ORIGINAL RESEARCH PAPER

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# MANAGEMENT OF EXTRA-ARTICULAR DISTAL THIRD TIBIAL FRACTURES USING INTERLOCKED INTRAMEDULLARY NAIL

KEY WORDS:

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**ABSTRACT**

**BACKGROUND:** Tibia is the most commonly fractured long bone in the body. Distal tibia fractures are 3- 10% of all tibia fractures. Distal tibia includes metaphysis, transition zone and distal diaphysis. Distal tibial metaphyseal fractures are a common consequence of road traffic accidents, falling injuries and other high-energy trauma. While high energy distal tibia fractures are more common in younger age groups and are typically caused by road traffic accidents and falls from height, low energy distal tibia fractures are more common in older age groups and are mostly caused by rotating forces. METHODS: This is a prospective study to evaluate the efficacy of intramedullary nailing of extra-articular distal third tibial fractures with fixation of fibula fracture only if fibula fracture is present in the distal third. Results were assessed. Patients were followed post operatively atevery 4 weeks for first three visits and thereafterevery three months till 9 months. At each follow up visit patient was assessed both clinically and radiologically. Functional outcome was assessed by Olerud-Molander Ankle Score. **RESULTS:** In this study sample of 20 patients with Extra articular distal tibia fractures were surgically treated with Interlocked intramedullary nailing. Post operatively Intra medullary nailing shows good outcome in majority of patients both clinically and radiologically without any complications. **CONCLUSION:** This study showed that treatment for distal tibial extra-articular fractures is improved by intramedullary nailing. Compared to plating, it has less soft tissue problems and is a more biological method of fixing since it avoids disrupting the fracture hematoma. The most often reported complications with IMN are angulation in the frontal plane and anterior knee comfort. To avoid any malalignment, we advise to keep the intraoperative reduction as anatomic as possible when inserting the guide wire, reaming and driving the nail. Interlocking nailing is effective in treating distal third tibial fractures.

## INTRODUCTION

Tibia is the most commonly fractured long bone in the body.[1] Distal tibia fractures are 3-10% of all tibia fractures.[2] Distal tibia includes metaphysis, transition zone and distal diaphysis. Distal tibial metaphyseal fractures are a common consequence of road traffic accidents, falling injuries and other high-energy trauma.[3] While high energy distal tibia fractures are more common in younger age groups and are typically caused by road traffic accidents and falls from height, low energy distal tibia fractures are more common in older age groups and are mostly caused by rotating forces.[4]

Treatment of distal tibia fractures is challenging because of the limited soft tissue envelope, subcutaneous location of the bone, poor vascularity, widening of metaphysis predisposing to the coronal plane malalignment and limited opportunities for surgical incisions.[5]

Numerous treatment methods are available both conservative and surgical methods aiming at main goals of any fracture care i.e. obtaining length, proper axial alignment, rotational stability.[6] Treatment selection is influenced by the proximity of the fracture to the plafond, fracture comminution and injury to the soft tissue envelope.[7]

Conservative treatment is reserved for closed, stable, minimally displaced tibial fractures and it involves closed reduction and POP cast application with or without functional cast bracing.[7,8]

Surgical methods are open reduction and plating, minimally invasive percutaneous plate osteosynthesis, external fixation, interlocked intramedullary nailing.[3] In the past, plate fixation achieved an acceptable degree of reduction and rigid fixation but it usually required relatively extensive exposure and soft tissue dissection including the risk of infection, delayed weight bearing and non-union especially for fractures with a severe soft tissue injury or open fractures.[3]

In recent years, closed reduction and minimally invasive percutaneous plate osteosynthesis has provided superior option for treating these fractures. It uses indirect reduction methods and allows stablisation of distal tibia fractures while preserving vascularity of the soft tissue envelope. Although percutaneous plating techniques limit dissection and periosteal stripping but still rates of post operative infection and soft tissue compromise are high. In addition, symptomatic hardware prominence and irritation are not uncommon.[3,4]

External fixation is effective in the setting of contaminated wounds or extensive soft tissue injury. Spanning external fixation is rarely used for definitive treatment of nonarticular distal tibia metaphyseal fractures. However, spanning external fixation is an excellent technique for temporary management of open non-articular fractures or fractures with extensive comminution and soft tissue injury.[4,9] Pin tract infection and secondary loosening can compromise stability of fixation or lead to deep infection and osteomyelitis.[4]

The majority of closed lower third tibia fractures and middle & lower third junction fractures of the tibia as well as open fractures with sufficient soft tissue cover when the fracture is not extending into the lower 4 cm of the tibia from the ankle joint are indications for intramedullary nailing.[10]

Locked intramedullary nailing is considered the treatment of choice in tibial diaphyseal fractures. Intramedullary nailing allows atraumatic, closed, stabilization while preserving the vascularity of the fracture site and integrity of the soft tissue envelope.[7] However, there are concerns about the stability of the fixation, breakage of nails and locking screws, risk of propagation of the fracture into the ankle joint and less than perfect alignment of fracture in the treatment of distal tibial fractures.[5,11] In addition, metaphyseal enlargement and frequent presence of a short distal fragment make reduction technically difficult.[12,13]

The common complications include chronic knee pain, angular malunion. Less frequent complications are interlocking screw failure, nail breakage, infection, cortical necrosis and delayed or non-union.[7] A consensus for the utilization of fibular fracture fixation at the time of distal tibia fracture treatment does not exist and remains a heavily debated topic.[14]

We are going to do a prospective study to evaluate the efficacy of intramedullary nailing of extra-articular distal third tibial fractures with fixation of fibula fracture only if fibula fracture is present in the distal third and it is not possible to get two locking screws purchase of the nail. However, fibula fracture in syndesmotic area will be fixed irrespective of locking screws purchase.

## MATERIAL AND METHODS

This clinical was conducted in the Department of Orthopaedics, Government General Hospital ,Kurnool, Andhra Pradesh, during the period January 2022 – December 2022.

**Sample Size:** 20 patients

**Study Population :**

Extra-articular distal third tibial fractures with or without fibula fracture in skeletally mature adults.

**Study Design** : Prospective study

### Inclusion criteria

Extra-articular distal third tibia fracture with or without fibula fracture in skeletally mature patients

- Closed fractures
- Gustilo-Anderson grade I and II fractures

### Exclusion criteria

- Fractures in proximal two third tibia
- Segmental fractures of the tibia
- Old malunions with refractures
- Distal metaphyseal fracture with intra-articular extension into ankle joint.
- Pathological fracture
- Skeletal immaturity
- Gustilo-Anderson grade III fractures

### Surgical Technique

Patient laid supine under spinal anaesthesia on standard radiolucent table. The injured limb was painted and draped in such a way that it can be left freely hanging down from the side of the operating table. Standard anterior longitudinal medial parapatellar tendon splittingincision was used. The entry point was made with an awl just below the articular margin of the tibial plateau in lateral view and medial to the lateral tibial spine in anteroposterior view after confirming that there was no rotational malalignment of tibia with an image intensifier. Guide wire was passed and fracture reduction was achieved manually. It was ensured that adequate flexion of the knee was possible to achieve central placement of the guide wire without hitting the posterior cortex. Reaming was done with sequentially increased size of manual cannulated reamers till the chattering of bone heard. Reamers were passed just distal to fracture site along the guide wire and not in the distal fragment till the subchondral bone to get better hold of nail. Interlocked Tibial Nail of proper length and one size smaller than the largest reamer was attached to zig. Nail was pushed in medullary canal manually to reach just distal to fracture site. Gentle hammering was done to push the nail further in distal fragment to avoid splinter at fracture site. Fracture fragments were aligned during the reaming as well as nailing to avoid coronal and sagittal plane malalignment. Sequential assessment under fluoroscopy was done for correct placement of nail. Steinmann pin was used for distal locking screws. Concurrent fibula fixation with 3.5 mm one third tubular plate / square nail was done in cases where fibula fracture was present in the distal third and it was not possible to get two distal locking screws purchase of the nail or fibula fracture in syndesmotic area irrespective of locking screws purchase. Back hammering was done if any gap between fracture fragments. Proximal locking was done with either only static or both static and dynamic locks.

### Postoperative Regimen

Third generation cephalosporin antibiotics were administered in suitable doses. The limb was kept elevated to control postoperative swelling. Postoperative radiological assessment of the leg with antero-posterior & lateral skiagrams (full length view which must include views of both the knee & the ankle). From first postoperative day the patient was encouraged to do active and assisted hip, knee, ankle and toe movements. Care of the soft tissue was done by regular antiseptic dressings and debridement as and when required. The skin sutures were removed after 12-14 days after operation. Non-weight bearing crutch walking was started as early as possible. Protected weight bearing walker walking was started at 6 weeks. Full weight bearing was started after evidence of clinical or radiological union.

### Follow-up

After stitch removal, the patients were asked to come for follow up in OPD every 4 weeks for first three visits and thereafter every three months till 9 months postoperatively. At each follow up visit patient was assessed both clinically and radiologically. X-ray was taken to note the progress of the union. Clinical examination was done to note the range of movements at the knee, ankle and foot, time taken for fracture union, residual shortening, deformity and any other complaint. Functional outcome was assessed by Olerud-Molander Ankle Score.

## OLERUD- MOLANDER ANKLE SCORE[18]

The Olerud-Molander score is a self-administered patient questionnaire.

The least possible score is 0 (totally impaired) to a maximum possible score of 100 (completely normal). It is based on nine different aspects:

| Parameter | Degree | Score |
|---|---|---|
| 1. Pain | None | 25 |
| | While walking on uneven surface | 20 |
| | While walking on even surface outdoors | 10 |
| | While walking indoors | 5 |
| | Constant and severe | 0 |
| 2. Stiffness | None | 10 |
| | Stiffness | 0 |
| 3. Swelling | None | 10 |
| | Only evenings | 5 |
| | Constant | 0 |
| 4. Stair Climbing | No problems | 10 |
| | Impaired | 5 |
| | Impossible | 0 |
| 5. Running | Possible | 5 |
| | Impossible | 0 |
| 6. Jumping | Possible | 5 |
| | Impossible | 0 |
| 7. Squatting | No problems | 5 |
| | Impossible | 0 |
| 8. Supports | None | 10 |
| | Taping, wrapping | 5 |
| | Stick or crutch | 0 |
| 9. Work, ADL | Same as before injury | 20 |
| | Loss of tempo | 15 |
| | Change to simpler job/ part-time work | 10 |
| | Severely impaired work capacity | 0 |

| SCORE | GRADE |
|---|---|
| 91-100 | Excellent |
| 61-90 | Good |
| 31-60 | Fair |
| 0-30 | Poor |

### Radiographic assessment:

Radiographic assessment included malalignment, time to union and loss of reduction. Radiographic assessment was done comparing the anteroposterior and lateral views of the affected leg with both the knee and ankle joints included. The varus/valgus angles were calculated by the Paley and

Tetsworth method. Lines were drawn horizontally over the tibial plateau and tibial plafond. Their midpoints were identified and connected with a vertical line. Then a perpendicular was drawn to the horizontal line over the tibial plafond. The angle formed between the perpendicular and line joining the midpoints of the plateau and plafond was considered as the varus/valgus angle based on lateral or medial angulation respectively. The same method was followed in the lateral view to calculate the procurvatum/recurvatum angles. These angles were calculated from the immediate postoperative radiograph and the final follow up radiograph. The residual deformity, malalignment and loss of reduction were noted. The diagnostic criteria for radiological assessment of distal tibia fractures, consistent bony union, malunion, non-union and delayed union are defined below.

**Diagnostic criteria:**
Extra-articular distal tibia fractures: Fracture of the distal third of the tibia present 4cms-11cms above the tibial plafond.

Consistent bony union: It was defined based on two criteria described by Sarmiento
1. The ability of the patient to bear weight without pain
2. Visible bridging callus on three out of four cortices across the fracture in the AP/lateral radiographs.

**Malunion:** Malunion was defined as
1. Varus or valgus deformity more than 5 degrees
2. An anteroposterior angulation more than 10 degrees
3. A shortening of the limb more than 1 cm.

**Delayed union:** Delayed union was defined as failure of fracture union by 6 months after surgery.

**Non-union:** Non-union was defined as failure of fracture union within 9 months of surgery.

## OBSERVATIONS AND RESULTS

**Age:** Majority of the subjects belonged to 36-45 years age group (40.0%) followed by 18-25 years, 26-35 years, 36-45 years and > 45 years (20.0% each). The mean age was 38.15±13.14 (18-66) years.

**Gender:** There were 13 (65.0%) males and 7 (35.0%) females. Mechanism of injury: Most of the subjects had RTA (55.0%) followed by Fall (45.0%).

**Subjects according to side:** Right side was affected among 70.0% and left side among 30.0% subjects.

**Table 1: Distribution of study population according to Type of Fracture**

| Type of Fracture | | Frequency | Percentage |
|---|---|---|---|
| Open | Gustilo-Anderson Type I | 5 | 25.0% |
| | Gustilo-Anderson Type II | 1 | 5.0% |
| Closed | Tscherne-Gotzen Type O | 7 | 35.0% |
| | Tscherne-Gotzen Type I | 6 | 30.0% |
| | Tscherne-Gotzen Type II | 1 | 5.0% |

As per AO-Classification, there was A1 fracture among 17 (85.0%) and A2 among 3 (15.0%) subjects.

**Table 2: Distribution of study population according to Fibula fracture level**

| Fibula fracture level (in relation to Tibia fracture) | Frequency | Percentage |
|---|---|---|
| Distal | 6 | 30.0% |
| Proximal | 8 | 40.0% |
| Same Level | 6 | 30.0% |

**Table 3: Distribution of study population according to Fibula Fixation**

| Fibula Fixation | Frequency | Percentage |
|---|---|---|
| No | 16 | 80.0% |
| Yes | 4 | 20.0% |

There was DM II among two (10.0%) subjects (one developed non-union and other had delayed union) and DM II + HTN among one (5.0%) subject.

**Table 4: Distribution of study population according to Union (in weeks)**

| Union (in weeks) | Frequency | Percentage |
|---|---|---|
| 12-16 weeks | 4 | 20.0% |
| 17-20 weeks | 8 | 40.0% |
| 21-24 weeks | 6 | 30.0% |
| > 24 weeks (delayed union) | 1 | 5.0% |
| Non-union | 1 | 5.0% |
| Mean | 18.75±5.65 (14-28) | |

**Table 5: Distribution of study population according to Functional outcome**

| Olerud&Molander Score | Frequency | Percentage |
|---|---|---|
| Excellent | 4 | 20.0% |
| Good | 15 | 75.0% |
| Fair | 1 | 5.0% |

**Table 6: Distribution of study population according to Complication**

| Complication | Frequency | Percentage |
|---|---|---|
| Nil | 11 | 55.0% |
| > 5 degrees Valgus | 2 | 10.0% |
| > 10 degrees Recurvatum | 1 | 5.0% |
| Anterior Knee pain | 3 | 15.0% |
| Delayed union | 1 | 5.0% |
| Non - union | 1 | 5.0% |
| Superficial Infection | 1 | 5.0% |

The complications were malunion among three (15%) subjects (10 degrees valgus, 11 degrees recurvatum, 8 degrees valgus). Delayed union, non-union and superficial Infection among one (5.0%) subject each. Anterior knee pain was reported among three (15.0%) subjects (out of which one patient underwent surgery for implant removal). One patient (58 years old male with DMII) that developed non-union was not willing for any additional intervention as he had only mild discomfort on full weight bearing. At 18 months follow up, patient sustained ipsilateral femoral shaft fracture for which he was being operated upon with IMN for femur and tibia fracture was found to be united.

## DISCUSSION

About 7–10% of all lower limb fractures are distal tibia extra-articular fractures.19 Casting can effectively treat closed fractures that have little or no displacement, although there is a high risk of knee and ankle stiffness. With many researchers expanding the guidelines to encompass distal tibial fractures and even partial articular fractures, intramedullary nailing is regarded as the gold standard in the treatment of tibial shaft fractures.20-22

In contrast to plating, nailing in distal tibial fractures offers a more biological fixation, minimally invasive surgery, and fewer soft tissue problems.

Treating tibial distal third fractures associated with fibular fracture at the same level becomes even more difficult. This fracture pattern reflects a high-energy trauma causing significant soft tissue injury and gross comminution.

### Age
In our study, majority of the subjects belonged to 36-45 years age group (40.0%) followed by 18-25 years, 26-35 years, 36-45 years and > 45 years (20.0% each). The mean age was 38.15±13.14 (18-66) years.

### Gender
In current study, there were 13 (65.0%) males and 7 (35.0%) females. Due to higher outdoor activities, increased vehicle use, and hard labour conducted by men in the Indian community as opposed to women, there were more male patients in our study.

### Mechanism of injury
In present study, most of the subjects had RTA (55.0%) followed by fall (45.0%).

### Associated fracture of fibula and concurrent fibula fixation
In our study, there was an associated fibular fracture in all patients, out of which six (30%) subjects had fibular fracture proximal to tibial fracture, eight (40%) had same level fracture, and the rest six (30%) had fibular fracture distal to tibial fracture (out of which two subjects had syndesmotic injury).

In present study, fibula fracture fixation was done among four (20.0%) subjects (two patients with syndesmotic injury and rest two patients in which fibula fracture was present in distal third & it was not able to get purchase of 2 distal interlocking screws). Among these 4 patients, it was found that two patients developed malunion and one patient had delayed union. Fibular fracture fixation didn't render any additional benefits in avoiding complications of malunion and in one patient led to delayed union as well.

Grading

In present study, as per Tscherne-Gotzen Grading, there was Grade I fracture among 6 (30.0%), Grade II among 1 (5.0%) and Grade O among 7 (35.0%) subjects. As per Gustilo-Anderson Classification, there was Type I fracture among 5 (25.0%) and Type II among 1 (5.0%) subject. As per AO-Classification, there was A1 fracture among 17 (85.0%) and A2 among 3 (15.0%) subjects.

### Time to Union
In present study, union took 12-16 weeks among 20.0%, 17-20 weeks among 40.0%, 21-24 weeks among 30.0% and >24weeks among 5.0% subjects. The mean time to union was 18.75±5.65 weeks. Lau et al.15 showed that the average time for bony union was 18.7 weeks. Collinge and Protzman.16 reported that the mean fracture healing time was 21 weeks (range, 9-60 weeks). Paluvadi et al.17 reported that closed distal tibial fractures operated by MIPO technique, the mean fracture healing time was 21.4 weeks (range 16-32 weeks). Gawali et al.23 found that radiological and clinical union was evident in all patients with average duration of 18 weeks.

### Outcome
In our study, it was found that Olerud&Molander Score was Excellent among 4 (20.0%), Good among 15 (75.0%) and Fair among 1 (5.0%) subject.

### Complications
We observed that the three subjects (15%) developed malunion (10 degrees valgus, 11 degrees recurvatum, 8 degrees valgus). Delayed union, non-union and superficial infection were reported among one (5.0%) subject each. Anterior knee pain was observed among three (15.0%) subjects (out of which one patient underwent implant removal at 1 year post surgery). One patient (58 years old male with DMII) that developed non-union was not willing for any additional intervention as he had only mild discomfort on full weight bearing. At 18 months follow up, patient sustained ipsilateral femoral shaft fracture for which he was being operated upon with IMN for femur and tibia fracture was found to be united.

**Pre-operative X-ray Immediate post-operative X-ray**

**One month follow-up X-ray3 months follow-up X-ray**

**6 months follow-up X-ray One year follow-up X-ray**

### RANGE OF MOTION

### CONCLUSION:
This study showed that treatment for distal tibial extra-articular fractures is improved by intramedullary nailing. Compared to plating, it has less soft tissue problems and is a more biological method of fixing since it avoids disrupting the fracture hematoma. The most often reported complications with IMN are angulation in the frontal plane and anterior knee comfort. To avoid any malalignment, we advise to keep the intraoperative reduction as anatomic as possible when inserting the guide wire, reaming and driving the nail. Interlocking nailing is effective in treating distal third tibial

fractures. It is possible to obtain acceptable alignment and range of motion. Fibular fracture fixation doesn't render any additional benefits in avoiding complications like malalignment and delayed union. Only patients with syndesmotic disruption require fibular fixation. Central placement of IMN and purchase of 2 distal locking screws (possible by modern nails with more distal locking options) are the two most important factors in obtaining good outcome in distal third tibial fractures.

Limitations of our study:Sample was not homogenous. Sample size of our study is limited to one centre and is small. So, generalization cannot be made to a larger population.

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