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Comparing Intramedullary Nailing and Plate Fixation in Management of Displaced Extra-Articular Distal Tibia Fractures

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ABSTRACT

Background: Locked plating and intramedullary (IM) nailing are 2 used common modalities in treating distal tibia extra-articular fractures.

Objectives: To study and compare between techniques regard outcome and complication therefore, to improve outcome of patients with displaced extra-articular distal tibia fractures.

Patients and Methods: The current trial was a non-random controlled clinical trial conducted on 18 patients with tibial fracture at the Orthopedic Department, College of Medicine, Zagazig University. A total of 18 patients were divided into 2 groups of 9, with 9 patients in Group (I) receiving an intramedullary nail and 9 patients in Group (II) receiving a plate.

Results: Operation duration and hospital stay were longer among plate group. Majority of both groups were excellent and good. We found that nail group has better outcome. The postoperative Teeny and Wiss score's did not differ significantly across the groups. In terms of postoperative complications, there was no significant difference between the groups.

Conclusion: Both techniques can provide effective treatment and fixation for closed extra-articular fractures. Intramedullary nailing showed lower infection rate and faster time to healing but with more mal-alignment reduction.

Keywords: Extra-articular Distal Tibia Fractures, Intramedullary Nailing, Plate Fixation.

INTRODUCTION

In terms of long bone fractures, distal tibial fractures are the most prevalent. 17 per 100,000 years[(1)], while newer research suggests that this number may be on the reduction [(2)].

Most of the time, these injuries occur as a result of a high-energy traumatic incident, such as a fall from a great height, car accident, motorbike accident, or sporting event [(2)].

Fractures of the distal tibia are often classified as either intra-articular or extra-articular (42A1 and 43A1) classification by AO and OTA. Extra-articular fractures are further subdivided into three categories based on their morphology and degree of comminution: 43-A1 refers to non-comminuted fractures, 43-A2 refers to wedge fractures, and 43-A3 refers to comminuted fractures. Fractures that simply extend into the joint without depressing the joint surface are classed as 43-B1, and are often treated in the same way as 43-A fractures [(3,4)].

The mechanism of damage, treatment, and prognosis for these breaks are distinct from those of pilon breaks (intra-articular distal tibial breaks). In comparison to diaphyseal or mid-thigh fractures, the consequences that arise from being so close to the ankle joint are much higher. As a result, there are still challenges in treating distal tibia fractures [(5)].

Although there are several options for treating these fractures, including locking plates and intramedullary (IM) nails, each has its own set of drawbacks. Intramedullary nailing has a higher risk of anterior knee discomfort, a broken bolt or screw across the nail, and bone malalignment [(5)].

Although a "locking" tibial plate can help with reduction, the increased soft tissue dissection that is required raises the danger of infection, wound collapse, and collateral injury [(6)]. Until the proximal two-thirds and distal thirds of the tibia join, the medullary cavity is very homogeneous across the bone. At that point, the cavity begins to enlarge until it reaches the subchondral area of the ankle. Because of this, you can see why nails tend to pull out of such fractures. However, open reduction with internal fixation employing plate fixation remains challenging due to the restricted soft tissue envelope at this location. Nonunion and other soft tissue problems are common results of this [(7)].

Patients with extra-articular distal tibial fractures treated with either nail or screw fixation had comparable rates of deep infection, delayed union, and implant removal, but nail fixation was linked to considerably more malunions, as described by **Mao *et al.*** [(8)]. By contrast, **Zelle *et al.*** [(9)] discovered that the rates of malunion were comparable between the two groups.

AIMS OF THE STUDY

The purposes of this research are to study and compare between techniques regard outcome and complication therefore, to improve outcomes of displaced extra-articular distal tibia fractures.

SUBJECTS AND METHODS

Subjects:

At Orthopedic Surgery Department of Zagazig General Hospital 18 patients who had extra-articular distal tibial fractures as intramedullary nailing, or plating

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was used for treatment (where IMN has successfully treated 9 cases (6 men, 3 women) and a total of 9 male cases were treated by MIPO).

Ethical consent:

An approval of the study was obtained from Zagazig University Academic and Ethical Committee (IRB Approval: #9302/1-2-2022). Every patient signed an informed written consent for acceptance of participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Inclusion criteria:

Between the ages of eighteen and seventy, distal tibial extra-articular fractures that have closed, and open fractures of simple and type I (Gustilo).

Exclusion criteria:

Absolute: Injuries to the nervous system or the compartments of the body that result in fractures. Bone fractures that are obviously pathological. Fracture within the joint capsule (proximal or distal). Fracture blisters and extensive soft tissue damage. Open fractures of type II, and III Gustilo, and open infected fractures.

Relative: Patients< 18 or >70 years. Segmental fractures, and diabetes, liver disease, and chronic kidney disease are examples of medical co-morbidities.

Systematic random sampling was used to split the patients into two equal groups, one for those undergoing laparoscopic surgery and another for those undergoing open surgery:

Patients who had an intramedullary interlocking tibia nail placed as part of a closed reduction and internal fixation procedure made up Group I, and patients in Group II who received a closed reduction and internal fixation procedure using a medial distal tibial locking plate

This is what all of the participants in this research had to go through:

1. A thorough review of the patient's medical history and an orthopedic examination.
2. X-ray anteroposterior (AP) on the affected side.
3. All patients had full preoperative lab investigation before surgery including: complete blood picture, random blood sugar, viral screen, coagulation studies (PT/PTT) as well as kidney and liver function tests.

Surgical technique:

The cases included in this study were managed within one to two days following the trauma.

Group I:

The Process of Preparation before Surgery:

In order to determine the fracture and damage geometry of the tibia prior to surgery, anteroposterior and lateral radiographs of the affected extremity, including the knee and ankle, are required.

Methods and Strategy:

The cut reaches all the way down to the underside of the kneecap (patella). Identification of the patellar tendon's medial aspect and subsequent reflection of the tendon to the side. The medullary canal is accessed using a curved awl inserted into the space between the front tibia and the knee. You shouldn't cut into the tibia or knee. Anteroposterior and lateral fluoroscopic images are used to pinpoint the precise location of the awl. Fractures of the distal tibia necessitate an anteroposterior (AP) approach, using the bone's middle as the site of origin. The point of the awl should be slightly below the joint line on the lateral radiograph. The canal is then guided by a guide wire with a bulbous end. The bulb-tip guide is operated by a T-handle located approximately halfway up the guide wire.

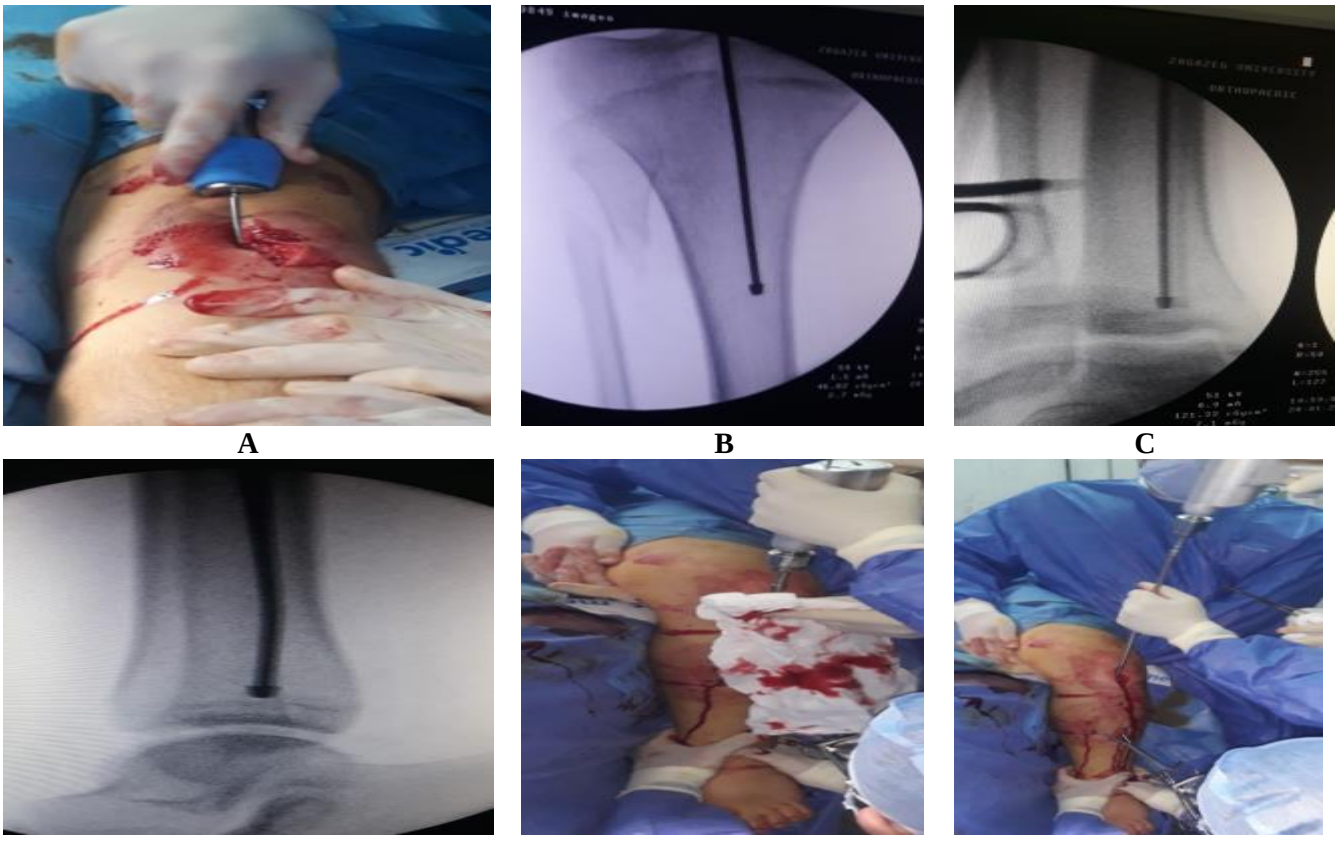


Figure (1): A & B: Placement of a guide wire with a bulbous tip into the medullary canal. **C & D:** Guide wire inserted into the sub chondral bone just above the ankle joint. **E & F:** Intramedullary canal reaming.

While the guide wire is advanced to the fracture site, the bulb tip is targeted posteriorly to enter the tibia and then instantly twisted anteriorly and passed down to the fracture site, under image intensification, the fracture is minimized, and a guide wire is inserted into the distal fragment to fix the bulb tip in subchondral bone above the ankle. Nail length is measured from the outside using a long ruler and then checked using an image intensifier.

Correct reaming technique is essential for a successful surgical procedure. To avoid damaging the skin and other soft tissues around the incision, the surgeon will begin with a small diameter reamer and expand it in 0.5 mm increments until cortical contact is established. As the reamer advances, the fracture must be minimized.

A plastic exchange tube is passed over the bulb tip and over the fracture site before a straight tip guiding wire is introduced to position the nail. Over this guide wire, the nail is inserted into the tibial canal.

Interlocking proximal and distal screws are then put once the nail has been seated completely. The proximal and distal tibial locking screws can be precisely placed with the use of targeting devices that connect to the intramedullary nail. The trocar-tipped pin is centred in the incision by placing its sharp point on the skin. Using an image intensifier, surgeons place Poller (blocking) screws distally to the fracture site in the anteroposterior direction to improve control, straighten the bone in the coronal plane, and secure the fracture. After that, we irrigate the wounds and bandage them up. Prior to wound closure, final radiographs are collected while the patient is under anesthesia.

Group II:

If a fibular fracture was observed, it was originally treated by lateral open reduction and internal fixation with a 1/3tubular plate (where 7 cases was present with fibular fracture, 4 cases done ORIF by plate, 1 case by K-wire and 2 cases not fixed). If a fibular fracture is present, it must be reduced and stabilized in order to establish the proper tibial length.

An antero-medial tibial incision was made at the level of the medial malleolus and extended proximally for further 2–3 centimeters past the end of the fracture line.

To avoid harming the periosteum, a plate was placed into a subcutaneous extra-periosteal tunnel that had been carefully carved out using a dissector. Under the picture intensifier, the proper plate length was chosen. A minor incision (2-3 cm) was made above the

fracture site to insert the plate proximally and centrally across the tibial shaft.

Manual manipulation, reduction forceps, or a schanz pin were used to do the percutaneous reduction of the fracture. Two screws, one above the medial malleolus and one directly below the fracture site, were then put at the extremity's distal end to stabilize the plate and aid in bone reduction.

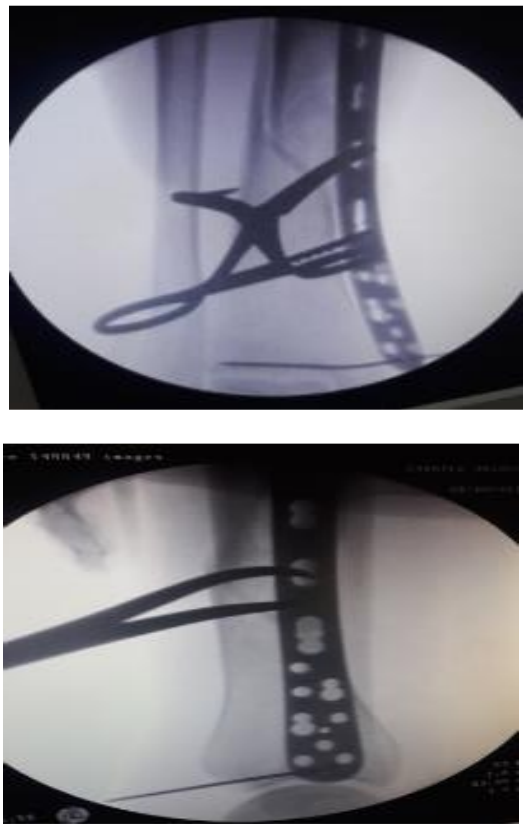


Figure (2): The plate correctly positioned so that the plate itself acts as a reduction mould.

Inter-fragmentary lag screws were inserted either percutaneously outside the plate or through the plate to compress the ends of the fracture for spiral and short oblique fractures operated on using an image intensifier.

When compressing transverse fractures, non-locking holes were used to insert eccentric screws. Suturing was done by deep and superficial sutures.

Postoperative follow-up:

Patients were checked on every four weeks, with the last check taking place six months after initial treatment. At 9 months, we did a final clinical examination using Teeny and Wiss's 100-point scale for evaluating clinical outcomes.

Statistical analysis

In order to analyze the data acquired, Statistical Package of Social Services (SPSS) version 20 was used to execute it on a computer. In order to convey the findings, tables and graphs were employed. The quantitative data was presented in the form of the mean, median, standard deviation, and confidence intervals. The information was presented using qualitative statistics such as frequency and percentage. The student's t test (T) is used to assess the data while dealing with quantitative independent variables. Pearson Chi-Square and Chi-Square for Linear Trend (X2) were used to assess qualitatively independent data. The significance of a P value of 0.05 or less was determined.

RESULTS

Age was distributed as 41.0±11.92 and 37.22±9.45 respectively with, and no significant differences were found as regards gender as well as age **(Table 1)**.

Table (1): Demographics

			Nail Group	Plate Group	t/ X2	P
Age			41.0±11.92	37.22±9.45	0.745	0.467
Sex	**Male**	**N**	6	5	0.23	0.62
		%	66.7%	55.6%		
	Female	**N**	3	4		
		%	33.3%	44.4%		
Total		**N**	9	9		
		%	100.0%	100.0%		

Majority of both groups were happened by RTA with closed type and A1 class and when comparing the rates of injury among groups, we found no significant differences **(Table 2)**.

Table (2): Injury characters among groups

			Nail Group	Plate Group	t/ X2	P
Pre-operative period			3.11±1.05	4.0±1.22	1.650	0.118
Mechanism	**FFH**	**N**	2	4	1.0	0.31
		%	22.2%	44.4%		
	RTA	**N**	7	5		
		%	77.8%	55.6%		
Type	**Closed**	**N**	7	6	0.27	0.59
		%	77.8%	66.7%		
	Open	**N**	2	3		
		%	22.2%	33.3%		
AO Classification	**A1**	**N**	6	5	0.29	0.86
		%	66.7%	55.6%		
	A2	**N**	2	3		
		%	22.2%	33.3%		
	A3	**N**	1	1		
		%	11.1%	11.1%		
Associated fibula	**No**	**N**	5	4	0.22	0.63
		%	55.6%	44.4%		
	Yes	**N**	4	5		
		%	44.4%	55.6%		
Total		**N**	9	9		
		%	100.0%	100.0%		

Operation duration and hospital stay were longer among plate group but not significantly. The time it took for couples to be married did not differ significantly between the groups **(Table 3)**.

Table (3): Operation characters among studied groups

	Nail Group	Plate Group	t	P
Operation duration/Hour	78.22±10.63	84.11±8.57	1.854	0.071
Hospital stay/Day	2.85±0.70	3.38±0.70	1.874	0.061

Majority of both groups were excellent and good we found that nail group has better outcome with non-significant differences between groups **(Table 4)**.

Table (4): Union time in months among studied groups

	Nail Group	Plate Group	t	P
Union time/ Month	5.77±1.41	6.11±1.45	0.456	0.654

The postoperative Teeny and Wiss score's did not differ significantly across the groups (Table 5).

Table (5): Teeny and Wiss score for post postoperative evaluation among studied groups

			Nail Group	Plate Group	t/X2	P
Pain			44.44±11.3	42.22±10.01	0.358	0.725
Distance			6.55±1.29	6.22±1.31	0.321	0.753
Swilling			2.33±0.56	2.44±0.42	0.270	0.791
Stair			2.44±0.51	2.22±0.36	0.676	0.509
Running			3.55±0.25	3.33±0.81	0.290	0.775
Hill			2.44±0.43	2.55±0.41	0.112	0.956
Support			6.66±1.12	6.33±1.12	0.354	0.728
Planter range			1.55±0.42	1.44±0.31	0.324	0.750
Dorsal range			4.33±0.70	4.0±0.68	1.000	0.332
Toe raising			3.66±0.45	4.11±0.87	0.658	0.520
LIMP			6.22±1.10	6.0±1.31	0.244	0.810
Total score			84.22±20.13	80.77±18.32	0.302	0.767
Score	**Poor**	**N**	1	1	1.03	0.79
		%	11.1%	11.1%		
	Fair	**N**	1	2		
		%	11.1%	22.2%		
	Good	**N**	2	3		
		%	22.2%	33.3%		
	Excellent	**N**	5	3		
		%	55.6%	33.3%		
Total		**N**	9	9		
		%	100.0%	100.0%		

There was no significant difference between groups founded regard complication **(Table 6)**.

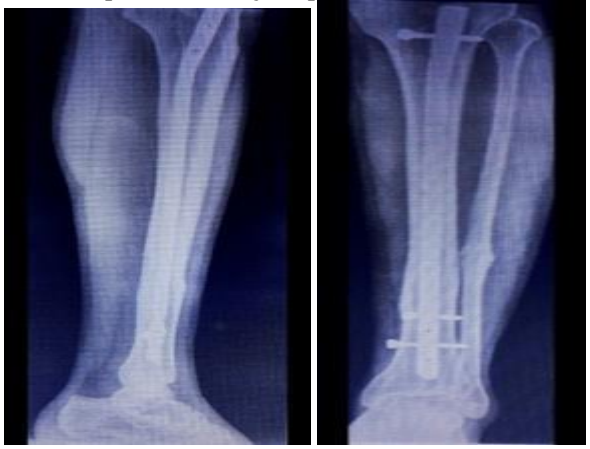
Table (6): Complication distribution between studied groups

			Group		X2	P
			Nail Group	Plate Group		
Infection	**-VE**	**N**	6	4	0.90	0.34
		%	66.7%	44.4%		
	+VE	**N**	3	5		
		%	33.3%	55.6%		
Deformities	**-VE**	**N**	9	8	1.05	0.303
		%	100.0%	88.9%		
	+VE	**N**	0	1		
		%	0.0%	11.1%		
Delay union	**-VE**	**N**	9	7	2.25	0.13
		%	100.0%	77.8%		
	+VE	**N**	0	2		
		%	0.0%	22.2%		
Non union	**-VE**	**N**	8	9	1.05	0.303
		%	88.9%	100.0%		
	+VE	**N**	1	0		
		%	11.1%	0.0%		
Total		**N**	9	9		
		%	100.0%	100.0%		

A: Preoperative x-ray

B: Postoperative x-ray of patient.

C): Two-month x-ray



D: 6 months x ray

Figure (3): Male patient, 28 years old. Co-morbidities: No, Mode of trauma: road traffic accident, Fracture side: left.AO classification: 43A2.Closed fracture associated with fibular fracture, Fracture of lower third tibia was fixed by Expert nail.

A: Preoperative x-ray.

B: Post operative x-ray.

C: 2 months post operative x-ray.

D: 6 months post operative x-ray.

Figure (4): Male patient, 44 years old. Co-morbidities: No, Mode of trauma: road traffic accident, Fracture side: Right.AO classification: 43A2.Closed fracture associated with fibular fracture, Fracture of lower third tibia was fixed by MIPO

DISCUSSION

Although there are several options for treating these fractures, including locking plates and intramedullary (IM) nails, each has its own set of drawbacks. Intramedullary nailing has a higher risk of anterior knee discomfort, a broken bolt or screw across the nail, and bone malalignment [5].

Eighteen individuals who had suffered tibial fractures were included in the current investigation. Dispersed between 2 groups, each including 9 people: Group (I) had fractures treated with intramedullary nails, whereas Group (II) had their breaks treated with plates. There was no statistically significant difference in the distribution of age or sex between the two groups (41.0±11.92 and 37.22±9.45, respectively).

Mauffrey *et al.* [10] the median age of patients in the nail group (range: 39-60 years) and the plate group (range: 24-43) from the randomized pilot trial comparing different methods of fixation for distal tibia fractures in adults was 50 years. There were fewer men than women in the plate group (9:3) but more in the nail group (7:5). Overall, the sex ratio between the two groups of patients was rather even [10]. When comparing the IM nail group with the plate group, the IM nail group had a higher mean age, therefore this difference had to be adjusted for in the statistical analysis.

The present results showed that regarding group (1), the preoperative period was 3.11, the mechanism of fracture was RTA in 55.6% of cases, and 44.4% were FFH. 66.7% of cases had closed fracture. Resecting the AO classification, 55.6% were A1, 33.3% were A2, and 11.1% of cases were A3. 44.4% of cases had associated fibula. Concerning group (2), the preoperative period was 4, the mechanism of fracture was RTA in majority of cases. 77.8% of cases had closed fracture. Resecting the AO classification, 66.7% were A1, 22.2% were A2, and 11.1% of cases were A3. 55.6% of cases had associated fibula. Regarding the character injury distribution, there was no statistically significant difference between groups ($p>0.05$).

Nonunion of the tibia has been linked to fibula fracture fixation or an intact fibula by several authors. **Vallier *et al.*** [11] similar pattern was seen despite differences in distal tibia fracture treatment. This conclusion is consistent with prior data from their hospital.

A greater rate of distal tibia nonunion was observed by **Nork and colleagues** [12], with subsequent surgeries being performed on 19% of patients to achieve union. Although their patients shared many similarities with ours, 53% of those in their series underwent fibulfixation.

The findings found that operation duration was 78.22 in Group (I), and was 84.11 in group (II). About the hospital stay, group (I) was 2.85 and group (II) was 3.38. Operation duration and Hospital stay were longer among plate group. Operation times and lengths of stay in the hospital were similar among groups.

Guo *et al.* [13] found that the IM nailing group had significantly shorter surgical times and lower intra-operative radiation exposure.

Elmezian *et al.* [14] reported that regarding to time of surgery, in nail group mean operative time was 116 min. with standard deviation of 16.47. Plate group mean operative time was 127 with standard deviation of 18.89, ($P=0.182$) which is not significant in this study [14].

According to the results of the present research, the average union time was 5.77 months in the nail group and 6.11 months in the plate group. Union time did not differ significantly across groups.

In contrary to the current findings **Elmezian *et al.*** [14] reported that the union time was 13.1 months in nail group, and 16.78 months in plate group. There was a significant difference between the groups regarding the union time.

The current results reported that regarding the nail group, the pain level was 44.44, distance was 6.55, swelling was 2.33, stair was 2.44, running was 3.55, hill was 2.44, support was 6.6, plantar range was 1.55, dorsal range was 4.3, toe raising was 3.66, LIMP was 6.22, and the total score was 84.22. 55.6% of cases had excellent outcome. Concerning the plate group, the pain level was 42.22, distance was 6.22, swelling was 2.44, stair was 2.22, running was 3.33, hill was 2.55, support was 6.33, plantar range was 1.44, dorsal range was 4, toe raising was 4.11, LIMP was 6, and the total score was 80.77. The outcome of cases was 33.3% for each excellent and good outcome. Majority of both groups were excellent and good we found that nail group has better outcome. There was no significant difference between the groups regarding Teeny and Wiss score for postoperative evaluation.

Elmezian *et al.* [14] showed that according the postoperative outcome in nail group 80% were with excellent outcome, and 20% were with good outcome, while in plate group 50% were with excellent outcome, 40% were with good outcome, and 10% were with poor outcome.

The results of the present study found that respecting nail group, only one third of cases had infection, all cases were without deformities or union delay. Only one case had non-union. On the other hand, as regard the plate group, 55.6% of cases had infections, one case had deformity, two cases had delayed union. All cases did not have non-union complication. Relative to postoperative complications, there was no significant difference between the groups.

Extensive dissection is generally necessary for open reduction and internal fixation of distal tibial fractures. This can lead to devitalization of tissue, which in turn creates an environment less conducive to union and increases the risk of infection [13].

One such less invasive option is closed IMN, which allows for load-sharing and avoids substantial

soft-tissue incision while protecting the extraosseous blood supply [7].

CONCLUSION

Both techniques (intramedullary nailing and plate fixation) can provide effective treatment and fixation for closed extra-articular fractures. Intramedullary nailing showed lower infection rate and faster time to healing but with more mal-alignment reduction. While in Minimally invasive plate osteosynthesis (MIPO) technique less mal-alignment reduction could be achieved but with more infection problems and slower rate of union. Good handling to soft tissues is an important factor to rapid healing of the fracture and to avoid complications. Good pre-operative planning for each patient to achieve good reduction with minimal soft tissue injury was an important as it reduce time of operation and the need for secondary surgeries. As a result, we now routinely use intramedullary nailing to repair these types of fractures.

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Author contribution: Authors contributed equally in the study.

REFERENCES

1. **Larsen P, Elsoe R, Hansen S *et al.* (2015):** Incidence and epidemiology of tibial shaft fractures. Injury, 46(4):746-50.
2. **Maredza M, Petrou S, Dritsaki M *et al.* (2018):** A comparison of the cost-effectiveness of intramedullary nail fixation and locking plate fixation in the treatment of adult patients with an extra-articular fracture of the distal tibia. Bone Jt J., 100B (5):624–33.
3. **Marsh J, Slongo T, Broderick J *et al.* (2007):** Fracture and dislocation classification compendium - 2007: Orthopaedic trauma association classification, database and outcomes committee. J Orthop Trauma, 21(10):1–133.
4. **Robinson C, Mclauchlan G, Mclean I *et al.* (1995):** Distal metaphyseal fractures of the tibia with minimal involvement of the ankle. Classification and treatment by locked intramedullary nailing. J Bone Joint Surg Br., 77(5): 781–7.
5. **Achten J, Parsons N, McGuinness K *et al.* (2015):** UK Fixation of Distal Tibia Fractures (UK FixDT): protocol for a randomised controlled trial of 'locking'plate fixation versus intramedullary nail fixation in the treatment of adult patients with a displaced fracture of the distal tibia. BMJ Open, 5(9): e009162. doi: 10.1136/bmjopen-2015-009162
6. **Kisan D, Samant S (2018):** An outcome analysis of extra articular distal tibia fractures treated with intramedullary nailing and plating. Natl J Clin Orthop., 2(2): 8–10.
7. **Li B, Yang Y, Jiang L (2015):** Plate fixation versus intramedullary nailing for displaced extra-articular distal tibia fractures: A system review. Eur J Orthop Surg Traumatol., 25(1):53–63.
8. **Mao Z, Wang G, Zhang L *et al.* (2015):** Intramedullary nailing versus plating for distal tibia fractures without articular involvement: a meta-analysis. J Orthop Surg Res., 10(1): 95. doi: 10.1186/s13018-015-0217-5.
9. **Zelle B, Bhandari M, Espiritu M *et al.* (2006):** Treatment of distal tibia fractures without articular involvement: A systematic review of 1125 fractures. J Orthop Trauma, 20(1):76–9.
10. **Mauffrey C, McGuinness K, Parsons N *et al.* (2012):** A randomised pilot trial of "locking plate" fixation versus intramedullary nailing for extra-articular fractures of the distal tibia. J Bone Joint Surg., 94(5): 704-708.
11. **Vallier H, Cureton B, Patterson B (2012):** Factors influencing functional outcomes after distal tibia shaft fractures. J Orthop Trauma, 26:178-83.
12. **Nork S, Schwartz A, Agel J *et al.* (2005):** Intramedullary nailing of distal metaphyseal tibial fractures. J Bone Joint Surg Am., 87(6): 1213-1221.
13. **Gao F, Ma J, Sun W *et al.* (2016):** The influence of knee malalignment on the ankle alignment in varus and valgus gonarthrosis based on radiographic measurement. Eur J Radiol., 85(1): 228-232.
14. **Elmezian A, Mohammed A, Yassin I (2020):** Comparative study between Interlocking Nail and Locked Plate in Distal Tibial Fractures Fixation. Al-Azhar Internat Med J., 1(12): 286-292.