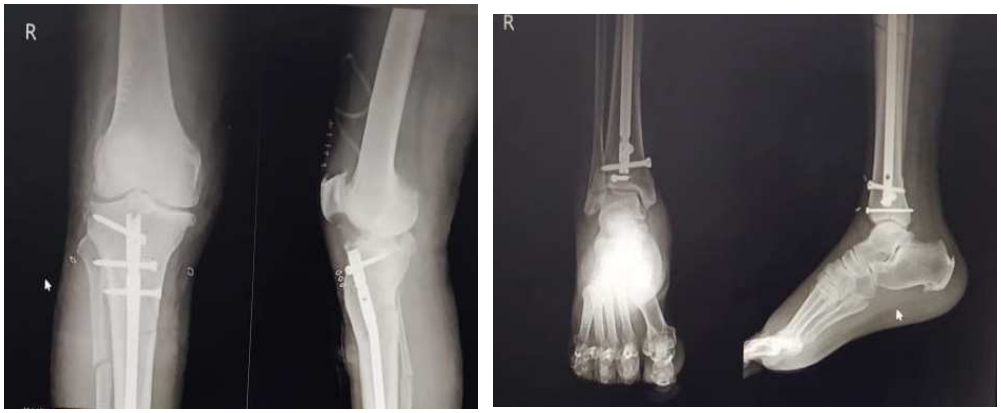
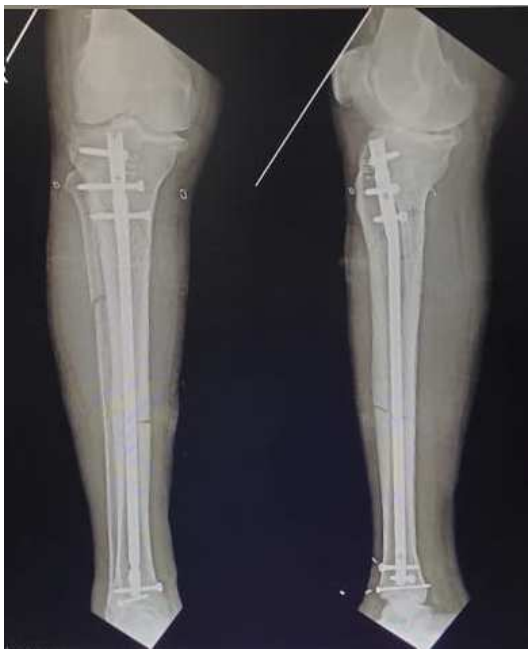


Figure 59 : postoperative check xrays



POSTOPERATIVE ROTATIONAL MALALIGNMENT MEASUREMENT:

CLINICAL THIGH FOOT ANGLE(TFA):

Figure 60 : rotational malalignment measured clinical using TFA with goniometer

X-RAYS:

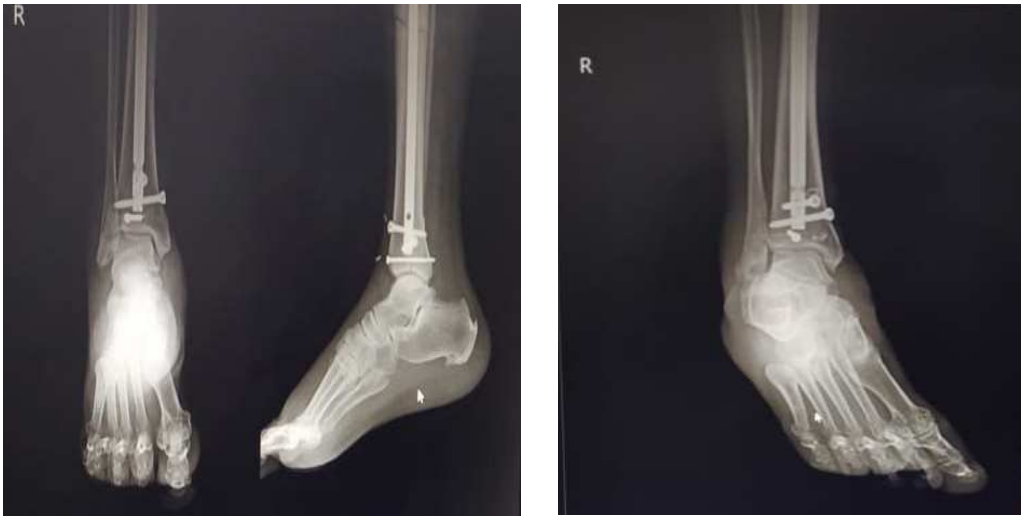


Figure 61 : rotational malalignemnt calculating using xrays by taking mortise view

COMPUTED TOMOGRAPHY:

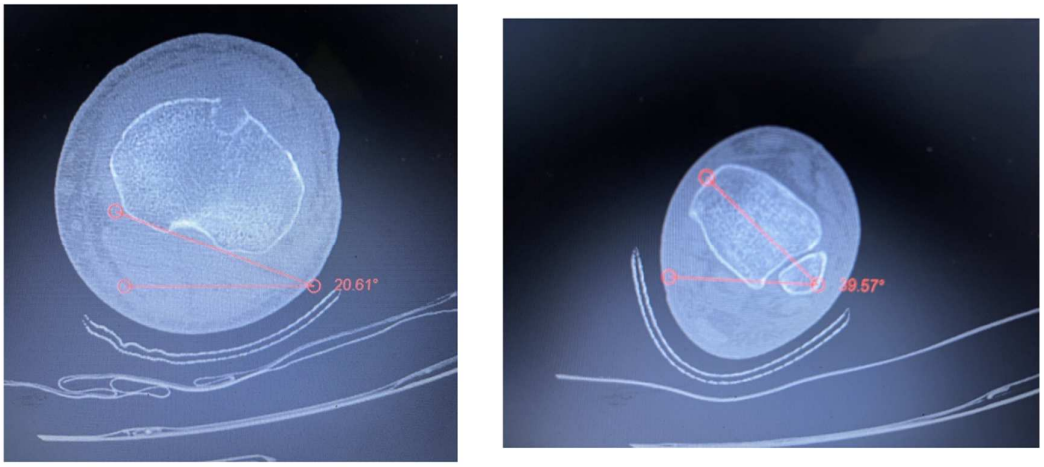


Figure 62 : CT measurements – proximal and distal cuts of operated limb

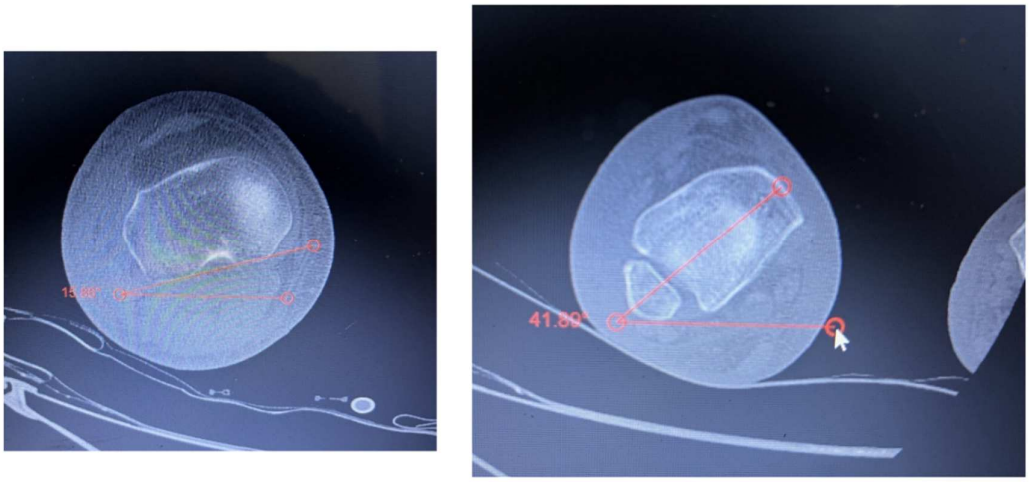
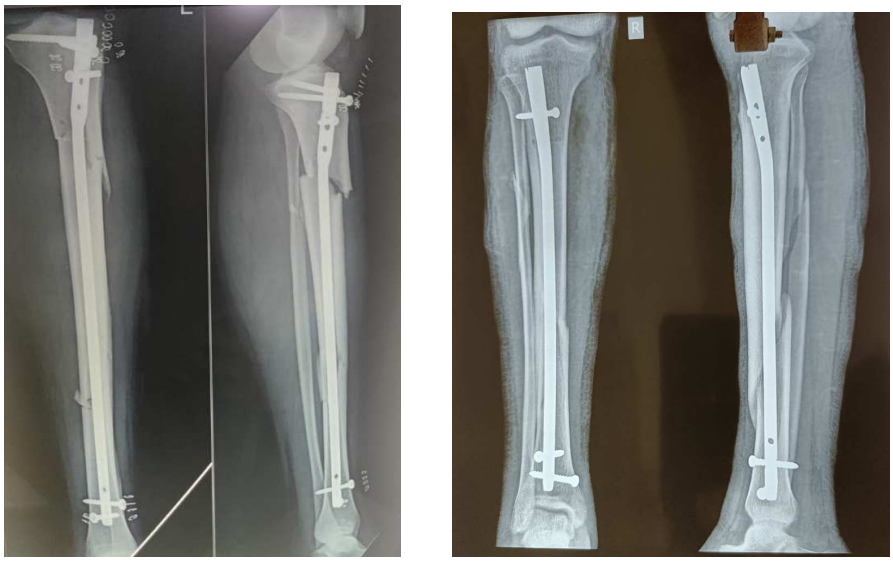


Figure 63: CT measurements – proximal and distal cuts of normal limb

X-RAYS OF SOME PATIENTS SHOWING MORE ROTATIONAL MALALIGNMENT WHEN DONE WITH IPN:



ANNEXURE IV

KEY TO MASTER CHART

IP Number	In Patient Number
MOI	Mode Of Injury
M	Male
F	Female
RTA	Road Traffic Accident
AO	Arbeitsgemeinschaft für Osteosynthesefragen
IPN	Infra Patellar Nailing
SPN	Supra Patellar Nailing
TFA-NOR	Thigh Foot Angle – Normal side
TFA - AFF	Thigh Foot Angle – Affected side
RD	Rotational Difference
INT	Internal
EXT	External
X-RAY - N	Measurement on x-rays on Normal side
X-RAY - A	Measurement on x-rays on Affected side
CT	Computed Tomography
OT Time	Intraoperative Time
FLU Time	Intraoperative Fluoroscopy Time
AKP-VAS	Anterior Knee Pain- Visual Analogue Scale
KUJALA	KUJALA Score
KFS - LEFS	Knee Functional Score - Lower Extremity Functional Score (LEFS)

NAME	AGE	GENDER	IP number	MOI	DIAGNOSIS	SIDE	AO TYPE	NATURE OF FRACTURE	NAILING	TFA-NOR	TFA-AFF	RD	INT/EXT
INDRAJEET SALGUPE	33	M	1129839	RTA	TIBIA MIDSHAFT FRACTURE	RIGHT	AO 42 A2	SIMPLE OBLIQUE	IPN	12	16	4	EXT
RAHUL GULGANJI	28	M	1134521	RTA	TIBIA MIDSHAFT FRACTURE	RIGHT	AO 42 A3	SIPMLE TRANSVERSE	IPN	10	14	4	EXT
ALLABAX NADAF	40	M	1144657	FALL	TIBIA PROXIMAL THIRD FRACTURE	LEFT	A0 42 B1	WEDGE SPIRAL	SPN	12	6	6	INT
MANIKCHAND WALVE	51	M	1146432	RTA	TIBIA DISTAL THIRD FRACTURE	RIGHT	AO 42 A1	SIPMLE SPIRAL	IPN	8	12	4	EXT
MANGALA NAIK	26	F	1150987	RTA	TIBIA MIDSHAFT FRACTURE	LEFT	AO 42 B2	WEDGE BENDING	IPN	14	10	4	INT
MAHADEV SANADI	78	M	1152493	RTA	TIBIA COMPLEX IRRGULAR FRACTURE	RIGHT	A0 42 C3	COMPLEX IRREGULAR	SPN	10	16	6	EXT
MAHADEV YASHWANTH	83	M	1161276	RTA	TIBIA SEGEMENTAL COMPLEX FRACTURE	RIGHT	AO 42 C2	COMPLEX SEGMENTAL	SPN	14	16	2	EXT
MASABI JAMADAR	55	F	1173832	FALL	TIBIA DISTAL THIRD SHAFT FRACTURE	LEFT	AO 42 B1	WEDGE SPIRAL	IPN	14	14	0	NIL
MALIKJAN SANADI	28	M	1173811	RTA	TIBIA MIDSHAFT FRACTURE	RIGHT	AO 42 A2	SIMPLE OBLIQUE	IPN	12	24	12	EXT
SAGAR LONDHE	20	M	1178646	RTA	TIBIA MIDSHAFT FRACTURE	RIGHT	A0 42 B3	WEDGE FRAGMENTED	SPN	14	10	4	EXT
ARJUN ADIANDRA	52	M	1182462	RTA	TIBIA MIDSHAFT FRACTURE	RIGHT	AO 42 A3	SIMPLE TRANSVERSE	SPN	10	10	0	NIL
SUDEEP LAKKANNAVAR	21	M	1184672	SPORTS	TIBIA PROXIMAL THIRD FRACTURE	RIGHT	AO 42 A1	SIPMLE SPIRAL	IPN	10	0	10	INT
PRASAD SHETTY	25	M	1187265	RTA	TIBIA COMPLEX IRREGULAR FRACTURE	RIGHT	AO 42 C3	COMPLEX IRREGULAR	SPN	14	22	8	EXT
PRAMOD GOUNDANKAR	26	M	1189765	RTA	TIBIA MIDSHAFT FRACTURE	RIGHT	AO 42 B3	WEDGE FRAGMENTED	IPN	12	6	6	INT
RAKESH MANE	20	M	1190243	INJURY	TIBIA PROXIMAL THIRD FRACTURE	RIGHT	AO 42 A2	SIMPLE OBLIIQUE	IPN	12	24	12	EXT
MARUTHI L	30	M	1192435	RTA	TIBIAL DISTAL THIRD FRACTURE	LEFT	AO 42 A2	SIMPLE OBLIQUE	SPN	10	10	0	NIL
PRABHAVATHI KOKITKAR	28	F	1195409	RTA	TIBIA PROXIMAL THIRD FRACTURE	LEFT	AO 42 A1	SIPMLE SPIRAL	SPN	12	14	2	EXT
ARUN METI	23	M	1196742	ASSAULT	TIBIA PROXIMAL THIRD FRACTURE	RIGHT	AO 42 A3	SIMPLE TRANSVERSE	IPN	8	14	6	EXT
LAXMI PATIL	40	F	1198657	RTA	TIBIAL PROXIMAL THIRD FRACURE	RIGHT	AO 42 A1	SIPMLE SPIRAL	SPN	12	8	4	INT
BHIMAGONDA CHOUGALA	31	M	1204590	FALL	TIBIA SEGEMENTAL COMPLEX FRACTURE	RIGHT	AO 42 C3	COMPLEX IRREGULAR	IPN	12	20	8	EXT
BASAVRAJ NAGAPPA	37	M	1206060	RTA	TIBIA MIDSHAFT FRACTURE	RIGHT	A0 43 C1	COMPLEX SPIRAL	SPN	16	28	12	EXT
PARASHARAM BIRADAR	68	M	1217865	FALL	TIBIA MIDSHAFT FRACTURE	LEFT	AO 42 A1	SIPMLE SPIRAL	SPN	10	12	2	EXT
MASABEE JAMADAR	55	F	1224768	RTA	TIBIA DISTAL THIRD FRACTURE	LEFT	AO 42 A1	SIMPLE SPIRAL	IPN	6	8	2	EXT
BALAGOUDA MANGOJI	17	M	1226754	RTA	TIBIA MIDSHAFT SPIRAL FRACTURE	RIGHT	AO 42 A1	SIMPLE SPIRAL	IPN	14	6	8	INT
BASAVRAJ KUTHOLE	25	M	1229803	RTA	TIBIA SEGMENTAL COMPLEX FRACTURE	LEFT	AO 42 C2	COMPLEX SEGMMENTAL	IPN	12	26	14	EXT
NINGAVVA KAMBLE	36	F	10010232	FALL	TIBIA MID SHAFT FRACTURE	LEFT	AO 42 A2	SIMPLE OBLIQUE	SPN	12	16	4	EXT
BHARMAPPA KOLKAR	26	M	10032433	RTA	TIBIA PROXIMAL THIRD FRACTURE	RIGHT	AO 42 A3	SIMPLE TRANSVERSE	IPN	14	2	12	INT
BASAGOUDA PATIL	41	M	10043562	RTA	TIBIAL PROXIMAL THIRD FRACURE	LEFT	AO 42 B3	WEDGE FRAGMENTED	SPN	10	12	2	EXT
NAGARAJ GANGAPPA	34	M	10023433	RTA	TIBIA MID SHAFT FRACTURE	RIGHT	A0 42 A3	SIMPLE TRANSVERSE	SPN	14	8	6	INT
RAKESH MANE	19	M	10032534	ASSAULT	TIBIA MIDSHAFT FRACTURE	RIGHT	AO 42 A2	SIMPLE OBLIQUE	IPN	16	12	4	EXT
IRAPPA BASANNAVAR	29	M	10019004	RTA	TIBIA PROXIMAL THIRD FRACTURE	RIGHT	AO 42 A3	SIMPLE TRANSVERSE	IPN	8	16	8	EXT
CHIDANAND HOSAMANI	51	M	10025763	RTA	TIBIA MIDSHAFT FRACTURE	LEFT	AO 42 B2	WEDGE BENDING	SPN	12	16	4	EXT
KASTURI HARANATTI	42	F	10029879	RTA	TIBIA DISTAL THIRD FRACTURE	RIGHT	AO 42 A3	SIMPLE TRANSVERSE	SPN	10	10	0	NIL
PUNDALIK SADAVAR	60	M	10045232	RTA	TIBIA MIDSHAFT FRACTURE	LEFT	AO 42 B2	WEDGE BENDING	IPN	14	18	4	EXT
SHIVAJI CHAVAN	73	M	10051322	RTA	TIBIA SEGMENTAL COMPLEX FRACTURE	LEFT	AO 42 C2	COMPLEX SEGMENTAL	SPN	14	20	6	EXT
NELSON LIMA	31	M	10052897	RTA	TIBIA MIDSHAFT FRACTURE	RIGHT	AO 42 A3	SIMPLE TRANSVERSE	IPN	12	18	4	INT
MAHESH GADAGE	27	M	10063231	FALL	TIBIA MIDSHAFT FRACTURE	LEFT	AO 42 A2	SIMPLE OBLIQUE	SPN	16	20	8	EXT
BASAVRAJ HULIKANNAVAR	53	M	10067892	RTA	TIBIA DISTAL THIRD FRACTURE	LEFT	AO 42 A3	SIMPLE TRANSVERSE	SPN	12	8	4	INT
SHIVANAND BANAVANNAVAR	52	M	10072134	RTA	TIBIA SEGMENTAL COMPLEX FRACTURE	RIGHT	AO 42 C2	COMPLEX SEGMMENTAL	IPN	12	20	8	EXT
MOHAMMAD SAEED	43	M	10074464	FALL	TIBIA MIDSHAFT FRACTURE	RIGHT	AO 42 A2	SIMPLE OBLIQUE	SPN	10	16	6	EXT

NAME	XRAY - N	XRAY - A	ROT DIFF	INT/EXT	CT ROT DIFF	INT/EXT	OT TIME	BLOOD LOSS	FLU TIME	KUJALA	AKP - VAS	KFS - LEFS	UNION TIME
INDRAJEET SALGUPE	14	20	6	EXT	6.2	EXT	96	62	122	59	4	72	6
RAHUL GULGANJI	12	16	4	EXT	5.7	EXT	110	78	140	53	4	69	7
ALLABAX NADAF	10	6	4	INT	3.4	INT	82	52	88	65	2	77	6
MANIKCHAND WALVE	16	18	2	EXT	4.3	EXT	96	64	118	68	3	72	4
MANGALA NAIK	14	10	4	INT	5.4	INT	98	63	127	60	4	69	5
MAHADEV SANADI	8	14	6	EXT	6.2	EXT	99	61	102	70	5	72	6
MAHADEV YASHWANTH	14	14	0	NIL	2.5	INT	89	58	96	71	5	73	5
MASABI JAMADAR	14	14	0	NIL	1.2	EXT	94	59	116	67	4	73	5
MALIKJAN SANADI	10	24	14	EXT	17.7	EXT	102	69	121	55	6	66	7
SAGAR LONDHE	16	10	6	EXT	5.3	EXT	78	41	91	77	3	76	4
ARJUN ADIANDRA	10	8	2	INT	2.9	INT	74	37	88	79	2	77	4
SUDEEP LAKKANNAVAR	14	4	12	INT	12.6	INT	107	63	120	59	4	68	6
PRASAD SHETTY	16	8	8	EXT	7.1	EXT	94	60	99	68	6	72	7
PRAMOD GOUNDANKAR	14	10	4	INT	6.4	INT	99	67	119	63	6	69	6
RAKESH MANE	14	24	10	EXT	13.8	EXT	104	58	132	51	7	65	8
MARUTHI L	14	16	2	EXT	1.2	EXT	81	42	94	76	3	75	4
PRABHAVATHI KOKITKAR	12	12	NIL	NIL	2.1	INT	71	39	89	78	3	76	4
ARUN METI	10	16	6	EXT	6.4	EXT	98	60	116	66	4	73	5
LAXMI PATIL	10	8	2	INT	3.7	INT	73	41	91	78	3	76	5
BHIMAGONDA CHOUGALA	14	22	8	EXT	7.9	EXT	120	71	131	53	7	66	8
BASAVRAJ NAGAPPA	14	26	12	EXT	13.9	EXT	91	59	93	70	5	76	6
PARASHARAM BIRADAR	10	12	2	EXT	2.8	EXT	80	51	91	69	4	76	5
MASABEE JAMADAR	8	8	0	NIL	2.6	EXT	92	64	118	67	4	71	5
BALAGOUDA MANGOJI	16	10	6	INT	5.4	INT	103	70	104	58	5	69	6
BASAVRAJ KUTHOLE	12	26	14	EXT	16.2	EXT	107	67	119	61	5	68	8
NINGAVVA KAMBLE	14	18	4	EXT	5.6	EXT	78	42	83	76	4	76	5
BHARMAPPA KOLKAR	16	4	12	INT	13.4	INT	111	69	127	53	6	67	6
BASAGOUDA PATIL	14	16	2	EXT	3.2	EXT	89	49	91	71	3	73	4
NAGARAJ GANGAPPA	12	4	8	INT	7.6	INT	82	51	80	72	4	74	5
RAKESH MANE	12	16	4	EXT	6.2	EXT	99	63	102	63	3	71	6
IRAPPA BASANNAVAR	10	18	8	EXT	11.3	EXT	103	68	116	66	4	68	5
CHIDANAND HOSAMANI	14	16	2	EXT	3.1	EXT	78	46	88	75	2	73	5
KASTURI HARANATTI	12	14	2	EXT	1.8	EXT	81	49	92	78	2	74	4
PUNDALIK SADAVAR	12	16	4	EXT	5.8	EXT	109	63	110	59	4	70	7
SHIVAJI CHAVAN	14	20	6	EXT	7.9	EXT	89	62	94	63	6	73	7
NELSON LIMA	14	12	2	INT	3.1	INT	96	60	101	68	3	73	5
MAHESH GADAGE	14	20	6	EXT	7.2	EXT	75	44	84	75	4	75	4
BASAVRAJ HULIKANNAVAR	14	12	2	INT	5.7	INT	82	48	90	70	5	73	6
SHIVANAND BANAVANNAVAR	10	20	10	EXT	12.7	EXT	105	68	136	54	6	68	8
MOHAMMAD SAEED	12	16	4	EXT	4.2	EXT	76	40	86	79	3	76	4