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A comparative study of intramedullary nailing versus minimally invasive percutaneous plate osteosynthesis for extra articular distal tibia fracture

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ABSTRACT

Background: Distal tibia fractures are among the most challenging orthopaedic injuries due to their subcutaneous location, limited blood supply and proximity to the ankle joint. These fractures often result in complications such as delayed-union, non-union, wound infection and malalignment. This study aims to compare the effectiveness of two minimally invasive surgical methods: Intramedullary Nailing (IMN) and Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) in treating extra- articular distal tibia fractures.
Methods: A prospective study was conducted on 30 patients with extra-articular distal tibia fractures. The participants were divided into two groups, 15 patients receiving IMN and 15 patients MIPPO. Clinical assessments were carried out to evaluate functional outcomes, union time and complications. Radiological evaluations were used to monitor the progress of fracture healing.
Results: Both IMN and MIPPO were effective in treating distal tibia fractures, with each technique having its advantages and drawbacks. IMN showed a shorter union time and fewer wound complications compared to MIPPO, which demonstrated better alignment and fewer malunions. However, IMN was associated with a higher incidence of anterior knee pain, whereas MIPPO had more cases of implant irritation leading to reoperation.
Conclusions: Both IMN and MIPPO offer viable treatment options for extra-articular distal tibia fractures. IMN is preferred in cases where early weight-bearing and faster union are critical, particularly in patients with soft tissue concerns. Conversely, MIPPO is advantageous in achieving better alignment and should be considered when soft tissue conditions allow. We conclude by Intramedullary Nailing as better treatment modality for distal tibia extra articular fractures.

Keywords: Distal tibia fracture, Intramedullary nailing, MIPPO, Fracture union

INTRODUCTION

In the modern fast-moving world, there is a great increase in number and severity of fractures. The goal of fracture treatment is to obtain union of the fracture in the most compatible anatomical position which allows maximal and full restoration of the extremity.[1] Tibia is one of the most commonly fractured long bone of the body. Distal tibia fractures are primarily located within a square based on the width of the distal tibia.[2] The incidence of distal tibia fractures in most series is 0.6% and it constitutes to about 10%–13% of all tibial fractures.[3] Treatment of distal tibia fracture is challenging because of its unique anatomical characteristics of subcutaneous location with precarious

blood supply and proximity to the ankle joint.[4] Not only these fractures are relatively common, but they are often difficult to treat because of the propensity for severe soft tissue injury or compounding as the bone is subcutaneous in location with limited vascularity, which increases the chances of infection, wound dehiscence and non- union and small distal fragmentation. These are difficult to control while achieving closed reduction.[5,6]

Because of its subcutaneous location, poor blood supply and decreased muscular cover anteriorly, complications such as delayed union, non-union, wound infection and wound dehiscence are often seen as a great challenge to the surgeon. Various surgical modalities used for these fractures include intramedullary nailing (IMN), minimally invasive percutaneous plate osteosynthesis (MIPPO), open reduction and internal fixation (ORIF) and External Fixation.[7,8]

In recent years, Intramedullary Nails were widely used because of their successful outcomes and minimal damage to bone and soft tissue, especially in open fractures.[9] Some researchers reported that intramedullary nailing was an effective technique for stabilizing distal tibia.[10,11] However, delayed bone healing, reoperation and a high incidence of primary and secondary malalignment have also been reported, especially in distal and proximal tibial fractures, which may associated with the large cavity.[12]

The treatment of distal tibial fractures with plate provided a reliable fixation by achieving anatomical reduction and restoring alignment of the limb, which could allow early rehabilitation exercise for patients. But the high incidence of wound problems and reoperation was also reported.[13]

With the development of minimally invasive technology, minimally invasive percutaneous plate osteosynthesis (MIPPO) has become an excellent method.[14] It protected the subcutaneous soft tissue of anterior medial tibia and enabled adequate soft tissue coverage overlying the plate with less wound complications.[15,16]

The two ideal minimally invasive methods, intramedullary nailing (IMN) and MIPPO have their own advantages and disadvantages in the treatment of distal tibial fractures, the best treatment for distal tibial fractures remains controversial, currently. The aim of our study is to compare the effect of intramedullary nailing and MIPPO in distal tibial fractures.

METHODS

Study type

The current study is a prospective study.

Study place

The study was carried out at Al-Ameen Medical College Hospital.

Study duration

The duration of the study was from May 2022 to May 2024.

Sample size

Totally 30 cases were studied. 15 cases were treated with intramedullary nailing and 15 cases were treated with distal tibia locking plate by MIPPO technique.

Ethical approval

Obtained from ethical clearance committee Al Ameen Medical College Bijapur.

Inclusion criteria

All extra articular distal tibia fractures, closed fractures, patients above 18 years

Exclusion criteria

Patients initially treated with plaster cast or plating or external fixator. Open fractures, fractures with intra articular extension are excluded. Patients medically unfit for surgery. The patients were randomly allocated into two groups, Intramedullary nailing group and MIPPO group, with an equal number of 15 patients in each group.

Procedure

After obtaining fitness for surgery and informed and written consent from the patient and pre-anaesthetic examination, the patient is prepared for the surgery. In the Operation Theatre (OT) patient is instructed to lie down on the OT Table in supine position. Spinal anaesthesia is administered and tourniquet is applied, parts are prepared, scrubbed, painted and draped.

Intramedullary nailing

A 4-5 cms vertical skin incision is taken over the patellar tendon, patellar tendon is split and retracted. Entry point is made with a bone awl in line with the medullary canal under C arm guidance. Fracture is reduced and guide is passed under C arm guidance.

Reaming of the medullary canal is done in increasing size 1mm more than the nail size. Nail of appropriate length and size is inserted and checked under C arm guidance. Proximal and distal locking is done under C arm guidance. Thorough wash is given, patellar tendon is sutured. Wound is closed in layers and sterile dressing is applied.

Plating by MIPPO technique

A 3–5 cm incision is made at the medial malleolus, avoiding subcutaneous flap elevation. The great saphenous

vein and nerve are preserved anteriorly. Epiperiosteal tunneling is performed and a plate is inserted along the anteromedial tibial surface from distal to proximal.

Initial fixation is achieved with a cortical screw in the distal holes, followed by fracture reduction and proximal fixation with cortical locking screw. Additional screws are placed using stab incisions under image guidance. Thorough wash given; wound is closed in layers after achieving haemostasis.

Post-operative protocol and follow-up

After surgery, the limb is kept elevated. IV antibiotics are administered for 5 to 7 days after surgery. On the fifth or seventh postoperative day, the switch to oral antibiotics is made. Give analgesics if necessary. Following anaesthesia recovery, active mobilisation of the knee, ankle and toes began.

On the following postoperative day, the patient was permitted to be nonweight bearing while using a walker or crutch, based on their overall condition and tolerance. On days 10 and 12 following surgery, skin sutures were taken out. Antibiotics used orally ceased following suture removal. Depending on the kind of fracture, the rigidity of the fixation and any related ailments, partial weight bearing with crutch walking or walker started after 14 days.

Further follow-up is performed at 6-week intervals, i.e., at 6, 10, 14, 18 and 22 weeks and each patient is evaluated clinically and radiographically in accordance with the AOFAS scoring system.

Statistical tool

The tool involved for analysis was Microsoft excels.

RESULTS

This study included 30 cases of extra-articular distal tibia fractures, with 15 patients treated via intramedullary nailing and 15 with a locking compression plate using the MIPPO technique. The average age in the nailing group was 38 years, compared to 44 years in the plating group. The average duration of surgery was significantly shorter in the nailing group (58.6 minutes) than the MIPPO group (66.9 minutes).

Complications were observed in both groups, with the nailing group reporting knee pain (20%) and ankle pain (13.3%), while the MIPPO group had ankle pain (20%), ankle stiffness (13.3%) and infections (13.3%). Radiological union averaged 17.6 weeks for nailing and 18.8 weeks for MIPPO. Full weight-bearing was achieved at an average of 11.5 weeks in the nailing group and 14.5 weeks in the MIPPO group.

Pain (40 points)	
• None	40
• Mild, occasional	30
• Moderate, daily	20
• Severe, almost always present	0
Function (50 points)	
Activity limitations, support requirement	
• No limitations, no support	10
• No limitation of daily activities, limitation of recreational activities, no support	7
• Limited daily and recreational activities, cane	4
• Severe limitation of daily and recreational activities, walker, crutches, wheelchair, brace	0
Maximum walking distance, blocks	
• Greater than 6	5
• 4–6	4
• 1–3	2
• Less than 1	0
Walking surfaces	
• No difficulty on any surface	5
• Some difficulty on uneven terrain, stairs, inclines, ladders	3
• Severe difficulty on uneven terrain, stairs, inclines, ladders	0
Gait abnormality	
• None, slight	8
• Obvious	4
• Marked	0
Sagittal motion (flexion plus extension)	
• Normal or mild restriction (30° or more)	8
• Moderate restriction (15°–29°)	4
• Severe restriction (less than 150)	0
Hindfoot motion (inversion plus eversion)	
• Normal or mild restriction (75–100% normal)	6
• Moderate restriction (25–74% normal)	3
• Marked restriction (less than 25% normal)	0
Ankle-hindfoot stability (anteroposterior, varus–valgus)	
• Stable	8
• Definitely unstable	0
Alignment (10 points)	
• Good, plantigrade foot, midfoot well aligned	15
• Fair, plantigrade foot, some degree of midfoot malalignment observed, no symptoms	8
• Poor, nonplantigrade foot, severe malalignment, symptoms	0

Figure 1: AOFAS score.

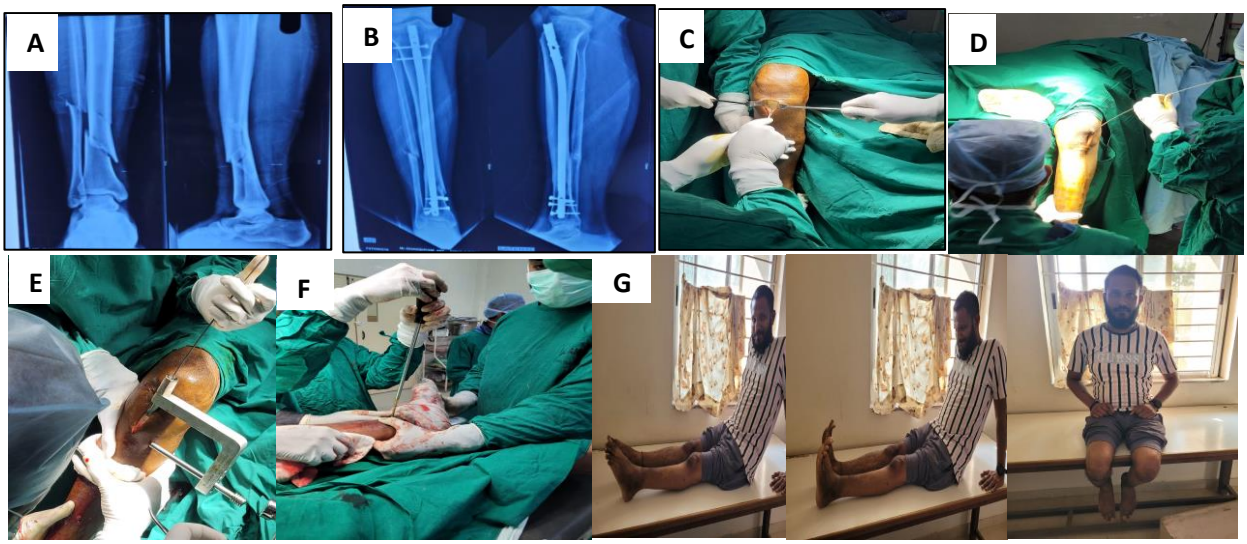

Figure 2: Closed reduction and internal fixation with intramedullary nailing. (A) Pre op X-ray; (B) post op X-ray; (C) skin incision; (D) insertion of guide wire; (E) insertion of intramedullary nail; (F) distal bolt locking; (G) patient showing full rom at 6 months follow up after intramedullary nailing

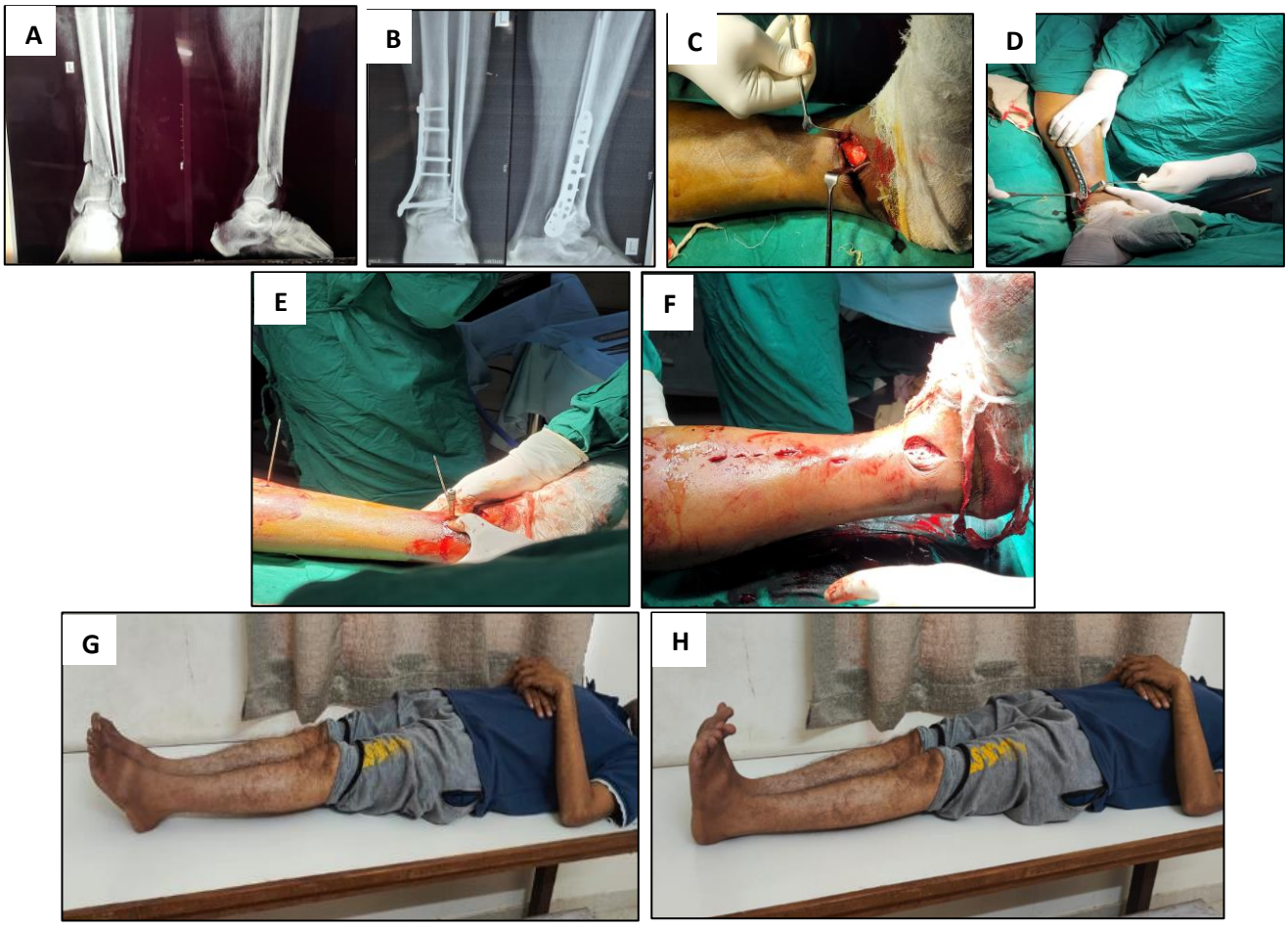

Figure 3: Open reduction and internal fixation for plating using MIPPO technique. A) Pre op X-ray; B) post op X-ray; C) skin incision; D) assessing the plate length; E) distal screw locking with sleeve; F) stab incisions for proximal locking; (G and H) patient showing full ROM at 6 months follow up after intramedullary nailing.

Table 1: Demographic and clinical profiles of the patients belonging to both groups.

Demographic characters		Nailing group (n=15)		Mippo group (n=15)	
		No. of patients	%	No. of patients	%
Age group (in years)	18-29	4	26.6	0	0
	30-49	8	53.3	8	53.3
	50-70	3	20	7	46.6
Gender	Male	14	93.3	13	86.6
	Female	1	6.6	2	13.6
Mechanism of injury	Fall from height	3	20	4	26.6
	RTA	12	80	11	73.4
Side of injury	Right	10	66.6	8	53.3
	Left	5	33.3	7	46.6

Table 2: Factors significant on comparison between the Plating and Nailing groups.

S. no.	Factors of significance	Nailing group	Plating group
1.	Duration of surgery (in minutes)	55	65
2.	Radiological Union (in weeks)	17.6	18.8

Table 3: Post-operative complications observed among both groups.

Complications	Nailing (n=15) (%)	MIPPO (n=15) (%)	Total (n=30) (%)
Ankle pain	2 (13.3)	3 (20)	5 (16.6)
Ankle stiffness	0	2 (13.3)	2 (6.6)
Knee pain	3 (20)	0	3 (10)
Infection	0	2 (13.3)	2 (6.6)
Shortening	1 (6.6)	1 (6.6)	4 (13.3)
Delayed union	1 (6.6)	2 (13.3)	3 (10)
Varus deformity	1 (6.6)	1 (6.6)	2 (6.6)
Valus deformity	2 (13.3)	1 (6.6)	3 (10)

Table 4: Association of modality of treatment with AOFAS score.

AOFAS	Nailing (%)	Plating (%)
Excellent (95-100)	6 (40)	4 (26.6)
Good (75-94)	7 (46.6)	8 (53.3)
Fair (50-74)	2 (13.3)	3 (20)
Poor (0-49)	0	0
Total	15 (100)	15 (100)

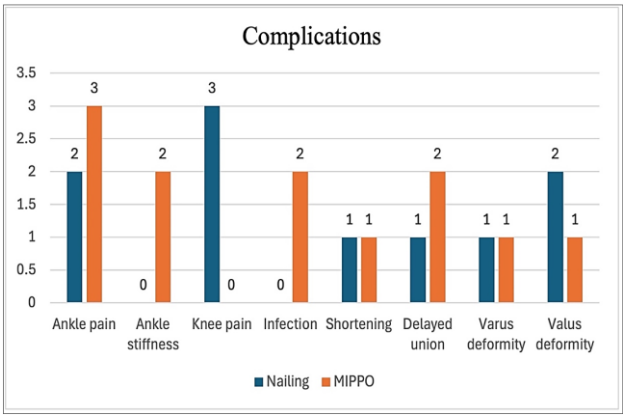

Figure 4: Complications of both intramedullary nailing and MIPPO.

Functional outcomes based on AOFAS scores were slightly better in the nailing group, with 40% excellent results compared to 26.6% in the MIPPO group, while both groups had good outcomes in 46.6% (nailing) and 53.3% (MIPPO) of patients.

DISCUSSION

Management of extraarticular distal tibia fractures is always difficult and contentious for the following reasons such as limited soft tissue covering around the distal tibia, precarious blood supply in the distal leg area, High energy trauma, particularly in high-velocity motor vehicle accidents and proximity to the plafond.

In this study 30 cases of extrarticular distal tibia fractures were studies. 15 cases were treated by MIPPO and 15 cases

were treated with intramedullary nailing. The average age of cases in this study is 38 years for nailing and 44 yeara for the MIPPO group. Out of 15 cases treated with MIPPO 13 patients were male and 2 patients were female, in 15 cases treated with intramedullary nailing had 14 patient's male and 1 patient female. Totally out of 30 cases 27 (90%) are male patients and 3(10%) are female patients. The most common side affected is right 18 patients (60%) and l2 patients (40%) had left side affected. The study's figures show that road traffic accidents (RTA) are the most common cause of fractures.

Most conventional research suggest that high-velocity vehicular accidents are the primary cause of fractures. The majority of cases were operated between 3-6 days following injury. This time frame was given to allow the edema to subside and the abrasions on the distal leg to heal. These procedures were made to limit the risk of infection and soft tissue complications. In our study, the surgical limb is splinted for 2 to 3 days. Later, ankle and knee range of motion began. The decision to use partial weight bearing is based on the signs of clinical and radiological signs union. Full weight bearing requires sufficient callus production in three out of four cortices. In our study, partial weight bearing was often permitted after 4 to 6 weeks. The average full weight bearing is 12 weeks for nailing and 16 weeks for the MIPPO group. The radiological union time in MIPPO group was 18.8 weeks and for nailing group was 17.6 weeks. Nadeem et al, in his study found average union time was 20.5 weeks in MIPPO group and 18.6 weeks in nailing group.[1] In our study, acceptable alignment was seen in 13 out of 15 cases in the MIPPO group and 12 out of 15 cases in the nailing group. In the MIPPO group, there were two cases of malalignment, one each of valgus and varus deformity of more than 5 degrees and 1 cases of valgus and 2 of varus malalignment in the nailing group. Malalignment was noted postoperatively and healed in the same position. Nadeem et al, in his study suggested that 6 patients had malunion in nailing group out of 30 patients and 2 patients out of 30 patients in MIPPO group.[17]

In our study in MIPPO group 1 case of superficial and 1 case of deep infection noted. Superficial infection was contained with appropriate antibiotic. One case of deep infection was present which was not amenable to the antibiotics and dressing, implant removal had to be done and antibiotic intramedullary nailing was done to achieve the union. Finally, the radiological union was achieved at the end of 26 weeks. We had no cases of infection in the nailing group. The average duration of surgery in our study for the nailing group was 58.6 minutes, whereas the plating group took 66.9 minutes.

Final outcome was assessed using AOFAS scoring system and graded as score of 95-100, 75-94, 50-74 and 0-50. In our study out of 15 cases of nailing group with scores 95-100 had 6 patients,75-9 had 7 patients, 50-74 had 2 patients and 0-50 no patients were recorded. In MIPPO group with scores 95-100 had 4 patients, 75-94 had 8 patients, 50-74 had 3 patients and 0-50 no patients were recorded.

However, the study's limitations, including the small sample size, necessitate further investigation with larger cohorts to solidify these conclusions. Future research should explore long-term outcomes, assess the impact of patient-specific factors on treatment choices and optimize postoperative management protocols to further enhance patient recovery and minimize complications.

CONCLUSION

In conclusion, our study demonstrates that intramedullary nailing offers a superior treatment option for extra-articular distal tibia fractures compared to the MIPPO technique. While intramedullary nailing exhibited a higher incidence of malunion, this was offset by its advantages of earlier weight-bearing, shorter operative time, and a significantly lower rate of infection. These factors collectively suggest that intramedullary nailing provides a more efficient and less morbid approach for the management of distal tibia fractures, ultimately contributing to improved patient outcomes.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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