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COMPARATIVE STUDY BETWEEN INTRAMEDULLARY INTERLOCKING NAIL AND MINIMALLY INVASIVE PERCUTANEOUS PLATE OSTEOSYNTHESIS FOR DISTAL TIBIA EXTRA-ARTICULAR FRACTURES

Sarfraz Iman[1], Manabjyoti Talukdar[2], Washim Akram[3]

[1]Associate Professor, Department of Orthopaedics, TMCH.
[2]Assistant Professor, Department of Orthopaedics, TMCH.
[3]PGT Trainee, Department of Orthopaedics, TMCH.

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Corresponding Author: Dr Washim Akram, PGT Trainee, Department of orthopaedics, TMCH.
Email: washimcr7@gmail.com

Abstract

Background: Distal tibial fractures includes the distal tibia between 4cm-12cm from tibial plafond. It constitutes about 10%-13% of tibial fractures. Because of its subcutaneous location, it have poor blood supply and paucity of muscular cover anteriorly, treatment of this fractures becomes challenging. Most commonest complication of this fractures includes delayed union, non-union, wound dehiscense. Motor vehicles accident is one of the commonest cause followed by falls, sports injury, and direct blow. Intramedullary interlocking nail and minimally invasive percutaneous plate osteosynthesis are two well accepted treatment procedure but each of them certain advantages and disadvantages. **Aim**: To compare the functional outcome, various complication, time to unite the fractures while treating with intramedullary interlocking nail and minimally invasive plate osteosynthesis for distal extra-articular tibial fractures. **Materials and methods**: This is a prospective comparative study done in department of orthopaedics, Tezpur Medical College and Hospital, Assam. The study was conducted in the Department of Orthopaedics, Tezpur Medical College and Hospital from 1st September 2018- 31st December, 2022. Total of 30 patients are grouped into two catogories, 20 in each group each using computerized web-based randomisation. The first group of patients were treated with intramedullary interlocking nail and second group of patients were treated with minimally invasive percutaneous plate osteosynthesis (MIPPO). AOFAS (The American orthopaedic foot and ankle society) is used to assess the ankle and hinfoot function. **Results**: time of union in patients treated with MIPPO was 21± 3 weeks while time of union in patients treated with I/L tibial nail was found to be 18 ± 2 weeks and the difference is statiscally significant (P value < 0.05). The mean AOFAS scores in the MIPPO group was 88± 7.3 and IMN groups is 94 ±5.3.the AOFAS score were comparable in our study (p-value < 0.05). **Conclusion**: In our study, knee discomfort, malunion, and nonunion are considerably more common in the IMIL group despite superficial infection being more common in the MIPPO group. Other metrics, such as the duration of the fracture union, the operation, the fluoroscopy, the hospital stay, and the AOFAS score, were, nevertheless, within similar ranges.

Keywords: Intramedullary interlocking nail, MIPPO, distal tibia extra-articular fracture, AOFAS score

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Introduction

The most frequent long bone fractures are distal tibial fractures. Although more recent statistics imply that the incidence may be dropping [2], published data suggest an incidence of 17 per 100,000 person-years [1]. Most often, they are caused by a force that is applied from the foot to the leg in the context of exceptionally high-energy traumatic events, such as falls, motorbike accidents, traffic accidents, or sports-related injuries [3, 4]. Road traffic accidents and fall from height are the most common modes of injury in distal tibial extra-articular fractures.Low-energy falls generate torsional spiral fractures of the metaphysis and distal diaphysis, whereas on the other extreme, high-energy blunt impact causes complex comminuted fractures.

In skeletally mature patients, displaced distal tibia fractures are treated surgically to provide better fracture alignment, pain relief, support for local soft tissues, and to promote mobility of the adjacent joints. Since the soft tissues in this area of the leg are very thin, managing these fractures presents a number of challenges. Additionally, tibial distal fractures are particularly more vulnerable to exposure due to their proximity to the ankle and the absence of arterial support.Several studies focusing on the methods of treatment of displaced distal tibial fractures have been published [5–11]. To date, locked plates, intramedullary nails and external fixation are the three most used techniques. Each of the techniques has some advantages and disadvantages over one another. Mal-alignment and knee pain have been associated with nailing; infections, wound complications and implant prominence are frequently reported after tibial plating; prolonged fracture healing, frequent need of secondary operations and infections of the pin tract are inherent problems in external fixation [6,7,11].

Traction was the initial course of treatment for distal end tibia fractures, which was followed by early range of motion. This method was founded on the idea of ligamentotaxis, which holds that soft tissue attachment to the bone may lessen fractures. However, it was later discovered that a highly comminuted fracture does not have any soft tissue attachment to lessen fractures(12).

The aim of this prospective comparative study is to provide a complete and comprehensive overview on the optimal surgical treatment of distal tibia fractures by analysing a broad pallet of outcome measures. Outcomes of interest include operation time, non-union, time to union, mal-union, infection, subsequent re-interventions and functional outcome.

Materials And Methods

Setting: Department of orthopedics, Tezpur Medical College And Hospital, Assam.

Study design: The study employed a hospital based prospective comparative study to investigate the effect of two modes of treatment in distal extra-articular tibial fractures to compare the functional outcome, various complication, time to unite the fractures.

Inclusion criteria:

1. Age > 18 years,
2. Either gender,
3. Informed consent,
4. Duration of injury < 3 weeks,
5. Intact neurological and vascular status

Exclusion criteria:

1. Age < 18 years,
2. Fractures with intra-articular extension,
3. Polytrauma patients,
4. Pathological fractures

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Intervention protocol: A total of 30 patients satisfying the inclusion criteria were randomized into:
Group A- Patients treated with intramedullary interlocking nail (comprised of 15 patients)
Group B- Patients treated with minimally invasive percutaneous plate osteosynthesis(comprised of 15 patients)

Procedure

All the patients were rehabilitated based on ATLS protocol. Thorough investigation were done to rule out associated injuries. After initial stabilization, anterio-posterior and lateral radiograph of leg with knee and ankle done and the leg was stabilized with posterior above knee splint.

INTRAMEDULLARY INTERLOCKING NAIL

The patient is positioned in supine position with hip flexed to 45º and the knee flexed to 90º on radiolucent table.A 5cm incision over medial aspect of patellar tendon was given, extending from tibial tubercle in a proximal direction.Patellar tendon is retracted laterally to expose the insertion area and awl is inserted where the anterior tibia reaches the joint. Nailing was done using standard technique and fractures were fixed using two proximal and two distal screws.

Figure 1: Intramedullary interlocking nail A) Pre-op x-ray B) Immediate post-op x-rays C) follow up at 3 month

MINIMALLY INVASIVE PERCUTANEOUS PLATE OSTEOSYNTHESIS

A longitudinal incision of 3-4cm made over medial malleolus, sephanous nerve and vein were preserved and retracted anteriorly. Then tunneling is done towards diaphysis using blunt tip

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of the plate. Reduction is done by manual traction and manipulation. Precontoured plate is placed in anteromedial aspect of distal tibia through the tunnel. The plate is hold temporarily by K-wire. Theproximal screw is placed by giving small stab incision while distal fragment is fixed by combination of locking and nonlocking screws.

Figure 2: minimally invasive percutenous plate osteosynthesis A) Pre-op x-ray B) Immediate post-op x-rays C) incision site

Results

Mode of injury: Road traffic accidents and fall from height are the two most common modes of injury in distal tibial extra-articular fractures.Low-energy falls generate torsional spiral fractures of the metaphysis and distal diaphysis, whereas on the other extreme, high-energy blunt impact causes complex comminuted fractures. Road traffic accident constitutes about 56.6 % of patients whereas 43.4% patients fractures results from fall from height. Among RTA, 52.9% people undergone MIPPO whereas 47% undergone I/l tibial nailing. Among fall from height, 53.8 % had undergone I/l tibial nail and 46.1 % had undergone MIPPO.

Table 1: Mode of injury

Mode of injury	Number of patients			
	MIPPO	%	I/L tibial nail	%
RTA	9	52.9	8	47
Fall from height	6	46.1	7	53.8

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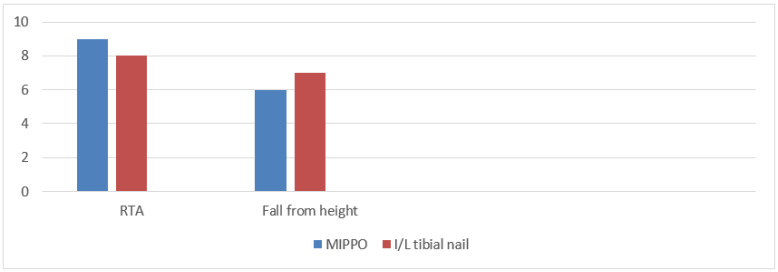

Figure 3: Mode of injury

Age distribution: Most of the patients belong to age group 25-40 years (66.6%) with male predominance (60%) followed by 50-60 years age group constitutes about 23.3 % patients. 73% male undergone MIPPO as compared 46% patients which undergone I/l tibial nailing. Among female, 26% undergone MIPPO and 54% undergone I/L tibial naling.

Table 2: Gender distribution

Gender	Number of patients				P value
	MIPPO	%	I/L tibial nail	%	
Male	11	73.3	7	46.6	
Female	4	26.6	8	53.3	**0.264**

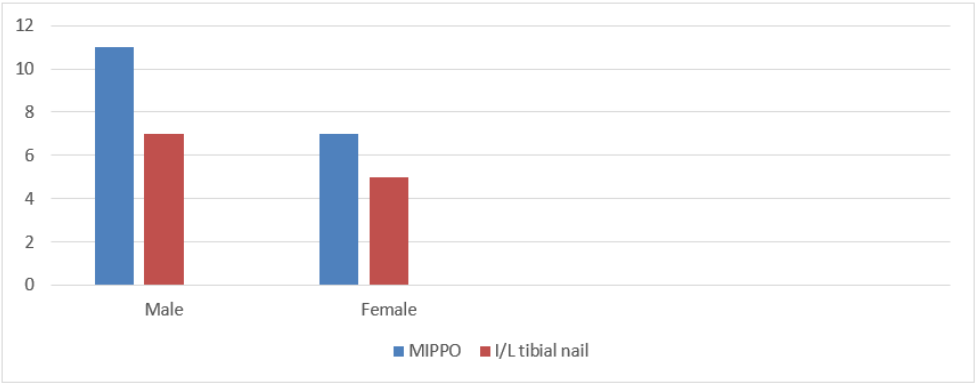

Figure 4: Gender

Table 3: Age

Age distribution(years)	Number of patients	Percentage (%)
20-30	9	30
30-40	11	36.7
40-50	3	10
50-60	7	23.3

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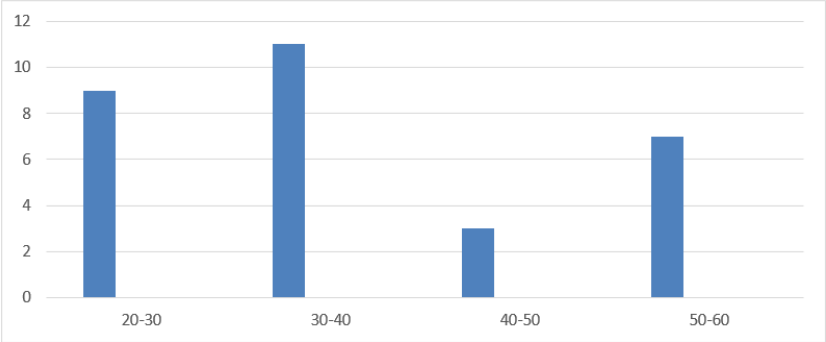

Figure 5: Age distribution

Time of union: Bony union is essential in patients undergoing fracture treatment. Bone union is generally assessed with conventional radiographs and by clinical examination. The three most commonly used clinical criteria are absence of pain or tenderness while weightbearing, absence of pain or tenderness on palpation and ability to bear weight. Plain radiographs remain one of the most commonly used methods of fracture union assesement. Absorbtiometry, photo densiometry, bone scintigraphy, ultrasonography and CT are all potential alternative to conventional radiographs. Bridging of the fracture at three or more of the four cortices in AP and lateral views, and/or obliteration of fracture line and/or cortical continuity by callus or trabeculae in conventional x rays is considered as radiological union. Interlocking tibial nail takes around 18 weeks for union to occur while MIPPO took around 21 weeks for bony union.

Table 4: Union time

Type of fixation	Union time(weeks)	P value
MIPPO	21 ± 3	
I/L tibial nail	18 ± 2 weeks	< 0.05

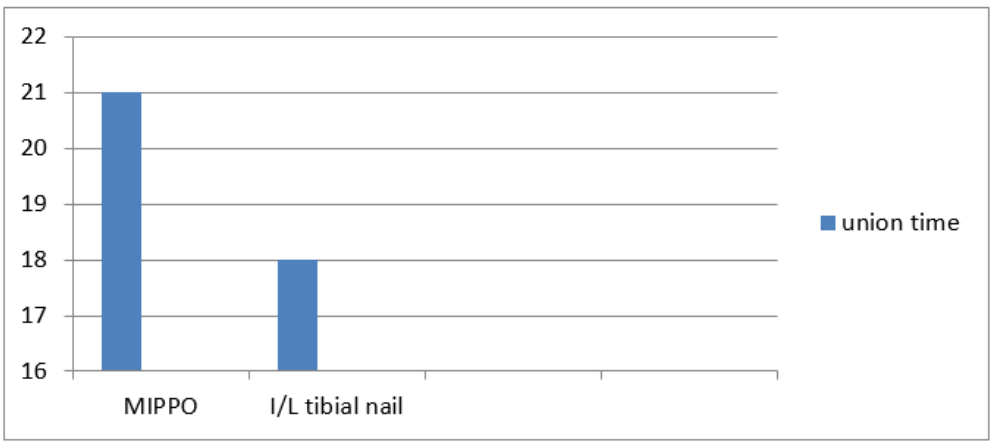

Figure 6

Duration of operation-Duration of operation or surgical time refers to the intra-service or skin-to-skin time, starting when the physician makes the first incision and ends when sutures are finished. We have used a stopwatch to calculate the time required for operation. All the surgeries were performed by the same surgeon. Patient treated with I/L tibial nailing takes less time(54±8 min) as compared to patient treated with minimally invasive percutaneous plate osteosynthesis (67±8 min).

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Table 5: Duration of operation

Fixation method	Duration of operation(min)	P value
I/L tibial nail	54 ± 8	
MIPPO	67 ± 8	.000012

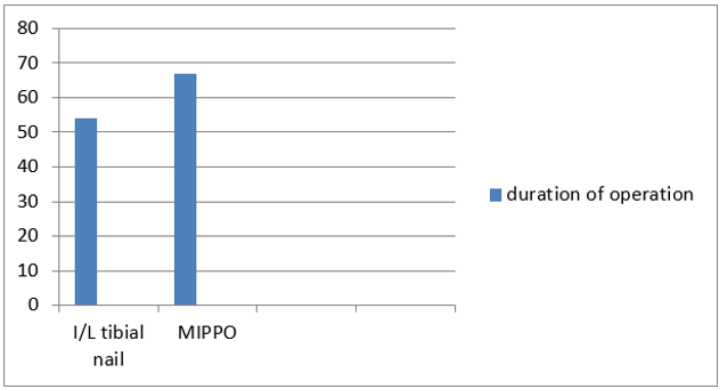

Figure 7

Blood loss during operation- Blood loss measurement serves as a pivotal role in operation, offering crucial insight into fluid management, blood transfusion decisions and ultimately influencing the postoperative outcomes and complications. The gold standard of accurate blood loss quantification involves weighing the surgical gauze used to absorb the blood in the surgical field and measuring the volumes in the suction bottles. Around 30 ml blood loss seen in tibial nailing as compared to 55 ml in MIPPO group.

Outcome of treatment- One of the most widely used tools for assessing how well patients who suffered complicated ankle or hindfoot injuries responded to therapy is the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Score. In clinical practice and research, patient-reported outcome measures are crucial because they provide a thorough assessment of the functional result or quality of life following non-operative or operative treatment of musculoskeletal injuries from the patient's viewpoint. In our study, mean AOFAS score in patients treated with intramedullary interlocking nail is 94 ± 5.3 while mean AOFAS score in patients treated with minimally invasive percutenous plate osteosynthesis is 88 ± 7.3

Post operative complication: The most common complication following MIPPO is superfacial infection which comprise 20 % cases(n=3) compared to 6.6 % case(n=1) following I/L tibial nail. Knee pain is most common among tibial nailing group comprises 13.3% cases(n=2). Non-union seen in one case of minimally invasive percutenous plate osteosynthesis. Malunion seen in 6.6% cases(n=2) in I/L tibial nailing group.

Table 6: post operative complication

Complication	I/L tibial nail	Percentage(%)	MIPPO	Percentage(%)	P value
Super facial infection	0	0	4	26.6	<0.05
Deep infection	0	0	1	6.6	>0.05
stiffness	2	13.3	1	6.6	>0.05
Knee pain	5	33	0	0	0.0421

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Ankle pain	0	0	1	6.6	>0.05
Non-union	1	6.6	0	0	>0.05
Cutenous necrosis	0	0	0	0	
Malunion	1	6.6	0	0	>0.05

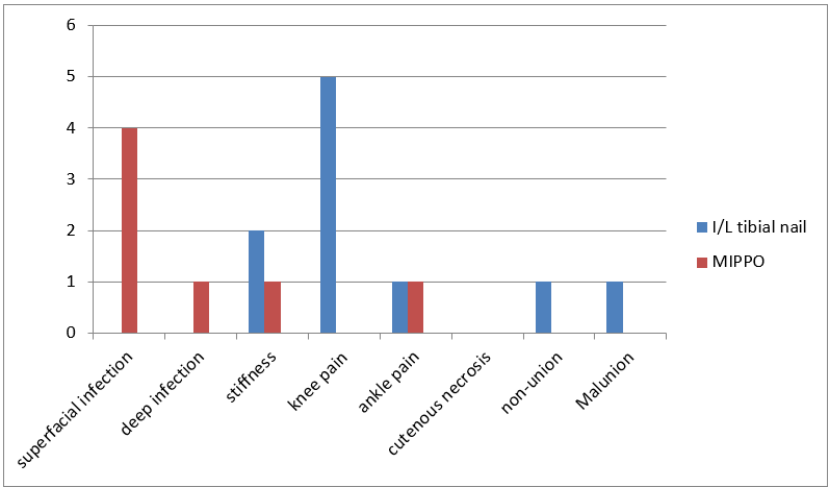

Figure 8

Discussion

An orthopedic surgeon faces a great deal of difficulty while treating an extra-articular distal third tibia fracture due to the limited soft tissue coverage, unique distal tibia architecture, and substantial bone comminution. Restoring length, alignment, and rotation in these fractures while maintaining the integrity of the soft tissue is the aim of treatment. The reduction and nailing of these types of fractures are technically challenging due to the long lever arm, canal expansion in the metaphyseal region, and epiphyseal-metaphyseal fixation issues [13, 14]. Several studies have documented a significant incidence of discomfort and infection as a result of the implant's prominence during tibia MIPO plating.

Because IMIL nailing is minimally invasive, causes less bleeding during surgery, allows for early weight bearing, lowers the risk of infection, reduces periosteal stripping, and speeds up the healing process, it has been utilized for many years to treat these fractures. The intramedullary nail, which is intended for interference fit in diaphysis, cannot give enough stability in the distal region because the distal tibia has a wide circular intramedullary cavity with thin cortex, whereas the diaphysis has a triangular narrow cavity with thick cortex.(15)

The IMIL nailing technique has been challenged by the invention of the MIPPO technique, which offers axial and angular stability at the screw plate interface rather than the plate bone interaction and is thought to preserve the periosteal blood flow surrounding the fracture.

The most common mode of injury was road traffic accident. 52.9 % patients among RTA undergone MIPPO and 47% patients undergone intra-medullary nailing. 13 patients presented with distal tibia extra-articular fracture due to fall from height among which 46.1% undergone MIPPO and 53.8% undergone intramedullary nailing. Most of the patients belong to age group 25-40 years (66.6%) with male predominance (60%) followed by 50-60 years age group constitutes about 23.3 % patients which is statistically insignificant.

In our study, the mean operative time in the MIPO group was 67± 8 minutes and in the IMN group it was 54±8 min. the P value is < 0.05 which is statiscally significant. In the study done by **Daolagupu *et al.*** [16], **Guo *et al.*** [17], and Janssen *et al.*[18], significantly longer operative

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time in the locking compression plate (LCP) group compared with the IMN group was reported (p-value <0.001).

In our study, time of union in patients treated with MIPPO was 21± 3 weeks while time of union in patients treated with I/L tibial nail was found to be 18 ± 2 weeks and the difference is statiscally significant(P value < 0.05). Studies conducted by **Yang *et al.*** [19] and **Dolagapu *et al.*** showed earlier union in the IMN group, which was significant. Other studies such as **Guo *et al.***, **Ram *et al.*** [20], **Im *et al.*** [21], and **Janssen *et al.*** found no significant difference in the union rate between the plating and IMN groups.

The mean AOFAS scores in the MIPPO group was 88± 7.3 and IMN groups is 94 ±5.3.the AOFAS score were comparable in our study (p-value < 0.05). **Guo *et al.*** and **Patil *et al.*** also reported comparable scores between the two groups. **Daolagupu *et al.*** also showed similar functional outcomes between the two groups, but using different functional outcome criteria.

In our study, most common complication was found to be superfacial infection which is seen 20% cases(n=3) of MIPPO and 6.6% cases(n=1) of intramedullary nailing. Deep infection seen in 6.6 % cases(n=1) of MIPPO. Knee pain was seen in 6.6 % cases(n=1) of intramdullary nailing. Malunion seen in 6.6 % cases(n=1) of intramedullary nailing. Similar to our findings, **Daolagupu *et al.*** found increased rates of infection and implant discomfort in the plating group compared to the nailing group. **Hu *et al.*'s meta-analysis** [22] showed that while both the MIPPO method and IMIL nailing are useful for treating distal tibia fractures, the MIPPO group is more likely to experience superficial infection and knee pain, while the IMIL group is more likely to experience malunion. According to **Vallier *et al.***[23], IMIL nailing has a higher rate of malunion than plate fixation.

Both techniques have demonstrated a dependable means of fixing distal extra-articular tibial fractures while maintaining the soft tissue, bone vascularity, and fracture hematoma that provide an environment that is conducive to fracture healing. In our study, knee discomfort, operation time, malunion, and nonunion are considerably more common in the IMIL group despite superficial infection being more common in the MIPPO group. Other metrics, such as the duration of the fracture union, the fluoroscopy, the hospital stay, and the AOFAS score, were, nevertheless, within similar ranges.

Numerous other contradictory research exist comparing the MIPPO procedure with IMIL nailing. According to Vallier *et al.*[23], IMIL nailing has a higher rate of malunion than plate fixation. When reamed IMIL nailing is used instead of MIPPO, Ali *et al.* [24] reported a shorter operating time and a faster fracture healing period. According to Bong *et al.* [25], owing of the large medullary cavity of the distal tibia and insufficient distal locking for the intramedullary nail, which causes loss of reduction and malunion, plates have superior torsional and bending strain than intramedullary fixation in terms of biomechanics.

The limitation of study were small sample size, short time period and one center oriented. Further multicentre studies with randomized controlled trials and larger sample size are recommendet before we firmly established it is an effective treatment modalities in distal extra-articular tibia fractures.

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Conflict of interest: None decleared

Ethical approval: The study was approved by the institutional ethics committee

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