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"Comparison of Intramedullary Nail and Plate Fixation in Extra-Articular Distal Tibia Fractures"

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ABSTRACT:

Background: Distal tibia fractures are common injuries classically included between four and twelve cm from tibia plafond, even without articular extension they are considered to be inherently unstable. Surgical treatment of these fractures still challenging with a lot of complications including mansion, nonunion, and wound problems because of its subcutaneous location, precious vascularity and lack of muscle coverage. Although open reduction internal fixation with plates provides anatomical reduction and early mobilization, it cannot be considered as the first line of treatment for distal tibia fractures because of extensive soft tissue damage and high rate of infection. Intramedullary nailing is another choice which minimizes surgical insult to the fracture and allows early rehabilitation; however, rates of nonunion and postoperative knee pain cannot be underestimated. Recently, MIPPO has been introduced as a good option for fixation of distal tibia fractures as it preserves periosteum and fracture hematoma, but it is not free of some disadvantages like angular deformity and hardware irritation.

Objectives: The aim of the current study was to compare the functional and radiological outcome, the process of healing and any other associated complications between minimal invasive percutaneous plate osteosynthesis and intramedullary interlocking nail in distal tibia fractures without articular extension.

Patients and methods: A total of 30 patients with extra-articular distal tibia fractures were included in this study with mean age of 35 years and standard deviation of 15.8 in 15 patients fixed by IMN and mean age of 34.3 years and standard deviation of 15.1 in 15 patients fixed by distal tibia locked plate with MIPPO technique. Our assessment measurements included operative time, superficial infection, deep infection, union, alignment, need for secondary operations and OMAS score after 6 months.

Results: Regarding to time of surgery, In IMN group, mean operative time was 115 minutes with standard deviation of 17.5. In MIPPO group, mean operative time was 120 minutes with standard deviation of 18.9 ($p = 0.74$), which is not significant in this study. In both groups, it was significant that early cases were more in operative time than late cases, which indicate that learning curve of MIPPO technique and IMN is equal and the experience of surgeon can reduce time of surgery and complications. Time to union showed statistically significant decrease in IMN group. In IMN group, time to union was 15 weeks with SD of 2.9, while in MIPPO group, it was 17.1 weeks with SD of 4. One patient in MIPPO group showed nonunion ($p = 0.04$). Regarding the distance from tibia plafond, 19 fractures were within 40 mm to 65 mm. In IMN group, 8 patients were graded as excellent and 2 as good, while in MIPPO, 5 patients were graded as excellent and 3 as good and the last one was poor. This did not show statistical significant difference, with slight advantage to IMN. In 9 patients, the fractures were within 66 mm to 90 mm. In IMN group, 3 were graded as excellent and one as good, while in MIPPO, 4 patients were graded as excellent and one as good.

Conclusion: IML nailing is more effective than MIPPO technique in fixation of extra-articular distal tibia fractures, as IMN showed lower infection rate and faster time to healing but with more mal-alignment in reduction. While in MIPPO technique, less mal-alignment reduction could be achieved but with more infection problems and slower rate of union.

Key Words: tibia, distal tibia fractures, biomechanics, intramedullary interlocking nail, minimal invasive plate osteosynthesis

INTRODUCTION

Fractures of the distal tibia are believed to result from either axial compression or torsion of the leg. The mechanism and energy that produce an injury must be considered in the treatment of fractures. Mechanism of injury can be grouped into those of high energy trauma and low energy trauma. High energy trauma produces a much higher incidence of soft tissue necrosis and subsequent wound infections with resultant delayed union of the fracture, than do low energy injury (**Courtney et al., 2011).**

Assessment of patients with fractures of the distal tibia should be carried out in a systematic fashion to assure other injuries are not over looked. Particular attention must be paid to the contralateral lower extremity, the lumbar and thoracic spines, particularly when these injuries occur as a result of a fall or motor vehicle accident (**Borrelli et al., 2002).**

The concept of intramedullary nailing of tibia fractures derives from the work of Kuntscher in the 1940. Intramedullary nailing is widely accepted as the operative treatment of choice for most open and closed diaphyseal tibia fractures. However, the use of this technique in distal tibia fractures has historically been associated with reports of malunion and delayed union often due to technical problems including difficult fracture reduction, fracture propagation into the ankle joint, hardware failure, and inadequate distal locking options (**Neumann et al., 2016).**

Alternative approach to the distal tibia via (MIPPO) technique has attracted the greatest interest in recent years. MIPPO has meant that plate fixation can be performed with less disturbance of the soft tissues, less risk of wound complications with preservation of the blood supply to the distal tibia (**Gupta et al., 2016).**

The aim of the current study is to compare the functional and radiological outcome, the process of healing and any other associated complications between MIPPO and IMN in distal tibia fractures without articular extension.

Patients

Thirty patients with extra-articular distal tibia fractures were treated using either minimal invasive plate osteosynthesis technique or intramedullary interlocking nailing, in a comparative prospective study conducted in Orthopedic Department at El-Salam Port Said Hospital, Egypt; 15 patients treated by IMN and 15 patients treated by MIPPO technique.

Inclusion criteria: Age more than 18 years, extra-articular closed fracture of lower third tibia (AO/OTA) type 43A1, 43A2, or 43A3, recent fractures within two weeks, follow up to 6 months.

Exclusion criteria: Fractures extending to tibia plafond (involving articular cartilage), pathological fractures, skeletally immature patients, open or segmental fractures, patients associated with general condition that affects bone mineralization e.g. renal, malnutrition and parathyroid hormone disturbance.

Methods

History and examination: Full name, age and gender, occupation and address.

Mechanism of injury, pain, swelling and associated symptoms of nerve injury. Co-morbidities and previous operations. General examination (blood pressure, pulse, temp…. etc.), Local examination (skin condition, peripheral pulsation, capillary

filling, etc.), Nerve injuries and vascular affection and any other associated injuries or concomitant fractures**.**

Radiological assessment: Plain AP and lateral radiographs of both knee and ankle were obtained for the injured limb as a routine preoperative investigation.

Intramedullary nailing:

Patient position: Supine positioning on a radiolucent table with removal the end of the table, and allow the injured knee to flex over the end of the table. **(Figure 1).**

Figure 1: Supine positioning on a radiolucent table

Approach and steps: The incision extends from the tibia tubercle to the inferior aspect of the patella. The medial aspect of the patellar tendon is identified and the patellar tendon reflected laterally **(Figures 2 A&B).**

Figure 2 (A): Patellar tendon is identified. (**B):** Patellar tendon reflected laterally.

Figure 3: Curved awl at the junction of the anterior tibia and knee joint.

A curved awl is used to open the medullary canal at the junction of the anterior tibia and knee joint **(Figure 3).** The exact entry point for the awl is determined on the anteroposterior and lateral fluoroscopic views. A bulb-tip guide inserted down the medullary canal **(Figure 4).**

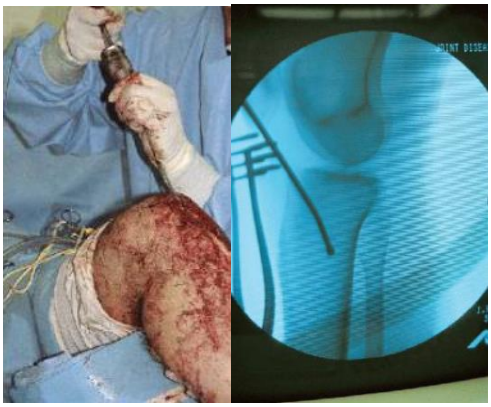

Figure 4: Insertion of a bulb-tip guide wire down the medullary canal

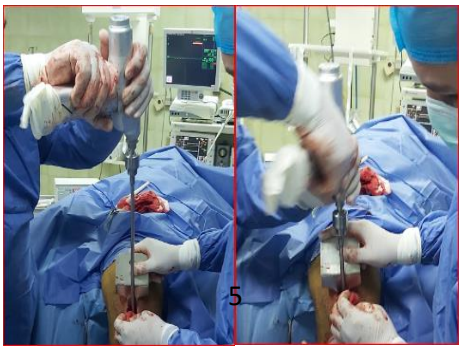

Figure 5: Reaming of the intramedullary canal

The bulb tip is initially aimed posteriorly to enter the tibia and then turned anteriorly and passed down to the fracture site, the guide wire is advanced to the fracture site, the fracture is reduced, and the guide wire is advanced under image intensification to reach subchondral bone centralized just above the ankle joint.

Reaming is a critical part of the surgical technique, the surgeon starts with a small diameter reamer and increases by 0.5 mm increments until cortical contact is reached. The fracture must be reduced as the reamer passes **(Figure 5).**

Before nail insertion, a plastic exchange tube is passed over the bulb tip and across the fracture site, the bulb tip is removed, a straight tip guide wire is inserted, and the plastic tube is removed. The nail is introduced down the tibia canal over this guide wire **(Figure 6 A&B).**

A

B

Figure 6: (A) The nail is introduced down the tibia canal over the straight-tipped guide. **(B)** Removal of straight tip guide wire after insertion of the nail.

After the nail is fully seated, proximal and distal interlocking screws are inserted. Targeting devices that attach to the intramedullary nail are very successful in placing the proximal and distal tibia locking screws **(Figure 7).**

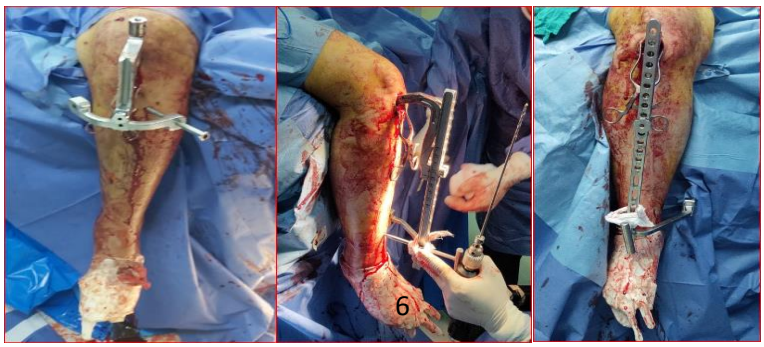

Figure 7: Insertion of proximal and distal locking screws through targeting devices.

A free hand technique may be employed for distal locking screw insertion. It requires targeting of the skin incision under image intensifier **(Figure 8).**

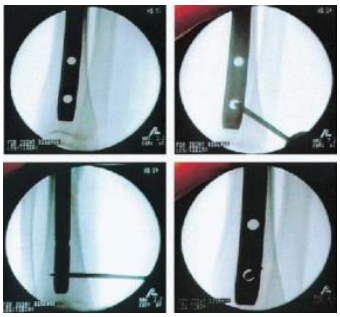

Figure 8: A freehand technique is used to insert the distal locking screws

A lateral radiograph should be checked to be absolutely certain the screw is in the nail and has not moved anteriorly or posteriorly. The wounds are then irrigated and closed. Before wound closure, Final radiographs are taken with the patient under anesthesia

Minimal invasive plate osteosynthesis

Patient position: Supine positioning on a radiolucent table. A rolled blanket bump is placed underneath the ipsilateral buttock to prevent limb lateral rotation. C-ARM fluoroscopy is placed from the contralateral side of the table. Tourniquet is applied **(Figure 9).**

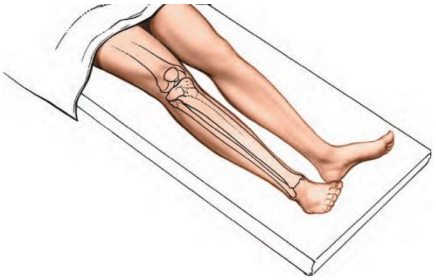

Figure 9: Patient position.

Approach and steps: A 2-3 cm longitudinal incision from distal end of fracture line to the level of the medial malleolus, 2-3 cm incision proximal to the end of fracture line (the proximal incision may be done percutaneously) **(Figure 10).**

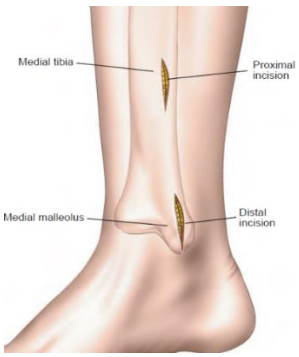

Figure 10: Skin incision

Figure 11: Epi-periosteal plane of plate in

The incision is carried straight across the subcutaneous fat, preserving the greater saphenous vein and saphenous nerve during the superficial dissection. Epiperiosteal plane is approached using the implant (plate) or blunt dissector **(Figure 11).**

Percutaneous clamp is used to maintain the reduction of the fracture, then lag screw is done percutaneously and drilled in an anterolateral to posteromedial direction, the reduction clamp is removed, then the plate is inserted in epiperiosteal tunnel and provisionally hold with K-wires. Plate may be inserted with reduction of fracture by reduction clamp directly without lag screw. Two non-locked screws are inserted (proximal and distal of the fracture) helps in bony reduction, and taking advantage of the anatomical configuration of the plate. After fluoroscopic verification of plate position, a total of six 3.5 mm screws are inserted into the plate with bicortical fixation. The distal screws are inserted under direct visualization, while the proximal screws are placed percutaneously under fluoroscopic guidance **(Figure 12).**

In spiral fracture, wedge fracture, and complex fracture, the plate is inserted without open incision on the site of fracture and without using of lag screw **(Figure 13).**

Figure 12: MIPPO technique requires only small incisions.

Figure 13: MIPPO technique without open incision to use lag screw.

The wounds are then irrigated and closed. Before wound closure, Final radiographs are taken with the patient under anesthesia.

Postoperative follow up

Sutures were removed 2 weeks postoperatively in the outpatient clinic and strengthening exercises were started. Patients were followed up every two weeks for three months, then after six months after surgery. Plain x-ray was performed during each visit. Partial weight bearing was allowed at six to eight weeks.

Fracture union was considered when callus appear in 3 out of 4 bone cortices on both AP and lateral radiographs. Patients not showing any signs of radiological healing within six months were considered as nonunion. Clinical evaluation of the ankle joint was obtained six months after surgery or once complete union has been noticed using Olerud Molander Ankle (OMAS) score.

Olerud-Molander score

The Olerud-Molander Ankle Score (OMAS) is a self-administered patient questionnaire. The scale is a functional rating scale from 0 (totally impaired) to 100 (completely unimpaired) and is based on nine different items: pain, stiffness, swelling, stair climbing, running, jumping, squatting, supports and activities of daily living. OMAS has been frequently used to evaluate subjectively scored function after ankle fracture.

The score is validated against linear analogue scale (LAS) measuring subjective recovery, range of motion in loaded dorsal extension, presence of osteoarthritis and presence of dislocations on radiographs, and it has been found to correlate well with these four parameters. The use of this system simplified the comparison of results presented by this study.

Outcome assessment

The research compared the mean operation time, the mean union time, rate of infection, rate of malunion, rate of nonunion and functional outcome (OMAS) score between the two groups.

Malunion was defined as angulation more than 5 degrees on any plane. Nonunion was defined as the absence of any sign of callus formation after six months. Infection was classified as deep infection, delay wound healing and superficial infection. Functional outcome was assessed using Oleurd-Molander Ankle Score.

Participants with any symptoms of surgical site infection were further investigated for hematological analysis (CBC, ESR, and CRP) and bacteriological culture. If infection is diagnosed, infection management including antibiotic administration and surgical debridement was performed and recorded. Any other noticed complications like (periprothetic fracture, implant failure, complex regional pain syndrome, and…. etc.) were assessed and compared.

Case presentation

Preoperative data: Male case 47 years old, Comorbidities: diabetic, hypertensive. Mode of trauma: RTA, Fracture side: left, AO classification: 43A2. Open G1 (puncture), Associated high fibular fracture **(Figure 14).**

Figure 14: Pre-operative x-rays, skin conditions

Operation: wound Debridement, closed reduction for the tibia by manual manipulation, fixation by expert ILN. Operative time: 140 min.

Postoperative: immediate post-operative x-rays were obtained **(Figure15).** Intravenous broad-spectrum antibiotics had prescribed until discharge. Oral antibiotics had continued for 2 weeks. LMW heparin had given every 24 hr. for 10 days.

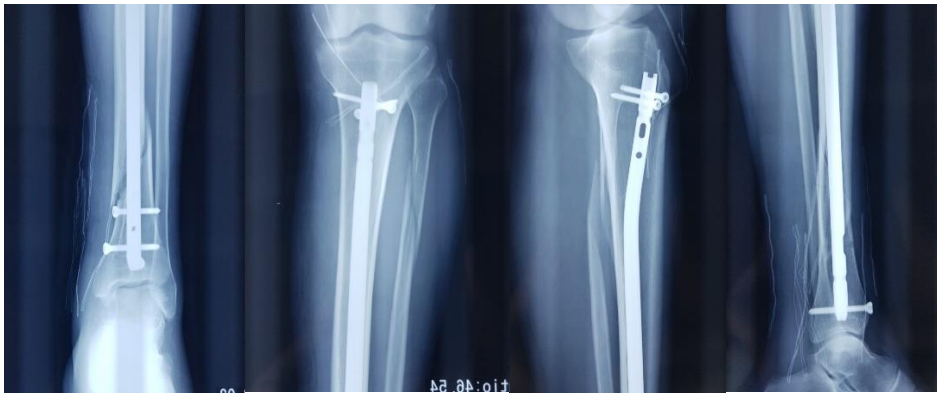

Figure 15: post-operative x-rays**.**

Follow-up: Follow-up period 6 months**. At 2 weeks:** Stitches were removed. Superficial infection of the skin, culture, sensitivity had done, antibiotics continued for 2 other weeks with repeated dressing. 2 weeks later the skin got better. **At 6 weeks:** Wound had checked to exclude infection, calf had examined to exclude DVT. Follow-up X-rays showed stable fixation. **At 3months***:* Follow up x-rays showed partial union of tibia fracture, nonunion of fibular fracture **(Figure16).** Case advised to full weight bearing. **At 6 months:** Follow up X-rays showed complete union of tibia, fracture **(Figure 17).** OMAS score was excellent.

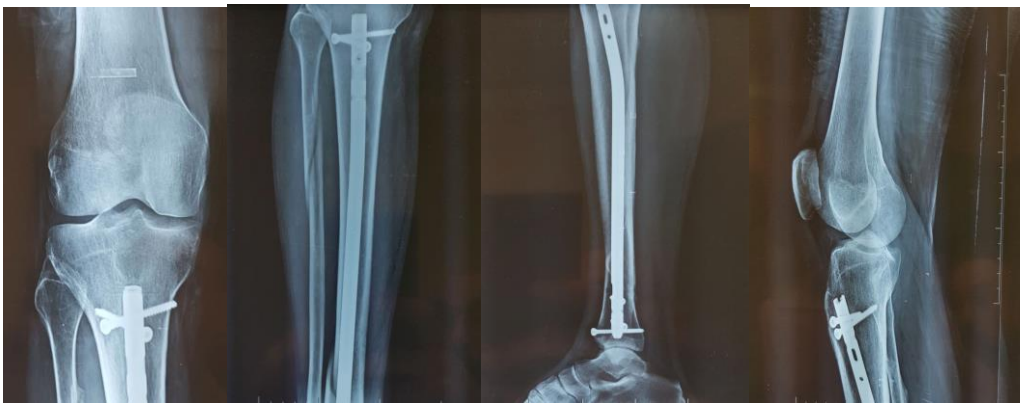

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Figure 16: Follow-up at 3 months X-rays

Figure 17: 6 months' Post-operative x-rays.

Results

In the IMN group, 6 patients (40%) had the right side affected and 9 patients (60%) had the left side affected. In the MIPPO group, 6 patients (40%) had the right side affected and 9 patients (60%) had the left side affected. Comparing the fractured side, between the two groups showed no statistically significant difference as shown in **Table** (**1**).

In the IMN group, 12 patients (80%) were closed and 3 patients (20%) were open G_1. In the MIPPO group, all patients were closed (100%). Comparing closed versus open fractures between the two groups showed no statistically significant difference as shown in **Table** (**2**).

Comparing the fracture patter according to AO classifications showed no statistically significant difference as shown in **Table** (**3**).

The mean operative time for the IMN group was 115 ± 17.5 minutes, while it was 120 ± 18.9 minutes for the MIPPO group **Table** (**4**). No statistical significance was found when the two groups were compared.

In IMN, 12 patients sustained fibular fracture (80%), while 3 patients have intact fibula. Three (20%) patients had fixed the fibula and 9 (60%) patients managed conservatively. In the MIPPO group, 12 patients sustained fibular fracture (80%), while 3 patients had intact fibula. Ten patients had fixed the fibula (66.7%) and 2 (13.3%) patients managed conservatively. Comparing intraoperative parameters between both groups showed a statistically significant difference between the two groups regarding fibular fixation **Table** (**5**).

Mean time for union in IMN was 15 ± 2.9 weeks, while in MIPPO group, it was 17.1 ± 4 weeks. This showed statistical significance for IMN (p = 0.04) **Table** (**6**).

In IMN group, two patients needed to secondary operation (dynamization and fibular revision); while in MIPPO group, 3 patients (20%) needed secondary surgeries (2 debridement and one revision). Statistically, this showed no significance **Table** (**7**).

In IMN group, 11 patients (73.3%) were graded as excellent, 3 patients (20%) good and one patient (6.7%) fair. In MIPPO group, 9 patients (60%) were graded as excellent, 5 patients (33.3%) good and one patient (6.7%) poor **Table** (**8**).

Table (1): Preoperative comparison between MIPPOO and IMN groups

		Nail/plate				**p value**
		Nail		**Plate**		
		No	**%**	**No**	**%**	
Side	**Right**	6	40	6	40	0.71
	Left	9	60	9	60	(NS)

Table (2): Preoperative comparison between MIPPOO and IMN groups

		Nail/plate				p value
		Nail		Plate		
		No	%	No	%	
Closed/open	**Closed**	12	80	15	100	0.6
	Open	3	20	0	0	(NS)

Table (3): AO classification of the fractures in both groups

		Nail/plate 12				p value
		Nail		Plate		
		No	%	No	%	
Classification details	**43A1.1**	6	40	2	13.3	0.3 (NS)
	43A1.2	3	20	4	26.7	
	43A1.3	3	20	2	13.3	
	43A2.1	0	0	1	6.7	
	43A2.3	3	20	3	20	
	43A3.3	0	0	3	20	

Table (4): Operative time in both groups

Operative time	**Nail/plate**		**p value**
	Nail	**Plate**	
Mean ± SD	115 ± 17.5	120 ± 18.9	0.74 (NS)
Range	100-150	100-150	
Median	120	120	

Table (5): Fibular fixation in both groups

		Nail/plate				p value
		Nail		Plate		
		No	%	No	%	
Fibula	**Intact**	3	20	3	20	0.02 (S)
	Fixed	3	20	10	66.7	
	Not fixed	9	60	2	13.3	

Table (6): Comparing time for union in both groups

Time for union	**Nail/plate**		**p value**
	Nail	**Plate**	
Mean ± SD	15 ± 2.9	17.1 ± 4	0.04 (S)
Range	12-22	12-24	
Median	12	17	

Table (7): Comparing need of secondary surgeries in both groups

		Nail/plate				**p value**
		Nail		**Plate**		
		No	**%**	**No**	**%**	
Need for secondary procedures	**Revision**	1	6.7	1	6.7	0.35 (NS)
	Debridement	0	0	2	13.3	
	Dynamization	1	6.7	0	0	
	No	13	93.3	12	80	

Table (8): OMAS score in both groups

		Nail/plate				**p value**
		Nail		**Plate**		
		No	**%**	**No**	**%**	
OMAS score	**Excellent**	11	73.3	9	60	0.55 (NS)
	Good	3	20	5	33.3	
	Fair	1	6.7	0	0	
	Poor	0	0	1	6.7	

Discussion

Distal tibia fractures are usually complex injuries occur as a result of violent trauma and usually require surgical fixation with different modalities (**Radaideh et al., 2022).**

Demographics: A total of 30 patients with extra-articular distal tibia fractures were included in this study (males 20, females 10). 15 patients fixed by IMN and 15 patients fixed by distal tibia locked plate with MIPPO technique. Our assessment measurements included operative time, superficial infection, deep infection, union (united, delayed union and non-union), alignment, need for secondary operations (dynamization, debridement and revision) and OMAS score after 6 months. In our

study, the mean age for the IMN group was 35 years while in MIPPO group it was 34.3 years. This can be explained because of active engagement and exposure to outdoor life and road traffic accidents in this active age group. **Vallier (2016)** found that the mean age for the IMN group was 40 years while in plate group it was 43 years. IMN group included 9 males and 6 females and MIPPO group included 11 males and 4 females, as males are more frequently exposed to outdoor activities and hence more involved in road side accidents, and industrial misfortunes.

Associated fibular fracture: In our study, fibula was fixed if within 7 cm from the tip of lateral malleolus. In each study group, 3 patients were with intact fibula (20%) and 12 patients were fractured (80%). In IMN group, only 3 fibular fractures (20%) were fixed and the other 9 patients (80%) were left to heal conservatively. In contrast, in the MIPPO group, 10 fibular fractures (66.7%) were fixed and 2 fractures (13.3%) were decided to be managed conservatively. This showed statistically significant difference ($p = 0.02$). ORIF of fibula in plate cases helped in maintaining the reduction of tibia through the operation which was important for proper plate and screws position, while in IMN reduction was able to be maintained with nail insertion, and its locking screws which added more rigid stability and prevented rotation. **De Giancomo and Tornetta (2016)** had reported that fibular fixation aid in obtaining accurate reduction of tibia and reduce risk of latter malalignment. **Mohammad Javan et al. (2017)** had conducted RCT about role of fibular fracture in extra articular distal tibia fracture included 24 patients and 25 patients in case control groups they didn't observe any significant difference between the two groups regarding non-union, union time and complications.

Time of surgery: In IMN group, mean operative time was 115 minutes with standard deviation of 17.5. In MIPPO group, mean operative time was 120 minutes with standard deviation of 18.9 ($p = 0.74$), which is not significant in this study. **Li et al. (2014)** showed significant decrease in operative time in IMN group. In retrospective study 110 patients were treated with MIPO vs. 156 patients were treated with IMN Chaofang **Wang et al. (2023)** had found that operation time was significantly longer in IMN group rather than MIPO group (109.8 minutes' vs 81.8 minutes). Time of surgery depends on many factors: presence of fibular fracture, difficulties in reduction, presence of good assistance and surgeon experience.

Rotational and coronal deformity: There was no statistically significant difference between the two methods of fixation ($P=0.22$). In IMN group,12 fractures (80%) were united in good alignment, while 3 fractures (20%) united with coronal plane deformity. In MIPO group, 13 fractures (86.7%) were united in good alignment, one (6.7%) united with rotational deformity (25-degree external rotation), the last one (6.7%) showed delayed union after 6 months and needed revision. The flare of distal diaphysis and wide metaphysis increased the challenge of accepted reduction especially in IMN group. **Wani et al. (2017)** reported that patients treated with IMN had significantly higher rotational malalignment than plate, but they did not find any significant difference in varus or valgus deformity and anterior/posterior angulation. **Costa et al. (2018)** suggested that there was no significant difference about lateral

deformity (P = 1.000) and anteroposterior deformity (P = 0.081) between IMN group and plate group.

Wound complications: In our study, 3 patients (20%) in MIPPO group developed deep infection; the three patients were closed fractures. Two of them become clean after debridement and the last one was resistant and ended with infected non-union and needed revision. Delayed debridement time was most probably the cause of resistant infection. While in IMN group, 3 patients (20%) developed superficial infection which healed with antibiotics according to culture and sensitivity and repeated dressing. The 3 patients were open fractures (G1). **Li et al. (2014)** showed that deep infection does not have a significant difference between the two groups. A higher soft tissue infection rate has been seen in patients treated with MIPO than IMN. Also, **Yavuz et al. (2014)** showed that only one patient out of 34 (3%) in plate group developed superficial infection and only three patients (9%) in plate group developed deep infection, with no significant differences between plate and IMN groups regarding infection. **Bisaccia et al. (2018)** didn't find a statistically significant difference between the two groups regarding infection rate, the infection rate for the IMN was 0; while the same rate was (5.88%) for the MIPO group 2 patients out of 34 developed infections. Chaofeng **Wang et al. (2023)** reported that SSI was developed in, 10 patients out of 110 (9%) in the MIPO group and 4 patients out of 156 (2%) in the IMN group. There were one deep SSI (0.9%) and 9 superficial SSI (8.2%) in the MIPO group. There were one deep SSl (0.6%) and 3 cases (1.9%) superficial SSI in the IMN group. The results showed that there was no significant difference in deep infection rate between the two groups. However, the superficial SSI rate in the MIPO group was higher than that in the IMN group. Infection (deep and superficial) showed best outcome if detected early with aggressive intervention. Patient follow up is very important for early detection of infection. Mode of trauma, good handling of soft tissues, skin coverage and general condition of the patient were also important factors in prevention of infection.

Union versus non-union: In our study, time to union showed statistically significant decrease in IMN group (P =0.04). In IMN group, time to union was 15 weeks with SD of 2.9, while in MIPO group; it was 17.1 weeks with SD of 4. This is the main significant postoperative result in our study. **Yavuz et al. (2014)** showed that time to union was 4.9 months in ILN group and 5.5 months in plate group, with no significant difference in both groups. They found three patients out of 34 (9%) in plate group with non-union, with no significant difference between plate and IMN groups, also **Vallier (2016)** showed that in IMN group, time to union was 18.5 weeks, while in MIPPO group, it was 18.8 weeks.

Secondary strategy: In IMN group, one patient (6.7%) needed dynamization after 3 months with no obvious signs of healing and one patient (6.7%) needed fibular revision. In MIPPO group, 2 patients (13.3%) needed debridement and one patient (6.7%) needed revision (debridement, plates removal and external fixator application**).** Statistically this study showed no significance (P=0.35) regarding need for secondary procedure (13.3%) in IMN group vs. (20%) in MIPPO group.

Mauffrey et al. (2012) showed significant need for secondary surgeries 7 patients out of 12 in plate group (58%) and one patient out of 12 in IMN group (8%). Debridement and removal of plate after short time of union due to skin irritation were the main secondary operations in plate group, while dynamization (removal of dynamic screw to induce healing) was the majority in IMN group. **Yavuz et al. (2014)** showed non-significant need for secondary surgeries only 3 out of 34 patients (8.8% in plate group). **Elmazian et al. (2020)** in contrast showed non-significant difference between two groups of 20 patients with extra articular distal tibia fractures treated with IMN vs. MIPPO technique (P=0.305) regarding revision only one patient out of 10 (10%) in MIPPO group needed debridement.

Functional outcome: In our study, 11 patients (73.3%) in IMN group got excellent in OMAS score and 3 patients (20%) got good, while one patient (6.7%) was graded as fair. In MIPPO group, 9 patients (60%) got excellent, 5 patients (33.3%) were good and one patient (6.7%) was poor. The patient who got poor score showed fibular non-union (P=0.55, statistically insignificant). **Yavuz et al. (2014)** used AOFAS score as functional outcome measure. They showed close results with mean score in plate group 88.1 and in IMN 88.3 (p = 0.794). **Soni Yougesh et al. (2022)** showed that both MIPPO and intramedullary nailing are equally effective in terms of functional outcome according to OMAS score the mean score was 79.27 (80.8 in MIPPO group and 77.2 in IMN group) without any significant difference among the groups (p value 0.33).

The distance from tibia plafond: 19 fractures were within 40 mm to 65 mm (10 patients (66.7 %) in IMN group and 9 patients (63.3%) in MIPPO group). In IMN group, 8 patients (80%) were graded as excellent and 2 patients 20% as good, while in MIPPO, 5 patients (55.6%) were graded as excellent and 3 patients (33.3%) as good and the last one (11.1%) was poor. This did not show statistical significant difference (P=0.17), but only slight advantage to IMN. In 9 patients, the fractures were within 66 mm to 90 mm (26.7 % in IMN group and 30% in MIPPO group). In IMN group, (75%) were graded as excellent and 25% as good, while in MIPPO, (80%) of patients were graded as excellent and (20%) as good. Also, this did not show statistical significant difference. Two fractures were within 91 mm to 120 mm (one patient 6.7% in IMN group and other one 6.7% in MIPPO group). The patient in IMN group (100%) was graded as fair, while the patient in MIPPO group (100%) was graded as good. In general, the distance of fracture from tibia plafond showed no significant difference (P=0.17) in clinical &functional outcome in both groups. Good reduction should be achieved, although the difficulties of reduction in distal fractures (from 40 mm to 65 mm) due to the distal diaphyseal flare and wide metaphysis especially in IMN. **El Zohairy et al (2021)** suggested that IMN must have the priority in extra articular distal tibia fractures extending more than 5 cm from the tibia plafond, and MIPO should have the priority in fractures with good skin condition or extending less than 5 cm from the tibia plafond.

AO classification: In our study, 20 patients were fracture type 43A1; 12 patients in IMN group and 8 patients in MIPPO group. In IMN group, 9 patients (75%) were graded as excellent,

2 patients (16.7%) were graded as good and one patient was graded as fair. In MIPPO group, 4 patients (50%) were graded as excellent, 3 patients (37.5%) were graded as good and the last patient (12.5%)was graded as poor. Seven patients with fracture type 43A2; 3 patients were fixed using IMN and 4 fixed using MIPPO. Two patients (66.7%) in IMN group were graded as excellent, and one (33.3%) as good. In MIPPO group, 3 patients were graded as excellent (75%) and one (25%) as good. Three patients in MIPPO group with fracture type 43A3, 2 patients (66.7%) were graded as excellent and one (33.3%) as good. Those results did not show statistical significance. Also, **Yavuz et al. (2014)** found the same results. Good planning and preparation of patient, proper surgical environment, dealing with different tools to reach acceptable reduction with minimal soft tissue injuries, good skin coverage and closely follow up to deal with complications early are the keys to get good outcome regardless of fracture type or distance from tibia plafond. **Kruppa et al. (2015)** reported no significant association between fracture type, severity and malunions.

Conclusion

IML nailing is more effective than MIPPO technique in fixation of extra-articular distal tibia fractures, as IMN showed lower infection rate and faster time to healing but with more mal-alignment in reduction. While in MIPPO technique, less mal-alignment reduction could be achieved but with more infection problems and slower rate of union.

Finally, to improve clinical decision making, further studies should be performed with longer follow up period and adequate sample size with strict inclusion and exclusion criteria to overcome bias. External fixation should be part of the comparative research in the future studies

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