

E-ISSN: 2395-1958  
P-ISSN: 2706-6630  
IJOS 2020; 6(4): 612-618  
© 2020 IJOS  
[www.orthopaper.com](http://www.orthopaper.com)  
Received: 02-08-2020  
Accepted: 28-08-2020

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## Intra-medullary interlocking nail in extra-articular distal third tibia fractures

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DOI: <https://doi.org/10.22271/ortho.2020.v6.i4i.2394>

### Abstract

**Background:** This study was performed to evaluate the results of intramedullary nailing of extra-articular distal tibial fractures.

**Methods:** 24 tibial fractures that involved the distal 3rd of the tibia which were treated with reamed intramedullary nailing using either two or three distal interlocking screws. Obtained Radiographs were examined to determine the immediate and final alignments and fracture healing.

**Results:** The average time to union was 15.6 weeks.

**Conclusions:** Intramedullary nailing is found to be an effective alternative for the treatment of distal metaphysealtibial fractures.

**Keywords:** Third tibia, interlocking nail, metaphysealtibial fractures

### Introduction

Fractures of the distal third of tibial shaft occurs commonly as a consequence of road traffic accident, fall from height, sports and direct injury <sup>[1]</sup>.

Various modalities of treatment have been reported till date with advantages and disadvantages of each modality. Conservative management, closed reduction and interlocking nailing, open reduction and plating, minimally invasive percutaneous plate osteosynthesis and external fixation are some of the modalities presently available for the treatment of these fractures.

Distal tibial fractures are quite challenging in terms of treatment even for most of the experienced surgeons. Tibia is a subcutaneous bone with vulnerable soft tissue coverage resulting local soft tissue problems and delayed bone healing. Soft tissue breakdown and bone healing are major complications and the risk is more with open reduction and internal fixation <sup>[2]</sup>.

Fractures of the distal third tibia are different, in that the bone is subcutaneous with no muscle covering on the anteromedial aspect and consequently less blood supply to the tibia. This precarious vascularity, as compared to other long bones, may lead to delayed union or nonunion. Treatment remains a major substantial therapeutic challenge in orthopedic trauma; considering its anatomy, it is difficult to achieve reduction and maintain it owing to wide metaphysis, bad skin condition, and fracture comminution <sup>[3]</sup>. In addition, it is even more difficult if fibula fractures are at the same level, which contribute to additional mechanical instability and associated syndesmotic injury if fibula fractures occur in the lower 10 cm area.

### Various modalities are available, such as

- Interlock Nailing
- External fixation spanning ankle joint
- Minimally invasive plate osteosynthesis (MIPO) with locking plates

Intramedullary Nailing is indicated for the majority of closed lower third tibia and middle and lower third junction fractures of the tibia <sup>[4]</sup> as well as for open fractures with adequate soft tissue cover when fracture is not extending into the lower 4 cm of tibia from the ankle joint <sup>[5]</sup>.

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### Minimally Invasive Plate Osteosynthesis (MIPPO) with Locking Plates

Displaced, unstable fractures of distal third of tibia, mainly fractures within 3 cm from ankle joint – with or without articular involvement<sup>6</sup> – provide best indications for plating, particularly when skin envelope is good and patient can afford; Patients which were treated with MIPPO are not included in the present study.

#### Advantages of Closed Nailing over Plating

- In closed nailing, fracture hematoma is preserved, which is vital and essential for fracture healing; which yields high union rate.
- If it is done intramedullary it acts as a load-sharing implant. So, early weight bearing can be started, as against plating, which is a load-bearing implant and weight bearing should be allowed after fracture union.
- There is an advantage of controlled impaction over nail during surgery.
- Using two screw proximal and two to three screws in distal fragments provide better rotational stability.
- Resulting reduced operative time, minimal soft tissue dissection, minimum blood loss and therefore reduced rate of infection.
- Reaming procedure gives advantage of internal bone graft at fracture site at the time of reaming. While in comminuted fracture, a reamer should be just pushed and negotiated across comminuted fragments without any rotary movement.

Reamed intramedullary nails are preferred for closed fractures, as reaming allows the use of implants of larger diameter and offers a high union rate<sup>[7]</sup>. The solid so-called unreamed nails are presently preferred to the external fixator as the implant of choice for most open-tibial fractures at the lower third tibia – when fractures do not extend within 4 cm of distal tibial end, i.e., from the ankle joint<sup>[8]</sup>.

External fixators are associated with complications like need of secondary operation, prolonged healing time and pin tract infection<sup>[9, 10]</sup>.

Patients managed with both plate and nail can be mobilized early. Advocates of plating suggest better alignment with this technique. However, plating is associated with wide soft tissue dissection and disruption of the fracture hematoma, which can lead to interference with the normal physiology of bone healing, wound dehiscence, infection, hardware prominence and delayed healing<sup>[11-17]</sup>.

Intramedullary nailing spares the extra-osseous blood supply, allows load-sharing, and avoids extensive soft-tissue dissection<sup>[18]</sup>.

Minimally invasive percutaneous plate osteosynthesis is a newer technique which is associated with minimal soft tissue dissection leading to less disruption of fracture hematoma and preservation of periosteal blood supply with promising results and less wound complications<sup>[13, 19]</sup>.

There are many recent changes in the design of intramedullary nail, which are now compliant to this spectrum of fractures. Difficulties in reduction, distal propagation of the fracture, hardware failure, and inadequate distal fixation are some major concerns and have led to mal-alignment due to which the acceptance of intramedullary nailing as a treatment for distal metaphyseal fractures remains controversial.

However, despite using locking plate, one study revealed that 48% of the patients required implant removal either for irritation by hardware and skin impingement or infection<sup>[20]</sup>.

The present study was conducted to evaluate the results of distal third tibial shaft fractures treated with Intra-Medullary Interlocking nailing in terms of fracture union rate and complications associated with such a treatment.

#### Material and Methods

This is a prospective study between August 2018 to June 2019; about 52 tibial fractures were treated in the Department of Orthopedics and Emergency Health Care at a tertiary care hospital. The inclusion criteria for the present study were the skeletally mature patients with displaced fractures of tibia or extending into distal third shaft and metaphysis. Type I and Type II open fractures were included in the study. The fractures extending into distal tibial articular surface, open grade III B fractures were excluded. About 24 patients meeting these criteria were included in the study.

#### Methods

The main objective of surgical fracture treatment is to restore sagittal and coronal alignment as well as rotation and length. For distal fractures of the tibia, proper reduction and stable fixation of the distal fragment are of great importance for a good outcome. For the same reason, adequate radiological assessment in and bi-planar antero-posterior (AP) and lateral intervention are done using an image intensifier intra-operatively.

Anteroposterior and lateral radiographs of the affected leg with knee and extent of comminution.<sup>21</sup> The fibular fracture was noted, and surgery planned accordingly to fix the fibula. The leg was immobilized in a plaster slab till definitive surgery.

Patients with poor skin condition<sup>22</sup> were managed with limb elevation, local magnesium sulfate dressing. Patients with compound fractures were taken for immediate debridement under regional anesthesia. It was followed by regular dressing, along with intravenous antibiotics. Routine laboratory investigations included HB, CBC, BSL, LFT, KFT, HIV, HBSAG, ECG, and CXR.

#### Operative Technique: Intramedullary Nailing

Surgery was performed under tourniquet and spinal anesthesia under image intensifier television (IITV) control on radiolucent fracture table. Routine antiseptic wash and scrubbing with povidone iodine scrub was done. It was followed by painting with povidone iodine and draping of the operative area. The surgery was carried out under tourniquet to achieve bloodless operative field and to decrease blood loss.

- Fractures are reduced by closed methods of gentle traction and external manipulation and guide wire passed and fixed in a central position<sup>[23]</sup> in both AP and lateral view and IITV control and reamed intramedullary nailing done.
- In treating distal third fractures, it is advisable to use temporary polar screw or thick K-wire, so that guide wire, reamer, and subsequent intramedullary nail remain in the center (as there is widening of medullary canal at the diaphysis-metaphyseal junction) so that varus/valgus or anterior posterior angulation can be avoided<sup>[24-25]</sup>.

The patient was positioned supine on a normal regular table with a radiolucent triangular frame kept under the knee joint so that knee is flexed upto 90 degree or breaking the table at the level of knee. Entry point for ante-grade nailing was done by keeping the knee in 90-degree flexion.

Once the entry point is defined, medullary canal was opened and a ball tipped guide wire passed into the distal fragment across the fracture. Sometimes a reduction tool device had to be used to pass the guide wire and reducing the fracture, which helped the guide wire into the distal fragment correctly in a central placement, thus avoiding varus or valgus mal-alignment or angulation.

When fixing distal tibial fractures, correct positioning of the guide wire is mandatory, and should be achieved at all times. Determination of Nail length is important and a crucial step. Intramedullary reaming is done 1 or 1.5 mm more than the nail

chosen for the patient. The guide wire enables correct nail placement.

Guide wire placement in distal fragment should be central in AP and lateral, so that subsequent reaming and nail insertion comes in ideal central position.

Once the fracture is reduced and the nail placed correctly, distal locking is performed. Distal tibial fractures usually require bi-planar fixation, so AP.

Interlocking screws may be beneficial. The locking procedure is performed free hand using a drill under image intensifier (Fig-1).



**Fig 1:** Pre-Operative radiograph of distal 3<sup>rd</sup> tibia fracture



**Fig 2:** Post-Operative radiograph intramedullary nail and one AP and Two mediolateral screw.

Once distal locking is done, proximal locking is done using drill assembly device used to insert the nail.

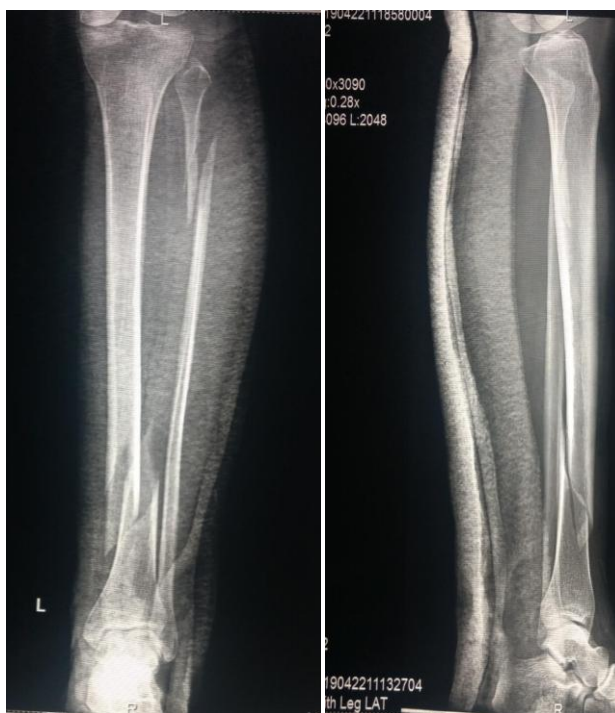
Post operatively, all patients were kept partial weight bearing. They were closely followed up monthly for first 4 months or till union. Subsequently, they were followed after every 3 months till end of 1 year.

### Results

Out of 24 patients included in the study, one patient was lost to follow up after 8 weeks post operatively. Twenty-three out of 24 patients (85%), had fracture union without the need for any further surgical intervention (Fig). There were 14 males and 10 females. In majority of cases mode of injury was road

traffic accident. All were treated with closed intramedullary interlocking distal tip tibia nail. The average time to union in these 23 patients was 15.6 weeks with range being 14 to 20 weeks. There was no significant difference in the mean time for union based on the type of fracture ( $F \frac{1}{4} 0.681$ ;  $p > 0.05$ ).

Mean Procurvatum was 3 degree and mean valgus deviation was 3° (range of 7 degree valgus to 12° varus. 2 patients where reduction was lost in first follow up were both elderly males with poor soft tissue condition. Reduction was lost in first follow up, i.e within 4 weeks in both patients. Both patients were counseled for revision surgery but both of them refused to undergo additional surgical procedure.



**Fig 3:** Pre-Operative radiograph of distal 3<sup>rd</sup> tibia fracture



**Fig 4:** 4 week's old radiograph with distal screw fixation and one AP and one mediolateral screw

One of the patients had varus angle of 12° post-operatively after ambulation and at the time of union it reduce slightly to 10°, which is still considerable degree of varus.



Fig 5: Immediate post op and when patient started walking.



Fig 6: 1 year old post operative radiograph.

Table 1: Demographic data

S. No	Parameters	Our study	Mugundhan Sengodan [38]	Satish R Gawali <i>et al.</i> [39]
1	Total number of Patient	24	20	60
2	Age	50±15	35	35
3	Male :Female	14:10	16:04	40:20
4	Varus/valgus angulation	±3	±1.7	±1.5
5	Union time(weeks)	15.6	11.5	18
6	Malunion	02	-	02

**Discussion**

Intramedullary interlocking nailing has become a well-established management option in tibial shaft fracture treatment. However, there still is an ongoing discussion about whether the advantages of intramedullary nailing also apply to distal tibial fracture treatment. In the management of distal tibial fractures, collateral damage including additional trauma or soft tissue laceration should be avoided. In accordance to the delicate soft tissue situation of the distal tibia and the advantages of minimally invasive, symmetric and dynamic fracture fixation options, efforts are increasingly being made to deal with distal tibial fractures – even those with concomitant intraarticular fracture components – with intramedullary nailing devices. Nevertheless, many studies have reported complications such as malalignment and nonunion following intramedullary nailing of distal tibial fractures [27, 29, 30, 31].

The use of sophisticated, less invasive surgical techniques in combination with modern intramedullary nail designs significantly decrease the complication rate, allows distal tibial fractures to be fixed under minimal invasive aspects, and yields advantages of intramedullary fracture fixation.

When considering fractures localized in the distal third of the tibia, the surgeon has multiple options, depending on the

fracture location, associated fracture components of the ankle joint, the soft tissue situation, and the patient’s general state of health. Conservative management is rather associated with minimally displaced extra articular and intraarticular distal tibial fractures. It is limited to closed fractures only. It requires a long immobilization period and therefore is associated with an increased risk of ankle stiffness [32].

External fixation of distal tibial fractures is an option in open fractures, comminuted fractures or fractures with a difficult soft tissue situation. The control of fragments and reduction is limited. This option is associated with a reduced ankle motion and may be complicated by malalignment, pin infection and nonunion [33].

In fractures of the distal tibia with major involvement of the intraarticular surface of the tibial plafond, fracture reduction and anatomical restoration of the articular surface is mandatory. These cases necessarily require open reduction and internal fixation with plates. These fractures usually need casting or external fixation prior to definitive treatment due to the likely presence of compromised soft tissue and swelling.

Open reduction and internal fixation in the area of the distal tibia is always associated with an increased risk of secondary soft tissue breakdown. The vascularity is further disturbed by the additional surgical intervention involved in opening the

fracture [28].

The advantages of intramedullary fracture fixation are numerous: it is a familiar technique for fixing tibial shaft fractures; it allows osteosynthesis under biological aspects; there is no need to open the fracture site and soft tissue dissection is not necessary; and the blood supply is spared. It enables symmetric, dynamic and load-sharing fracture stabilization without the need to restrict joint ROM. In contrast to open reduction and internal fixation, intramedullary nailing can be performed initially on the day of admission. The intramedullary approach produces superior results, as described by Robinson [26] and Nork [34], who reported a 100% union rate. El Ibrahimy [35] confirmed that good results with no major complications were obtained with reamed nailing. Fan [36] reconfirmed that there were no signs of nonunion or malunion. One reported disadvantage/complication of intramedullary nail fixation in distal tibial fractures is implantation failure with nail breakage, which may have been related to the insertion of thin, unreamed nails in the past. Another commonly discussed disadvantage is a potential decrease in fixation stability when nails are used in metaphyseal fractures. This problem can be anticipated by applying a modified surgical technique using blocking screws and modern interlocking nails with threaded locking holes that enhance the angular stability of the construct. Studies that have compared intramedullary nail fixation and plate fixation in distal tibial fractures consider older nail designs that have been improved upon recently, especially in relation to optimizing metaphyseal fracture stability [37]. In parallel with this development, new plate designs and techniques for internal fixation have been published that could overcome the reported problems with previous plating techniques and designs, and offer a good alternative to intramedullary fixation.

### Conclusion

We conclude that intramedullary nailing of distal tibial fractures is a reliable method of fracture fixation, possessing the advantages of closed reduction and symmetric fracture stabilization of an area with delicate soft tissue situation. It is advisable to use temporary polar screw or thick K-wire and Steinmann pin, so that guide wire, reamer, and subsequent intramedullary nail remain in the center. Bi-planer fixation, Anterior-Posterior and medio-lateral interlocking screws, simultaneous fibula fracture fixation at the same level or below are suggested for early mobilization and better outcome.

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