

# Comparative Study between Intra-medullary Nailing and Minimally Invasive Plate Osteosynthesis (MIPO) in Closed Distal Tibia Fracture in a District Hospital in Bangladesh

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### Abstract

**Introduction:** Tibia fractures are the most common long bone fractures encountered by the orthopedic surgeons and distal tibia fractures have the second highest incidence of all tibia fractures after the middle third of tibia the distal tibial fractures are unique and are considered as most challenging fractures to treat due to its proximity to the ankle joint and its superficial nature. The objective of this study is to compare two osteosynthesis systems developed for surgical treatment of distal tibia fractures: the intramedullary nailing and the MIPO technique.

**Methods:** The study was conducted between Jan 2018 to Dec 2019. 30 patients with extra-articular distal tibia fracture treated with intramedullary nailing and MIPO technique were reviewed retrospectively and clinical outcome was evaluated according to American Orthopaedic Foot and Ankle Score.

**Results:** 15 patients were treated with intramedullary nail and 15 with MIPO technique. Fibular fixation was done in cases where fibular fracture was at or below the level of tibial fractures. We found no difference in terms of time for fracture union, mal-union, non-union, duration of surgery and amount of blood loss. But there was significant difference in terms of infection and duration of hospital stay. Also weight bearing was possible much earlier in intramedullary group as compared to the MIPO group.

**Conclusion:** Thus we conclude that intramedullary nailing is better choice of implant in patients with extra-articular distal tibia fractures and helps in early weight bearing and ambulation of patient with fewer complications.

**Key Words:** Intra-medullary Nailing, Minimally Invasive Plate Osteosynthesis (MIPO), Closed Distal Tibia Fracture

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### Introduction

Fractures of distal tibia metaphysis occur typically as a result of axial and rotational forces on lower extremity and represents approximately 10% of the fractures of distal end of tibia.<sup>1,2</sup> The degree of associated soft tissue injury is higher in distal metaphyseal fractures than with shaft fractures.<sup>3</sup> This fracture can be treated by plating or with closed reduction and reamed intramedullary nailing. However, two of the most used techniques are locked intra-

medullary interlocking nail and minimally invasive plate osteosynthesis (MIPO). Open plating of the medial aspect of distal tibia caused a statistically significant greater disruption of extraosseous blood supply of the metaphyseal area than percutaneous applied plates.<sup>4</sup> The best treatment for displaced, extra-articular fractures of the distal tibia (specifically the lower third of the tibia) remains controversial. These injuries are particularly difficult to manage due to the limited soft tissue coverage, poor vascularity of the area, and proximity of the fracture to the ankle joint. Infections, nonunion, and malunion are well-recognized complications of fractures of the distal tibia also, there is difficulty in maintenance of reduction, and thus management of these fractures is very controversial; in the more distal metaphyseal region of the tibia, the nail fixation may be less stable.<sup>5</sup> The bolts or screws that are inserted into the nail may break<sup>6</sup>, malalignment may occur<sup>7</sup>, and there is a risk that the nail

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will penetrate into the ankle. The Fixation of Distal Tibia Fractures (FixDT) trial was designed to compare intramedullary nail fixation with locking plate fixation for adult patients with a displaced fracture of the distal tibial joint<sup>8,9</sup>. Intra-medullary nails for distal tibia fractures are technically difficult to perform and must be addressed with care. Also, the maintenance of reduction of proximal and distal metaphyseal fractures can be difficult to control with an intramedullary device, leading to mal-alignment; rates varying from 5% to 58%. Failures in controlling distal fragments may lead to deformities and problems in union like mal-union and non-union. Intra-medullary nailing of the tibia has also been associated with knee pain in up to 71% of patients.<sup>4</sup> But, the advantages of closed intramedullary nailing are that it minimizes surgical insult to the fracture and adjacent soft tissues have been associated with shorter time to union and a shorter period of disability. MIPO is an alternative treatment for these fractures, because it does not need large exposure for reduction, thus providing biological fixation. However, failure to achieve satisfactory reduction may result in angular deviations, non-union and pseudoarthrosis.<sup>9</sup>

### Objectives

The objective of the study was to set the indications for both modalities of fixation in various fracture subtypes; to compare the functional outcomes of distal metaphyseal fractures of tibia managed by both methods at 2 years; and to study complication rates with different modalities of fixation.

### Materials and methods

This is prospective study conducted in Department of Orthopaedics, 250 Bedded General Hospital, Tangail between January 2018 and December 2019. The study consisted of 30 patients' metaphyseal fracture of tibia with either reamed intramedullary nailing or locked plating with open reduction method or minimally invasive techniques. Biplanar injury radiography was evaluated to determine the fracture location and involvement of distal part of tibia.

#### *Inclusion Criteria:*

Skeletally mature patient, involving distal 5cm of tibia (AO types A1, A2, A3 and B1) and all closed and Gustilo-Anderson type I fractures.

#### *Exclusion Criteria:*

Skeletally immature patient and Fractures with intra-articular extension (AO type B, C2, C3) 3), Open fractures of Gustilo-Anderson type 2&3, all cases with DM where excluded. The eligible patients were randomly divided into two group, Group 1 includes patients managed with closed reduction and reamed nailing and Group 2 includes patients treated with locked plating techniques by

minimally invasive method (MIPO). The patients in both groups were matched for various confounding variables (age, sex, fracture types, comorbid condition, and associated fractures) and fifteen patients in each group were selected for final outcome study. Follow ups took place at 6 weeks and 3, 5, 7, 9 and 12 months after surgery with clinical and radiological examination. A distal tibial fracture was defined as a fracture extending within 2" Müller's squares" of the ankle joint. The criterion for inclusion was the presence of a distal fragment of at least 2.5 cm in length, with no articular incongruity and located within 10 cm from the tibial plafond. 7 Patients were excluded if the fracture was open, pathological fractures, the fracture extended into the ankle joint, there was a contraindication to intramedullary nail fixation (eg, a total knee replacement or previous deformity of the tibia), there was a contraindication to anesthesia, or the patient was unable to complete questionnaires. All patients gave written informed consent. Tscherne classification was used to assess the extent of the soft tissue injuries in closed fractures.

For intramedullary nail fixation, an intramedullary nail is inserted at the proximal end of the tibia and passed down the hollow center (medullary canal) of the bone to hold the fracture in the correct anatomical position. The reduction technique, the surgical approach, the type and size of the nail, the configuration of the proximal and distal interlocking screws, and any supplementary device or technique was left to the discretion of the surgeon as per standard clinical practice. For locking plate fixation, a locking plate is inserted at the distal end of the tibia and passed under the skin onto the surface of the bone. The associated fibular fracture was fixed either with plate or intra-medullary nail, only if it was at or below the level of tibial fractures. Fixed-angle screws must be used in at least some of the distal screw holes—this is standard practice with all distal tibia locking plates.

Non weight bearing was recommended for at least 8 weeks post-operatively for both groups. Surgeon discretion was used to determine progression of weight bearing based on fracture pattern, soft tissue injury, bone quality and patient comorbidities. Patients were followed up for a minimum period of 12 months post-operatively. Patients were evaluated with radiographs in both anteroposterior and lateral views of ankle joint and distal tibia preoperatively, immediate post-operatively and at approximately 6 week intervals thereafter until fracture union. Mal-union was defined as 5 degree of angular deformity or translation/shortening of 10 mm. Fracture union was defined clinically as no pain or tenderness at the fracture site and radiologically as healing of at least three of four cortices on bi-planar plain radiographs. Delayed union was defined as lack of any healing on plain radiographs within 3

months. Non-union was defined as lack of any healing on plain radiographs within 6 months. Local complications included infection, vascular and neurological injury, venous thromboembolism, and malunion. At the end of follow-up (after 1 year), clinical outcome was evaluated according to the American Orthopedic Foot and Ankle score as excellent (90e100), good (75e89), fair (50e74) and poor (<50).



Fig. 1 : ORIF by interlocking nail



Fig. 2 : MIPO by distal tibial locking plate

### Statistical analysis

The two groups were compared with respect to age, sex, Arbeitsgemeinschaft für Osteosynthesefragen (AO) fracture type, number of closed and open fractures (Gustilo-Anderson type I), pre-operating waiting period, operating time, duration of hospital stay, bony union time, incidence of wound complications, malunion and non-union of the fracture and the American Orthopedic Foot and Ankle score. Unpaired Student t test and uncorrected c2 test were used as the statistical test, and analysis was performed using “open EPI” online site (data analysis online site). The chosen level of significance was  $p < 0.05$ .

### Results

Partial weight-bearing ambulation was started at 8 weeks in the interlocking intra-medullary nail group as compared with 12 weeks in the MIPO group ( $p = 0.01$ ). Fractures of tibial distal third are difficult to treat. When associated with a poor lining of soft tissues, these fractures are frequently comminuted or present a small metaphyseal fragment. Traditional techniques fail to achieve an appropriate reduction and maintenance of fractures or may further damage soft parts. Biological fixation of tibial distal third fractures is beneficial and technically feasible. The advantages are as follows: it reduces injuries on soft parts, it does not compromise bone vascularization and presents a low complication rate, especially when compared with open reduction and internal fixation. These fractures, when not involving joints, may be treated by two different manners: locked intra-medullary nail or bridge plate using a minimally invasive technique.<sup>5</sup> In this study, we found that the cost of treatment for the intramedullary nail group was lower as compared with the MIPO group. Also, the longer duration of hospital-stay in the MIPO group further increased the cost of treatment.

In randomized prospective study of 85 distal tibia fractures by Guo et al,<sup>9</sup> the operation was delayed for up to 10 days if the leg was considerably swollen and bruised when plating was used as the treatment modality in contrast intra-medullary nailing was associated with earlier operation. In the present study, the preoperative waiting period was 6 days as compared with 3 days for the interlocking nail group which was found statistically significant. Their study also concluded that the mean radiation time and operating time were significantly longer in the minimally invasive locked compression plate group as compared with intra-medullary nail group, which was also the case in the present study. Thus, there was longer duration of hospital stay in the MIPO group as compared with the intra-medullary nailing group adding to the cost of treatment. Li et al<sup>10</sup> in their retrospective study including 46 patients found that the mean operating time and mean duration of hospital stay was  $76.1 \pm 16.6$  minutes and  $5.8 \pm 2.1$  days, respectively, for the interlocking nail group was significantly shorter when compared with  $90.4 \pm 20.3$  minutes and  $8.9 \pm 3.1$  days, respectively, in the MIPO group. Also, the time for full weight bearing was  $11.1 \pm 1.7$  weeks in the MIPO group, which was significantly longer than  $9.0 \pm 1.4$  weeks in the interlocking nail group. So, they concluded that multidirectional locked nailing may be considered a better surgical option as it offers advantages in terms of mean operating time, hospital stay and full weight-bearing time.



Surgical treatment for distal tibial metaphyseal fractures is a challenge because extensive soft-tissue injuries often disrupt the vascular supply to the fracture site and increase the risk of infection and delayed union or non-union because of the thin soft tissue envelop and precarious blood supply in this region. The American Orthopaedic Foot and Ankle surgery scoring system was used by Guo et al [10] and the Olerud-Molander Ankle Score by Li et al [11] to evaluate the functional results, respectively; both the studies showed no statistically significant difference between the functional outcome of either intra-medullary interlocking or MIPO group. Thus, suggesting that closed intramedullary interlocking nailing and a minimally invasive percutaneous plate osteosynthesis can be used safely and effectively to treat distal metaphyseal fractures of the tibia.

### Discussion

Both groups were comparable with regards to age, sex and fracture types. Mean age of cases was 40 years in group 1 compared to 42 years in group 2. Most common mode of trauma in both groups was road traffic accident (50 % cases) followed by sports related injury in group 1 (20% cases) and fall from height in group 2 (15% cases). This multicenter trial of patients with a fracture of the distal tibia found no significant difference between intramedullary nail fixation and locking plate fixation in disability rating at 6 months or 12 months.

The average duration of surgery in group 2 was 94 minutes (range, 70-120 minutes) whereas average duration of surgery in group 1 was 85 minutes (range, 65 to 105 minutes), ( $p=0.21$ ) meaning that difference between 2 groups regarding duration of surgery is not significant. No significant intraoperative complications were noted in both groups. Difficult reduction was observed in 3 patients in group 1 and 4 patients in group 2. Proximity to ankle joint amplifies the bending moment of the distal segment and may facilitate fracture propagation into the ankle joint. No such complication was observed in our cases.

Average time after which patient was allowed full weight bear on the operated limb was 14.25 weeks (range, 11-18 weeks) in group 1 and 17.32 weeks (range, 14-22 weeks) in group 2, ( $p=0.001$ ). The cases in group 1 were able to bear weight on the operated limb in significant earlier time and able to perform independent activities at earlier time compared to group 2.

There was no significant difference in union time between two groups. Higher rate of delayed union was found in group 2 (20%) compared to group 1 (10%). Two patients in group 1 failed to achieve union by 24 weeks. One of

them required autogenous bone grafting and went to union by 34 weeks and other patient required dynamization with bone grafting and went to union by 36 weeks.

Angular deformity was found in 15% of patients in group 1 and 10% of patients in group 2. Mean angulation in group 1 was 3.4 degree (range, 0-12) and 1.0 degree (range, 0-9) in group 2 ( $p=0.04$ ). Varus deformity of  $>5$  degree was found in 4 cases and valgus deformity  $>5$  degree in single case in group 1. 2 cases in group 2 had deformity  $>5$  degree, one had varus and other had valgus deformity. This shows that angular malalignments were more common in group 1. This complication may initially result from an incorrect entry site and entrance angle. In addition, the incidence of malalignment may be caused by instability due to the large difference between the diameter of the implant and medullary cavity of distal metaphysis. The nail does not contact the metaphyseal cortex; therefore it may translate along the interlocking screws unless anteroposterior locking is also performed. The use of Pollar screws has been described as additional stabilization technique and reduction tool to increase the strength of bone implant construct.

Malalignment can lead to complaints from the patient with regard to walking, practicing sports and so forth. Puno et al evaluated 27 patients with 28 tibial fractures at an average of 8.2 years (range, 612.5 years). They found a correlation joint malalignment and clinical outcome for fractures of tibia. Analysis showed that a greater degree of ankle malalignment produces poor clinical outcomes.<sup>12</sup> Long term effect of malalignment needs to be evaluated further.

Shortening ( $>1$  cm) was found in 20% of patients in group 1 and 10% of patients in group 2. Average shortening was 0.8 cm (range, 0-1.5) in group 1 and 0.3 cm (range, 0-1.3) in group 2 ( $p=0.012$ ). Clinically significant shortening was found in only 2 cases treated with intramedullary nailing and one case treated with plating.

Most important postoperative complication in nailing group anterior knee pain and postoperative infection patients treated with plating group. Incidence of anterior knee pain in nailing cases was 30%. This complication is seen exclusively in nailing group. Operative site infection was seen in 5% (all superficial) cases in group 1 and 15% (all superficial) cases in group 2. Superficial infection subsided with intravenous antibiotics and continued dressing, and healed eventually.

Patients treated with intramedullary nailing have statistically better ankle range of motion. Average ankle dorsiflexion was 15 degree and plantarflexion 22 degree in nailing group compared to dorsiflexion of 9 degree and plantarflexion of 13 degree in plating group.

Higher average functional ankle score was found in nailing group compared to plating group. The average Olerud and Molander score was 86 (range, 75-93) in group 1 and 80 (range, 59-93) in group 2 ( $p=0.008$ ).

### Conclusion

Thus, we conclude that interlocking intra-medullary nailing and MIPO are effective options in the management of distal tibia fractures, but interlocking nailing fares better than MIPO with regards to early weight bearing, less pre-operative waiting period, shorter ambulation and wound complications. Also, as the implant is cheaper, there is less preoperative waiting and shorter duration of hospital stay. Closed intra-medullary nailing is a potentially cost-effective alternative to MIPO for the treatment of distal tibia fractures. Among patients 16 years or older with an acute, displaced, extra-articular fracture of the distal tibia, neither nail fixation nor locking plate fixation resulted in superior disability status at 6 months. Other factors may need to be considered in deciding the optimal approach.

Due to small number of patients involved in our study, we cannot draw any definitive conclusions from our preliminary results but view them as valuable basis for further studies. Further research is necessary, in order to evaluate whether this surgical technique in long term provides us with the safe and effective management options for distal tibia fractures.

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