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Treatment of Extra Articular Distal Third Tibia Fracture: Plating Versus Nailing

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ABSTRACT

Background: The management of the fracture of lower third tibia remains a great challenge to the surgeon. The present study was aimed to evaluate and compare the intraoperative and postoperative outcomes between plate fixation, and intramedullary nail for identifying proper indications of both methods of fixation.

Patients and Method: During 2015 - 2019, 96 cases with distal tibial fractures had been treated using either M.I.P.O technique or Expert intramedullary nailing technique, in a prospective study conducted in Zagazig University Hospitals. 48 cases had been treated by M.I.P.O technique and 48 cases had been treated by Expert intramedullary nailing technique.

Results: The results suggest that M.I.P.O technique was not always the best choice for all types of fractures of lower third tibia. Expert I.M.N, with less soft tissue disruption, good coronal, and sagittal alignment, was considered a standard operative treatment for diaphyseal tibial fractures. However, cases with I.M.N should follow weight-bearing restrictions until there is obvious callus formation in order to prevent malunion, broken distal screws, or propagation of nail into ankle joint.

Conclusion: The study suggests that both Expert I.M nailing, and M.I.P.O. techniques were appropriate treatments of distal tibial fractures. M.I.P.O. fixation, and Expert I.M nailing were safe, and effective treatment options for fractures of lower third tibia, because both of them could provide similar good function outcomes. Expert I.M nailing must have the priority for distal tibial fractures with soft tissue injury, or fractures that occurred more than 5 cm from the tibial plafond. M.I.P.O should have the priority for distal tibial fracture with good skin condition, soft tissue condition, or fractures that occurred less than 5 cm from tibial plafond.

Keywords: Distal Tibial Fracture, Invasive Plate Osteosynthesis, Expert intramedullary nail.

INTRODUCTION

Fracture of the tibia is the most critical type due to its subcutaneous position in the leg, and poor soft tissue around it. Fracture of the lower third tibia represents 6% of all fractures of whole body, and constitutes about 10%–13% of all fractures of lower extremities. It is more frequent in men than women aged between 35-45 years old **(1)**. Fractures of the lower third tibia in adults occur as result of high energy trauma (road

traffic accidents, falling from height or sport related injuries), causing axial rotational forces on lower limb **(2)**.

It is often difficult to choose the optimal method for treating the fractures of the lower third tibia due to its closeness to ankle joint, poor blood supply, decreasing of the muscles covering the anterior, and complications, such as delayed union, nonunion, and wound infection, which are usually associated with comminution, and severe soft tissue injury. Therefore, the management of the fracture of lower third tibia remains a great challenge to the surgeon **(3)**.

Multiple methods of treatment of fractures of lower third tibia are in practice, including conservative treatment, external fixation, open reduction, internal plate fixation, and intramedullary nail **(4)**.

Plate fixation, and intramedullary nail had been well accepted, and were effective. However, the best method of fixation had not been conclusively proven. Plate fixation of fracture of lower third tibia could require anatomical reduction but might result in extensive soft tissue dissection, disruption in blood supply, delayed union, nonunion, and wound complications as diseases **(5,6)**. Closed reduction, and intramedullary nail could limit the soft tissue damage, and protect blood supply through minimally invasive plate technique, but they might result in a difficulty in distal nail fixation, malunion, breakage of locking distal screws, and the risk of nail propagation into the ankle joint **(7)**. In last decads, orthopaedic surgeons had made attempts to treat this fracture with plate fixation, and intramedullary nail, but the best technique of fixation is still undecided.

The purpose of this study is to evaluate, and compare the operative data and postoperative outcomes between plate fixation, and intramedullary nail technique for identifying proper indications of both methods of fixation. This study was conducted to identify the optimal method for treating the fracture of lower third tibia, clarify the advantages and disadvantages of each method, compare the problems of each method intraoperatively, and assess clinical and radiological outcomes post-operatively.

PATIENTS AND METHODS

A prospective study conducted in Zagazig University Hospitals. 48 cases had been treated by M.I.P.O technique and 48 cases had been treated by Expert intramedullary nailing technique. Between January 2015 to December 2019, 96 cases with distal tibial fractures had been treated using either M.I.P.O technique or Expert intramedullary nail technique.

The average age of the samples is 39 years, ranging from 18 years to 60 years. The data of cases had been collected, including the name, age, sex, occupation, address, special habits, mechanism of injury, associated injury, history of receiving treatment of diabetes, hypertension, and peripheral vascular disease.

Inclusion criteria: Adult patients with Extra-articular closed fracture of lower third tibia; AO/OTA type 43A1, 43A2, or 43A3 **-**The distal tibia was defined as the area within 4, 11 cm from the articular surface of ankle joint. Soft tissue injury in this study (closed fracture) was defined as crushing or marked swelling.

Exclusion criteria: Fractures extending to tibial plafond (fracture distal tibia involving articular cartilage). Pathological fractures. Skeletally immature participants.

Participants with open fractures.-Segmental fracture of tibia. -Participants associated with general condition that affects bone mineralization e.g. renal, malnutrition, and parathyroid hormone disturbance.

Preoperative Evaluation of the Cases:

After achieving haemodynamic stability, the cases' personal information was taken, associated comorbidities such as diabetes mellitus, HTN, and smoking were documented, and inquiries were made regarding the time, type, and mechanism of trauma. The skin and soft tissues around the fracture were carefully examined for abrasions, bruises, contusions, lacerations, skin defect, and soft tissue contaminations that might delay open procedures or require replacing it with closed I.M procedure. Neuro-vascular evaluation was done. Anteroposterior lateral radiographs of the entire tibia from knee to ankle were taken in all cases. Radiographs were analyzed for articular depression, fracture displacement, and shaft extension. CT scan had been done in 32 cases to delineate the fracture type, extent, fragment size, and location, and develop a fixation strategy that involves adequate fracture reduction, and stabilization with minimal dissection, without additional trauma to the soft tissues. Laboratory investigation was performed to demonstrate a complete blood count, liver function tests, kidney function tests, HBsAg, HCVAb, PT, and INR. One unit of blood was prepared of each case to use it according to the individual situation.

I. In M.I.P.O (minimal invasive plate osteosynthesis) Technique:

The incision was made straight across the subcutaneous fat, preserving the saphenous vein or nerve during the superficial dissection. Epiperiosteal plane was approached without hampering the fracture hematoma using the implant (plate) or blunt dissector. In fractures of the distal tibia, a longitudinal medial incision centered over the medial malleolus, was made in the tibial axis. A 2-3 cm incision was made from distal end of fracture line to the level of the medial malleolus, as well as 2-3 cm incision proximal to the end of fracture line (the proximal incision might be made percutaneously). If the fracture nature was oblique, the reduction clamp would be used to maintain the reduction of the fracture, then the lag screw would be threaded by percutaneous means, drilled in an anterolateral to posteromedial direction, then the reduction clamp would be removed, and the plate would be inserted in epiperiosteal tunnel, and provisionally held with K-wires.

II. Expert Intramedullary Nailing Technique:

The incision extended from the tibial tubercle to the inferior aspect of the patella. The medial aspect of the patella tendon was identified, and the patella tendon reflected laterally. Reaming is a critical part of the surgical technique. It must be done well to avoid complications. A skin protector should be used to prevent soft tissue damage around the skin incision. The surgeon started with a small diameter reamer (reamer 8 or 9), increased by 0.5-mm increments until cortical contact was reached. The fracture must be reduced, as the reamer was passed.Before nail insertion, a plastic exchange tube was passed over the bulb tip, across the fracture site. The bulb tip was removed, a straight tip guide wire was inserted, and then the plastic tube was removed. The nail was

introduced down the tibial canal over this guide wire. In stable fracture patterns, traction could be released when the nail tip passed the fracture site by 1 cm. This allows fracture impaction, and avoids distraction of the fracture. The tibia should be inspected proximally, and distally. If the nail was too short or too long, it should be removed, and replaced with another nail.

Post-operative Care of both Fixations:

Observation of vascularity, swelling, discoloration, and movement for first 48 hours. Sutures will be removed on 14th day. The patient is placed in a well-padded posterior splint with the ankle neutral or in slight dorsiflexion to prevent an equines deformity.

Non weight bearing mobilization was started which progressed to partial weightbearing after four weeks at least, Full weightbearing was advised once considerable callus was formed. Active range of movements of knee and ankle were initiated as soon as the patient's skin condition and pain permitted **(1,7)**.

Follow up of Cases:

Plain x-ray was carried out post operative, after two weeks, one month, two month, four month, and six month of surgery. Evaluation of clinical, and radiological outcomes was made.

Statistical Analysis:

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for Social Sciences) version 15 for Windows® (SPSS Inc, Chicago, IL, USA).Qualitative data was presented as number and percent. Comparison between groups was done by Chi-Square test. Quantitative data was tested for normality by Kolmogrov-Smirnov test. Normally distributed data was presented as mean ± SD. $P < 0.05$ was considered to be statistically significant.

RESULTS:

Assessment of parameters (pain, stiffness, swelling, stair climbing, running, jumping, squatting, support, and work) according to Olerud, - Molander score was indicated. P value in all these parameters > 0.05 (not significant). Functional outcome was assessed by Olerud - Molander score as shown in **Table (1)**.

Quality of reduction with MIPO and expert nail according to AO classification in our study with no significant radiological postoperative difference between the two groups which presented in **Table (2,3).**

Excellent and good results of distal tibia fractures according to the quality of reduction with no significant difference between the two groups **(Table 4).**

The preoperative assements and post operative outcome of cases were presented in **Figure (1,2,3)**.

Table (1): Clinical follow up according to olerud and molander score:

	Group 1 (n =48)		Group 2 (n = 48)		$\chi 2$	P
	No	%	No	%		
Pain						
No	32	66.7%	24	50%	2.786	0.426
Constant	0	0%	4	8.3%		
while walking on even surface out doors	4	8.3%	0	0%		
while walking on un even surface	12	25%	20	41.7%		
Stiffness						
No	44	91.7%	44	91.7%	0.0	1.0
Stiffness	4	8.3%	4	8.3%		
Swelling						
No	20	41.7%	16	33.3%	0.202	0.904
Constant	8	16.7%	8	16.7%		
only evening	20	41.7%	24	50%		
Stair climbing						
no problem	32	66.7%	28	58.3%	0.210	0.901
Impaired	12	25%	16	33.3%		
Impossible	4	8.3%	4	8.3%		
Running						
Possible	44	91.7%	44	91.7%	0.0	1.0
Impossible	4	8.3%	4	8.3%		
Jumping						
Possible	44	91.7%	44	91.7%	0.0	1.0
Impossible	4	8.3%	4	8.3%		
Squatting						
Possible	44	91.7%	44	91.7%	0.0	1.0
Impossible	4	8.3%	4	8.3%		
Support						
None	32	66.7%	28	58.3%	0.210	0.901
Tapping	12	25%	16	33.3%		
Stick	4	8.3%	4	8.3%		
Work						
Same as before injury	32	66.7%	28	58.3%	0.210	0.901
Loss of tempo	12	25%	16	33.3%		
Severe impaired	4	8.3%	4	8.3%		
	Group 1 (n = 48)		**Group 2 (n = 48)**		**T**	**P**
Olerud molander functional score	85.42 ± 23.98		80.42 ± 28.4		0.466	0.646

Table (2): Quality of reduction with MIPO according to AO classification:

Fracture type	Anatomical	Good	Fair	poor	Total
43 A1	16	16	0	0	32
43 A2	4	4	0	0	8
43 A3	0	4	4	0	8
Total	20	24	4	0	48

Table (3): Quality of reduction with expert nail according to AO classification:

Fracture type	Anatomical	Good	Fair	poor	Total
43 A1	16	16	0	0	32
43 A2	4	12	0	0	8
43 A3	0	0	0	0	8
Total	20	28	0	0	48

Table (4): Results of distal tibia fractures according to the quality of reduction:

Criteria	Anatomical		Good		Fair		poor		Total
	Gr.1	Gr.2	Gr.1	Gr.2	Gr.1	Gr.2	Gr.1	Gr.2	
Excellent	16	16	12	12	0	0	0	0	56
Good	4	4	8	12	0	0	0	0	28
Fair	0	0	4	0	0	0	0	0	4
Poor	0	0	0	4	4	0	0	0	8
Total	40		52		4		0		96

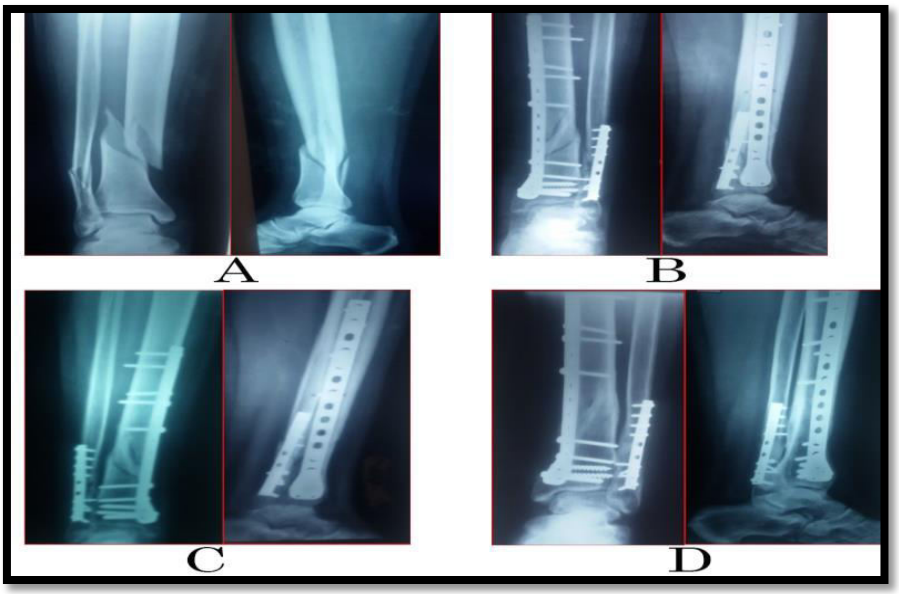

Figure 1: A case of male patient (22 years), no comorbidities, RTA, closed left fracture of lower third tibia 43A1 was fixed by MIPO, with fracture of fibula Webber C was fixed by 1/3 tubular plate. A: pre operative x-ray AP and lateral. B: post operative x-ray AP and lateral. C: follow up after 2 months AP and lateral. D:

follow up after 6 months AP and lateral. After 6 months Olerud and Molander score was excellent and no complications was documented.

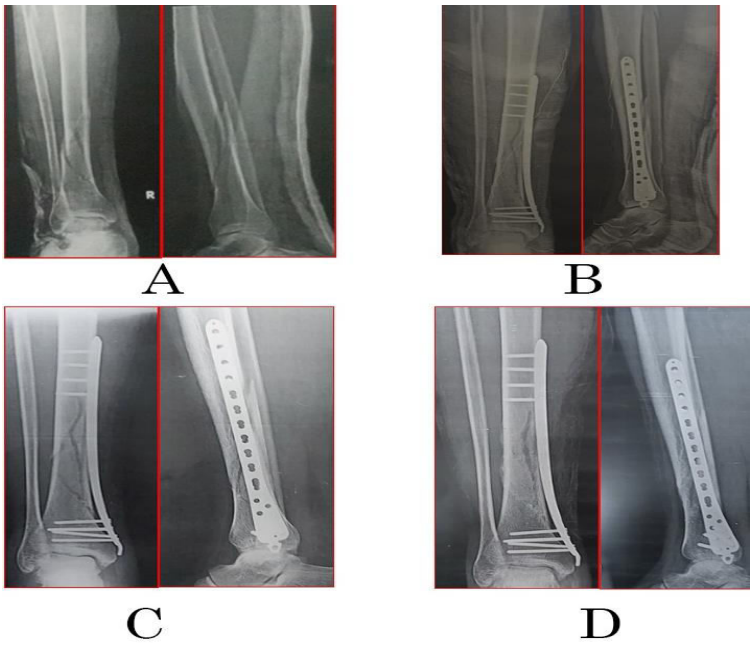

Figure 2: A case of male patient (57 years), diabetic and cardiac, RTA, closed right fracture of lower third tibia 43A1 was fixed by MIPO, with fracture of fibula Webber C not fixed. A: pre operative x-ray AP and lateral. B: Post operative x-ray AP and lateral. C: follow up after 2 months AP and lateral. D: follow up after 6 months AP and lateral. After 6 months Olerud and Molander score was excellent and no complications was documented.

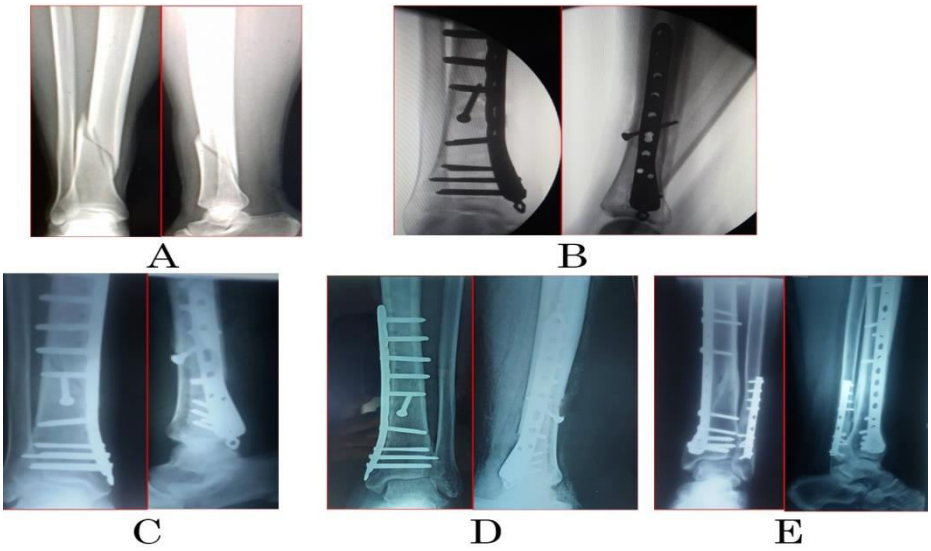

Figure 3: A case of male patient (30 years) old, no comorbidities, RTA, closed right fracture of lower third tibia 43A1 was fixed by MIPO, without fracture of fibula. A: pre operative x-ray AP and lateral. B: Post operative x-ray AP and lateral. C: follow up after 2 months AP and lateral. D: follow up after 4 months AP and lateral, the patient had deep infection, we did debridement and he taken I.V. A.B. according to C&S. E: After 6 months AP and lateral, the patient had osteomyelitis, we did removal

of plate and debridement of the infection at the end of the eighth months, Olerud and Molander score was fair.

DISCUSSION:

Distal tibial fractures are often a challenge to the orthopaedic surgeon. The treatment of this type of fracture was the interest of current research, since there is no universally agreed treatment method. The aim of the present study to compare outcomes between plate fixation, and intramedullary nail.

Surgical advances had been developed to improve plate fixation, limit iatrogenic soft tissue trauma, and preserve blood supply to the fracture site by less invasive technique (MIPO). If the distal tibial fractures treated with early plate fixation, secondary to high-energy trauma, due to auto accidents or falling from a height, increases rate of deep infection, and wound problems even with M.I.P.O technique **(7,8)**.

In our study, the average age for the both groups is 36 years. This may be explained because of active engagement, exposure to outdoors, and road traffic accidents in this active age group**.** According to AO classification, in nailing group 32 cases are 43A1, and 16 cases are 43A2. While in plating group, 24 cases are 43A1,20 cases are 43A2, and 4 cases are 43A3. In this study, there is not a statistically significance in effect of AO classification on mal alignment. These results were comparable with several studies: **Im et al.,(9) ; Janssen et al.,(10) ; Vallier et al.,(11) and Yang et al.,(12).**

In our study, we don't find a significant statistically difference in terms of time for partial, and full weight bearing, union time, rate of deep infection, and functional outcomes between the two groups.

This agree with a study of Kruppa et al.,(13) who reported that no significant association between fracture type, severity, and mal unions could be demonstrated. In previous studies, the starting partial weight bearing in nailing group was 6 weeks compared to 8 weeks in plating group. This suggests that intramedullary nailing guarantees shorter partial, and full weight bearing time compared to plating. However, this was not statistically critical **(14)**.

In our study, functional outcome is measured on Olerud - Molander score, and there is no significant value of functional score between the two groups. Functional score in this study was comparing with previous studies **Im et al.,(9) ; Janssen et al.,(10) ; Vallier et al.,(11) and Yang et al.,(12).**

In cases of severe soft tissue injuries, large bare area of skin defect, bone exposed or complex fractures, neither M.I.P.O nor I.M nailing is the good choice for the risks of disease, difficulty of reduction, or stability of fractures. Therefore, the good choice for these cases is the External Fixation. External Fixation seems a rational approach to obtain, and maintain the alignment of the distal tibia through

ligament taxis, thereby avoiding formal open reduction especially with type C distal tibial fractures **(7)**.

To improve clinical decision making, surgeons need data based on randomized, controlled trials. Therefore, future studies should be based on an adequate sample size which allows a meaningful interpretation of the results and a strict inclusion and exclusion criteria to overcome bias. External fixation must be evaluated as part of the comparative research in the future studies.

CONCLUSION

Our study suggests that both Expert I.M nailing, and M.I.P.O. techniques were appropriate treatments of distal tibial fractures. M.I.P.O. fixation, and Expert I.M nailing were safe, and effective treatment options for fractures of lower third tibia, because both of them could provide similar good function outcomes. Expert I.M nailing must have the priority for distal tibial fractures with soft tissue injury, or fractures that occurred more than 5 cm from the tibial plafond. M.I.P.O should have the priority for distal tibial fracture with good skin condition, soft tissue condition, or fractures that occurred less than 5 cm from tibial plafond.

We recommend using ILN for fixation of extra-articular distal tibial fracture especially in cases with soft tissue problems, as fractures occurred more than 5 cm from tibial plafond. We recommend using M.I.P.O for fixation of extra-articular distal tibial fracture especially in cases with good soft tissue condition, as fractures occurred less than 5 cm from tibial plafond. We recommend concurrent fibular fixation in distal metaphyseal fractures with syndesmotic injury. We don't recommend routine fibular fixation, because the essential benefit of closed nailing, and plating with M.I.P.O technique is in the avoidance of soft tissue dissection.

Finally, the choice of treatments should be based on the surgeon's experience,and general case's conditions especially soft tissue injuries, and skin condition.

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