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### A comparative study of management of distal one third tibia fracture by low multidirectional locked nail and minimally invasive plate osteosynthesis (MIPO)

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#### Abstract

**Background:** The distal tibia fractures are mainly due to road traffic accident, fall from height and sometimes twisting of ankle. Fractures around the ankle joint are difficult to manage because of precarious vascularity in nature. In addition it is in subcutaneous location which adds to further difficulty in the fracture management. Internal fixation devices such as locking intramedullary nails, locking compression plates are mainly used for the fracture fixation of distal tibia. It is critical to understand the fracture pattern occurring in the distal tibia and the form of fixation available.

**Methods:** A comparative study of management of fracture of distal one third tibia with low multidirectional locked nail and plating by MIPO was undertaken among 57 patients with extra-articular distal tibia fractures, in the department of orthopaedics, IMS & SUM Hospital, Bhubaneswar from June 2017 to June 2019. The Patients were followed up for clinical and radiological evaluation. The final results at the end of 1 year follow-up were evaluated using the Kaikkonen ankle score and Lysholm knee scoring system as excellent, good, fair, and poor.

**Results:** In IMLN group, mean time for union was 4.60+/-0.60months compared to 6.22+/-2.32 months in plating group which was significant (P=0.0018). Less complications in terms of delayed union, nonunion and incidence of infection and ankle stiffness, were seen in interlocking group as compared to plating group (P=0.001).

**Conclusion:** It is observed that low multidirectional locked nailing is better in terms of early total weight bearing, early union, and decreased risks of complications. Thus, it is a better choice for patient undergoing the treatment for extra-articular distal one third tibia fractures.

**Keywords:** Low multidirectional locked nailing, locking plate, MIPO, extra-articular distal tibia fractures

#### Introduction

In modern era, with the advent of high speed vehicle, it has been observed that there has been a drastic increase in the road traffic accidents. Out of which, distal tibia fracture is common and it accounts for less than 7% <sup>[1, 2]</sup> among all tibia fractures, and <10% all lower extremity fractures <sup>[3, 4]</sup>. It is age and gender dependent, common in males in the age group <sup>[5]</sup> of 30-50 years. The range of injury varies from low energy to high energy injuries. The low energy distal tibia fractures are mainly seen in older age group, usually due to rotational forces <sup>[6]</sup> where as high energy distal tibia fractures common in younger age groups usually due to road traffic accident and fall from height <sup>[7]</sup>. The spiral fracture is commonly encountered in these mechanisms of injuries. The mechanism of injury comprises of Axial loading, compression and torsional forces <sup>[8-10]</sup>. The distal tibia fractures are mainly due to road traffic accident, fall from height and sometimes twisting of ankle. Fractures around the ankle joint are difficult to manage because of precarious vascularity in nature. In addition it is in subcutaneous location which adds to further difficulty in the fracture management. "Minimally invasive plate Osteosynthesis" (MIPO) and low multidirectional locked nail are the modification of well-established conventional intramedullary nailing and open plating with certain limitation of each method. Malalignment and knee pain are frequently reported after multidirectional intramedullary interlocking nail application <sup>[11, 12]</sup> whereas wound complications, and hardware prominence have been associated with tibial plating <sup>[13]</sup>.

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Our study compares low multidirectional locked nail and MIPO by locking compression plate in extra-articular distal tibial fractures in view of their functional outcomes, the union rate and time, and the various complications associated with it. Blood supply is different on outside and inside of tibia. The anterior and posterior tibial vessel gives the periosteal blood supply that nourishes the outer one third of cortical bone. The nutrient vessels and the metaphyseal vessels supplies the remaining two third of the bone cortex and the the periosteum. The destruction of the endosteal vessel occurs while reaming but the vessel grows in between the nail and the bone widening the Haversian canal. Simultaneously the cortical bone receives the periosteal blood supply. Hence in the nailing technique blood supply is preserved.

### Materials and Methods

The present study was a prospective study conducted between June 2017 to May 2019 in the IMS and SUM Hospital, Bhubaneswar, a tertiary care center. 57 skeletally matured patients with extra articular distal tibial fractures AO Type 43A1, 43A2, 43A3, attending our OPD or emergency Department were randomly selected and allocated into two groups: low multidirectional locked nail and MIPO. Informed consent was obtained from each patient before participation in the study, after getting clearance from the ethical committee. All fractures meeting the AO criteria, age more than 18 years, those who gave valid consent, presence of distal fragment of at least 3 cm in length without articular surface involvement, duration of injury with in the 2 weeks, without neurovascular deficit affected limb, closed or Gustillo & Anderson type I injuries and patients with no other associated comorbidities were included in the study. Patient with open fractures (GA Type II or higher), intra-articular extension, pathological fractures, polytrauma patient with other associated comorbidities were excluded from the study.

After stabilization of the patient, the leg was immobilized in posterior splint till the surgery. Patients who presented within 6 h of injury without gross swelling of leg were operated on the same day or next day. Limbs with gross swelling were splinted and elevated till swelling subsided, and wrinkle sign

appeared over the ankle joint. Fractures associated with GA type-I open wounds were preliminary managed with swab for culture from the wound, iv antibiotics and no adhesive dressing and observed closely for any sign of infection.

**Surgical procedure:** The principles of surgical management is to maintain axial alignment and proper length, anatomic restoration of articular surface, early mobilization of adjacent joints and limb and rigid stable fixation of fractures. The velocity of injury, fracture pattern, the age of the patient, soft tissue status and comorbid condition like diabetes mellitus, hypertension, and peripheral vascular diseases are the determining factors for the operative treatment. Low multidirectional locked nail for nailing group and anteromedial plate or anterolateral plate was used for plating group by MIPO technique. If fibula fracture is within 5-8 cm then address the fibula fracture first with one third tubular plate or distal tibia locking plate. It maintains the length and indirectly helps in fracture reduction of tibia.

**Interlocking nail:** On standard operating table, supine position, adequate draping, at least 90 degree knee flexion required for nailing. Midline patellar tendon splitting approach. Serial reaming was done up to 1 or 1.5 cm above the desired nail. Insert the nail with proper jig. Confirm the distal end of the nail position by means of C-arm. Rotational alignment was evaluated by aligning anterior superior iliac spine, mid-patella and second ray of foot. Two locking screws applied in the proximal part with the help of jig provided. Using free hand technique under the c-arm guidance 2-3 locking screws applied distally (Fig-1a, b).

**Postoperative protocol:** Isometric quadriceps and knee and ankle exercise advised on day one. Partial weight bearing with the help of walker started on day two if fracture reduction was satisfactory. If fibula is fixed with plate non weight bearing was advised for one and half month, later weight bearing as tolerated advocated for next one and half months. Patient follow-up was done on 6<sup>th</sup> weeks, 3 months, and 6 months.

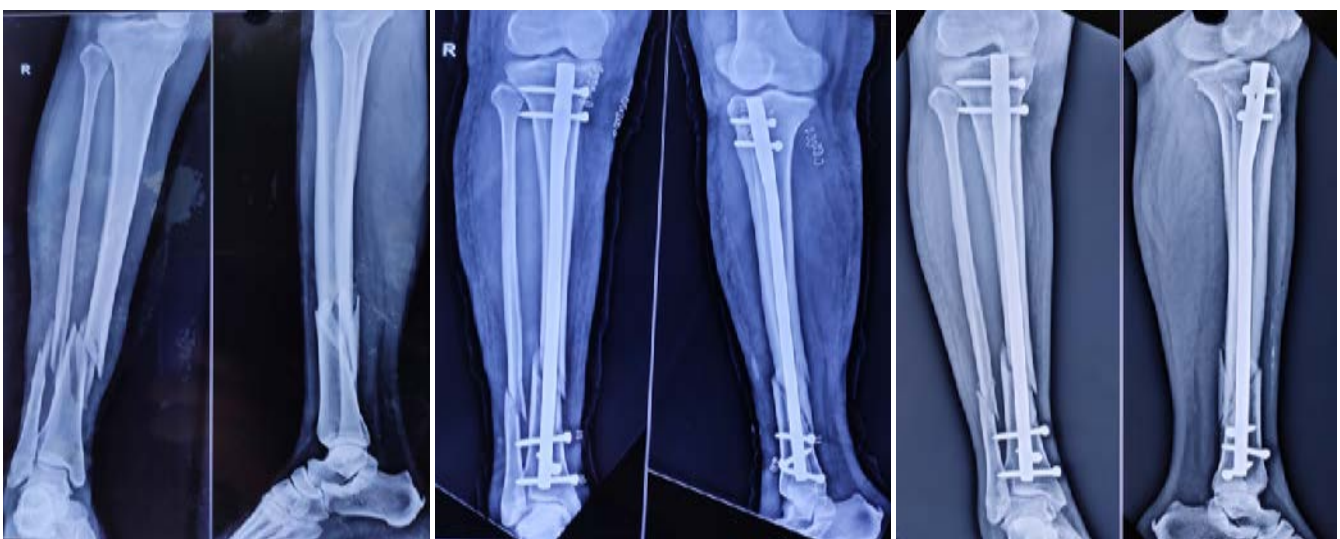


Fig 1: a, b (Intramedullary Nailing)



Fig 2: a, b, c (MIPPO)

**Plating:** - MIPPO technique was used in all cases. On standard radiolucent table, supine position, sand bad was given under ipsilateral buttock for good exposure. Tourniquet was used in all cases after extinguishing the extremity. The fibula fracture is addressed first in case of distal 5-8 cm of fibula fracture to restore the length indirectly. Generally Anteromedial plate was used but in case of fracture comminution on lateral side, blister or compound punctured wound over medial side anterolateral plate was used. Fracture reduced under c-arm by giving traction and maintained it by k wire and/or reduction clamp. Under image intensifier, two mini incisions were given, one at proximal end of anticipated plate position and another at distal end. Now a tunnel is created between these two incisions at extra periosteal fashion by advancing the periosteum or clamp from distal to proximal or vice versa. Plate is pulled through the subcutaneous tunnel under image intensifier. Fracture fixed with locking and cortical screws (Fig-2a, b, c).

**Postoperative protocol:** In all cases short leg posterior slab was applied immediately after surgery. Active knee exercise was started after 48 hours. Weight bearing was avoided till one an half months, depending on the comminution of fracture. Follow up radiological and clinical examination were done at 6, 12, 24 weeks. Partial weight bearing allowed once the radiological union was noted. After fracture consolidation, full weight bearing was allowed. All cases were assessed for

the functional outcome by using the Kaikkonen ankle score and Lysholm knee scoring system.

**Results and Observation:** Out of 57 patients, 9 (6 female & male) lost to follow up, so excluded from study. We used SPSS 21 Version, paired sample t test, Mc Nemar Chi Square statistical methods for data analysis and statistical significance was accepted when P value is <0.05.

Table 1: Age Distribution

Age group (In years)	Nailing		Plating	
	No of Patients (N)	Percentage (%)	No of patients(N)	Percentage (%)
20-30	6	25.00	2	8.33
31-40	8	33.33	8	33.33
41-50	10	41.70	10	41.70
>50	0	0	4	16.70
TOTAL	24	100	24	100

Table 2: Sex Distribution

Sex	Nailing		Plating	
	No of Patients (N)	Percentage (%)	No of Patients(N)	Percentage (%)
Male	15	62.50	18	75.00
Female	9	37.50	6	25.00
Total	24	100	24	100
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Table 3: Mode of Injury

Mode of Injury	Nailing		Plating	
	No of Patients (N)	Percentage (%)	No of Patients (N)	Percentage (%)
Road Traffic Accident	20	83.30	18	75.00
Fall From Height	4	16.70	2	8.30
Twisting of Ankle	0	0	4	16.70
Total	24	100	24	100

Table 4: Weight Bearing

Weight Bearing	Nailing		PLATING	
	No of patients(N)	Percentage (%)	No of patients(N)	Percentage (%)
Delayed	6	25.00	24	100
Immediate	18	75.00	0	0
Total	24	100	24	100

Table 5: Rom Ankle

ROM Ankle	Nailing		Plating	
	No of Patients (N)	Percentage (%)	No of Patients (N)	Percentage (%)
Full	16	66.66	12	50
Near- Normal	8	33.33	6	25
Mid-Range	0	0	6	25
Total	24	100	24	100

Table 6: Rom Knee

ROM Knee	Nailing		Plating	
	No of Patients (N)	Percentage (%)	No of Patients (N)	Percentage (%)
Full	16	66.66	24	100
Near Normal	8	33.33	0	0
Total	12	100	12	100

Table 7: Time for Union (In Months)

Time for union (in months)	Nailing		Plating	
	Mean	SD	Mean	SD
	4.60	0.60	6.22	2.32
t-value	3.312			
p-value	0.0018			
Significant	Significant			

Table 8: Complications

Complications	Nailing		Plating	
	No of Patients (N)	Percentage (%)	No of Patients (N)	Percentage (%)
Superficial infection	0	0	1	4.16
Malunion	4	16.66	3	12.50
Delayed union	2	8.33	5	20.83
Non union	0	0	1	4.16
Implant failure	0	0	1	4.16
Wound dehiscence	0	0	2	8.33
Total	6	24.99	13	54.14
p-value	0.03			
Significant	Significant			

## Discussion

Management of distal tibia fracture varies from patient to patient as well as types of fracture pattern. Recent changes in design of intramedullary nail have extended the spectrum of fractures amenable to this type of fixation. The new intramedullary nail with multiple locked multidirectional screw option in distal end of nail helps in treating distal tibia fracture. Also this system enhances axial and lateral stability thus minimizes malalignment [14]. Because of this modified design of nail it is superior to conventional interlocking nail. Intramedullary Nailing enables closed stabilization without hampering vascularity of the fracture site as well as maintains the integrity of the soft-tissue. The Intramedullary canal at this level prevents intimate contact between the nail and endosteum [14] and becomes reason of malalignment. The optimal treatment for these fractures remains controversial. This is owing to the associated significant soft tissue injury and precarious vascular supply of distal tibia. Treatment of distal tibia fractures is challenging owing to its subcutaneous location, limited soft tissue and poor vascularity. With the recent advancement in plating technique called "Minimally Invasive Percutaneous plate osteosynthesis" (MIPPO) reduces the iatrogenic soft tissue damage and less harm to bone vascularity as well as preserves the osteogenic fracture hematoma. But this technique not possible in each and every

cases, such as grossly displaced fractures and in that situation we have to open the fracture site with extensive soft tissue dissection resulting in dreaded complication related to plate like surgical site infection superficial or deep, wound dehiscence and delayed union. In our study, we used low multidirectional locked nail and anterolateral or anteromedial locking compression plate for treatment of these fractures. In the multidirectional locked nailing, the length and the diameter vary from patient to patient and for plating universally the 3.5 mm locking compression plate used for tibia fixation and 1/3rd tubular plate or locking fibula plate to address fibula fracture. Among 48 patients the 24 patients are treated with low multi directional nail and 24 patients are treated with 3.5mm locking anteromedial plate. Among 24 patients of nailing, 22 patients were operated in the closed method and 2 patient treated with open method. Among 24 patients of plating, 19 cases operated by MIPPO technique in rest of the 5 MIPO tried but could not achieve reduction so fracture site was opened for reduction. Titanium implant was used in all cases. Strong fixation and good reduction could be achieved by locking plating, but with this technique leads to the risk of infection, delayed union, non-union by disrupting the periosteal blood supply.

It was concluded that the superficial infection rate was 4.16%, and wound dehiscence was noted in two cases in patient with higher age group, out of 24 cases of plating with mean follow up of 12 months. Superficial infection was managed with parenteral antibiotics according to culture and sensitivity. Wound dehiscence required plastic surgery intervention and were managed with VAC dressing and muscle flap. The infection rates are comparable to the study done by Barcak E *et al.* [15] (3.6%). In the study conducted by Daolagupu [16], the mean time for union was about 18.26 & 21.7 weeks respectively for nail and plate. In our study the mean time for union for nailing was 4.6 months (18 weeks) and for plating was 6.22 month (25.7weeks). There were two cases of delayed union in the nail group at 4 months, after dynamisation at 4 months they united at 6.5 months and 6 months respectively uneventfully. Our study is comparable to study conducted by Fan CY29 *et al.* [17] and Also Mohammad *et al.* [18].

In our comparative study, most of the patient showed full range with excellent knee score, which is comparable to study conducted by Paraschous S *et al.* [20] (LYSHOLM knee scoring- 81 Good). 16 patients achieved full range of motion of ankle in nail group and 12 patients in plate group. Nail group showed excellent ankle score and good to excellent in plate group. This shows that the ankle function was restored well in all the patients. These results are comparable with the results of ankle function in the study conducted by Shon OJ *et al.* [19] (Average IOWA ANKLE rating score was excellent). Hence the overall functional outcome of patients treated in our study was good.

Three patients complained about anterior knee score in nail group which is comparable to study conducted by Yong Li [14]. This can be minimized with correct measurement of length of nail. There were four cases (16%) of malunion

(more than 5 degree of axial angulation) in nailing group whose ankle and knee scores was lesser compared to the other patients included in the study. This study is comparable to study conducted by Boos N *et al.* [21] in 51 cases of distal tibial fracture with interlocking nail with 16% incidence malunion. Ahmed *et al.* reported a success rate of 76.4% by using plating in 17 patients. 3 patients (12.5%) showed malalignment by MIPO plating. Malalignment was the major concern in nailing when compared to the plating; reduction and maintaining the reduction is better in plating group. Acceptable criteria of alignment are, <5 degree of valgus and varus angulation, <10 degree of anterior-posterior angulation, <10 degree of rotational malalignment. >50% cortical apposition, shortening <1cm.

In our comparative study the nail group showed early union compare to plate group as indicated by significant p value. We found delayed union in 3 patients in the plate group and 2 patients in the nail group. No incidence of non-union noted in the nail group whereas 2 cases of non-union, in which one was associated with implant failure noted in the plate group. Implant failure can be minimized by choosing proper implant length and number of screws. Two cases of wound dehiscence and deep infection noted leading to implant exposed in the plate group. These patients were of more than 50 years age group. Now a days low multidirectional intramedullary nail is being preferred due to its low lying distal screws option, protects periosteal the blood supply, low rate of infection, less soft tissue dissection, and early fracture healing as well as early rehabilitation

In our comparative study, we encountered more complications in plate group. The Chief complications were delayed union, nonunion, superficial infection, wound dehiscence and implant failure. Malunion rate was noted more in nail group. The fracture union time is shorter in the nail group as compared to the plate group as the functional exercise started earlier. Patient compliance was much better in nail group due to no need of post-operative splint, early weight bearing, early rehabilitation, less duration of hospital stay, less economic burden to patient and family. Therefore the multidirectional intramedullary nail is superior to the plate.

### Conclusion

Among these two modalities of treatment, intramedullary nail with multidirectional locking option giving excellent result in treating distal tibia fracture in view of the low complication rate, operating time, hospital stay, economic burden, early rehabilitation and fracture union.

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