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Short Term Outcomes of Distal Tibia Fractures Treated with Closed Reduction and Reamed Intramedullary Interlocking Nail in A Tertiary Care Center in North India.

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ABSTRACT

Objectives: This study aimed to analyze functional and radiological outcomes of distal tibia fractures treated with closed reduction and reamed intramedullary interlocking nailing.

Material and methods: A prospective study was conducted on 25 patients that fitted the inclusion criteria and underwent closed reduction and intramedullary interlocking nailing. All patients were reviewed at 6, 12, 18 and 24 weeks post-operative and were assessed for clinical and radiological signs of union, time of union, complications and functional score using the Olerud and Molander ankle score. (OMAS)

Results: In our study, there were 18 males(72%) and 7 females (28%) with mean age of 34.16±10.99 years.18 patients (72%) had closed fractures and 7 patients had open fracture (28%). According to the AO classification, 11patients (44%) had AO 43A1, 9 patients (36%) had AO 43A2 and 5 patients (20%) had AO 43A3 fractures. Bony union was seen in 21 patients (84%) at 3months (12^{th} week) of follow-up. 4 patients (16%) had delayed union eventually uniting by 6 months. (24 weeks) Mean union time was 15.17±7.20 weeks. 4 patients with delayed union was seen more in cases of open fracture (3 patients) compared to closed fracture. (1 patient) which was statistically significant. (p=0.0023) Using the OMAS, We observed a significant increase in the overall functional score over the follow up interval from 6 weeks to 24 weeks. Overall functional outcomes at 24 weeks revealed that 14 patients (56%) had excellent functional score, 7 patients (28%) had good functional score, and 4 patients (16%) had fair functional score. OMAS in different age groups showed that functional outcomes was higher during all follow up intervals in younger age groups (20-29 years) as compared with to older age groups. (50-59 years) Complications were noted in 2 patients (8%) who developed superficial infections, both of which were open fractures.1 patient (4%) had pain over the distal screw region due to screw prominence which needed removal.

Conclusions: We conclude that intramedullary nailing is a better way to treat distal extra-articular fractures of the tibia with early bony union rate, lesser incidence of infection and implant irritation and functional scores ranging from excellent to fair outcomes. We recommend that intraoperative reduction should be as near anatomic as possible and maintained while passing guide wire, reaming and inserting nail to prevent any mal angulation.

Keywords: Distal tibia fracture, intramedullary interlocking nail, functional outcome, Olerud Molander score

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1. INTRODUCTION

Distal tibia fractures (DTF) are the second most common fractures after tibia diaphysis fractures, accounting for < 7% of all tibial fractures and < 10% of all lower extremity fractures.[1] DTF are frequently observed with high velocity trauma primarily with road traffic accidents and sports related injuries [2]. These fractures in the meta-diaphyseal region (lower 1/3rd) requires a different management and are challenging as they are not differentiated from pilon fractures.[1] In recent years, India has seen a surge in trauma cases, due to rapid urbanization and increased vehicular traffic, with tibial fractures emerging as the most prevalent type[3]. With its distinct anatomical features like its subcutaneous antero-medial surface and positioning, lack of muscular protection anteriorly and inadequate blood supply poses a significant treatment challenge during management. Also, the knee and ankle joints being primarily hinge joints, are unforgiving for rotational deformity adjustments and requires careful consideration during reduction along with serious potential complications like delayed union, wound infections and wound dehiscence[4-7]

Optimal management and fixation methods remains controversial with lack of clear guidelines for DTF. Stable fixation is essential while minimizing soft tissue damage by careful tissue handling, surgical dissection or implant usage. Treatment considerations will include fracture characteristics, peri fracture soft tissue conditions along with clinical experience which is paramount is decision making process. Optimal treatment depends on fracture proximity to plafond, commination, displacement and soft tissue status along with good clinical acumen and extensive experience to tailor appropriate treatment depending on injury patterns [1]

With advancement in the field of orthopedics, development of newer implants with superior characteristics in terms of strength, design, profile and metallurgical properties have also evolved along with newer modalities of treatment which include plating (both open and minimally invasive plate osteosynthesis), intramedullary interlocking nail (IMILN), and external fixators[8]. (Unilateral fixator and illizarov ring fixators) Open reduction and internal fixation with plating involves extensive soft tissue dissection in an area of precarious blood supply owing to its unique anatomy, along with swelling and blistering that results following high energy trauma, plating often leads to soft tissue problems which include infection, wound dehiscence delayed healing and exposed implants necessitating flap coverage [8].

IMILN is a minimally invasive and biologically superior method of fixation without disrupting fracture haematoma or stripping soft tissue /perisosteum and is the gold standard for diaphyseal shaft fractures of tibia. Its utilization has surged in popularity for treating extra articular pilon fractures, with indications expanding to encompass distal tibia fractures with partial articular extension.[9, 10]

This study aimed to analyze the functional and radiological outcomes of DTF treated with closed reduction (CR) and reamed IMIL nails.

2. MATERIAL AND METHODS-

After approval of the ethics committee (ref no- SU/SM&R/76-A/2022/104) a prospective single Centre study was conducted on 25 patients, fitting in the inclusion criteria and attending the emergency department, out-patient and in patient department of the department of orthopedics in Sharda Hospital, School of Medical Sciences and Research, Greater Noida. The study duration was 2 years from July 2022 till June 2024.Written informed consent was taken from all patients willing to participate in study.

3. INCLUSION CRITERIA:

Patients with distal 1/3rd tibia fractures with or without fibula fractures, aged between 18yrs to 65 years, presenting within 2 weeks of injury to the hospital, with fractures that can be classified as AO Type- 43A-1, 43A-2, 43A-3[11]. All closed fractures and open fracture of Modified Gustilo Anderson Classification – Grade I and II, were included along with fractures involving area 4cm to 11cm from tibial plafond[12].

4. EXCLUSION CRITERIA:

patients who did not consent for the study, age less than 18years and older than 65 years, DTF with articular extension to tibial plafond, fractures involving area below 4cm and fractures above 11 cm from tibial plafond, open fractures- grade III, fractures associated with comorbidities affecting rehabilitation, neurovascular deficit, bilateral injuries, ipsilateral long bone fracture, pelvic fractures and spine fractures were all excluded from the study.

5. METHODOLOGY

All patients, underwent a detailed clinical examination, x-rays, blood laboratory tests as per hospital preoperative workup and a comprehensive pre anesthetic checkup for comorbidities assessment to ensure fitness for the surgical procedure. Pre-operative radiological evaluation included x-rays both anterior posterior (AP) and lateral view in 100% magnification of the affected leg with knee and ankle joints included.

6. SURGICAL PROCEDURE

All patients underwent a CR and reamed IMIL nail insertion on a standard fluoroscopic OT table in the supine position with the affected leg hanging over the side or flexed to 90^0 and using a patellar tendon splitting approach as per standard tibia nailing technique. Manual traction was used for reduction. Fracture reduction of the distal tibia and nail guidance was carried out under fluoroscopic guidance. To maintain reduction and centralization of nail, poller k- wires[13] were used. Final fracture reduction was assessed in both AP and lateral views on C-arm and on being acceptable, proximal locking was carried out using a jig while distal locking was carried out using free hand technique.

POSTOPERATIVE AND FOLLOW UP – all patient were given standard post-operative (PO) care which included intravenous antibiotics, anti-inflammatory and analgesia. All operated limbs were elevated and iced for 3 days post PO and dressing changed if soakage was present. Knee and ankle range of movement (ROM) was initiated as soon as patient was comfortable along with static quadriceps exercises in bed. Radiological evaluation was carried out in the immediate post OP with standard AP and lateral views of the leg and subsequently on designated follow up(6, 12 , 18 and 24 weeks of follow up) to assess fracture union, presence ,absence and delayed callus formation and alignment . Weight bearing of operated limb was restricted till 4- 6 weeks or when early callus formation was visible on x-rays and then partial or full weight bearing was introduced based on radiological union.

Functional outcomes was also assessed at each designated follow up visit using the Olerud and Molander Ankle Score [14](OMAS) which assesses nine parameters which include pain , stiffness, swelling , stair climbing, running , jumping, squatting , support and work with scores ranging from 0(totally impaired)to 100(completely normal).

7. DEFINATIONS

BONY UNION[15] - the ability to bear weight without pain and visible bridging callus on 3 out of 4 cortices on both AP and lateral radiographs

DELAYED UNION [16-] failure of fracture union even at 3 months post-surgery

NON UNION[16] - Failure of progressive fracture union even after 6 months of surgery

8. STATISTICAL ANALYSIS

All data was entered into a patient record form and analyzed using SSPSv21 software. The descriptive analysis was used to summarize as frequency, percentage, proportion, mean and standard deviation.

The categorical variables were analyzed using the chi square test and non-categorical variables were analyzed using the paired T test .The strength of the correlation was analyzed using Pearson coefficient correlation test. A p value of less than 0.05 was considered statistically significant.

9. RESULTS

In our study, there were 18 males (72%) and 7 females (28%) with a mean age of 34.16+/- 10.99 years. Based on age groups, there were 11 patients (44%) in the 20-29years (3 female and 8 male), 6 patients (24%) in 30- 39years (1 female and 5male), 5 patients (20%) in the 40- 49 years (2 female and 3 male) and 3 patients (12%) in the 50-59 years age group.

19 patients (76%) had high energy trauma as compared to 6 patients (24%) with low energy trauma causing fracture. 14 patients (56%) had right lower limb involvement and 11 patients (44%) had left side limb fracture. 18 patients (72%) had closed fractures and 7 patients. (28%) had open fractures. Based on AO classification, There were 11patients (44%) with 43A1, 9 patients (36%) with 43A2 and 5 patients (20%) with 43A3 type of fracture. 20 patients (80%) had associated fibula fracture and 5 patients (20%) had isolated tibia fracture only. Bony union was seen in 21 cases (84%) at 12 weeks follow up (3 months). 4 patients (16%) had delayed union but eventually obtained union at 24 weeks (6 months) follow up. 1 patient (4%) achieved union at 18 weeks and 3 patients (12%) achieved union at 24 weeks. The mean time for fracture union was 15.12+/_7.20 weeks. Radiological outcomes in open versus closed fracture types (Table 1) revealed a total of 4patients with delayed unions of which 3patients had open fractures and 1 patient had closed fracture and this difference is statistically significant on comparing these fracture types. (p=0.0223) Radiological outcomes in different AO types (Table 2) revealed bony union in all 11 patients with 43A1 at 12 weeks follow up, bony union was seen in 8 cases of 43A2 at 12 weeks follow up and 1 delayed union. Bony union was seen in only 2 cases of 43A3 type at 12 weeks while 3 patients had delayed union, however this difference is statistically not significant. (p= 0.354)

Functional outcomes using the OMAS (Table 3) revealed the following- at 6 weeks the mean OMS value was 36.2+/- 11.6, at 12 weeks the mean OMS value was 69.4+/-18.61,at 18 weeks the mean OMS was 80+/-19.03 and at24 weeks the mean OMS was 84.6+/- 19.78.We observed a significant increase in the overall functional score over the follow up interval form 6 weeks to 24 weeks (p value =0.0010)(Figure I). Overall functional outcomes at 24 weeks revealed that 14 patients (56%) had excellent functional score, 7 patients (28%) had good functional score, and 4 patients (16%) had fair functional score. (Figure II) Functional outcomes and relation with age groups showed that functional outcomes was higher during

all follow up intervals in younger age groups (20-29 years) as compared with to older age groups. (50-59 years) (Figure III) It was observed that older age groups patients had significantly lower functional outcome scores ($p< 0.05$) as compared to 20-29 years and 30-39 years age groups and non-significant as compared to 40-49 years age group at 6, 12 and 18 weeks. However at 24 weeks no significant difference was observed in functional outcome in any age groups. (table 4) Complications were noted in 2 patients (8%) who developed superficial infections, both of which were open fractures.1 patient (4%) had pain over the distal screw region due to screw prominence which was removed post fracture healing.

Table 1: incidence of Radiological outcome among closed and open fractures.

	Open	Closed	Total	P value Chi square test
Bony union	4 (16%)	17(68%)	21(84%)	**0.0223***
Delayed union	3(12%)	1(4%)	4(16%)	
Non-Union	-	-	-	

Table 2: Radiological union among different AO type fracture groups.

AO TYPE	Bony Union at12wks FU	Delayed(>12wks)	Non-union(>24 wks)	P value Fischer exact test
43A1	11	0	0	0.354
43A2	8	1	0	
43A3	2	3	0	
TOTAL	**21**	**4**	**0**	

Table 3: Showing OMAS value from 6th to 24th week of follow up.

	6th week	12th week	18th week	24th week	P value ANOVA
Open	34.28±13.97	65.71±24.39	77.14±25.95	80.71±16.67	0.0023*
Closed	36.94±10.99	70.83±16.47	81.11±16.40	86.11±16.67	0.0017*
Overall	36.2±11.66	69.4±18.61	80±19.03	84.6±19.78	0.0010*
P value Paired T test	**0.6188**	**0.7145**	**0.1938**	**0.4744**	

Table 4: Showing relation of functional score according to age groups.

Age Group	6TH Week	12TH Week	18TH Week	24TH Week	P value Anova
20-29	39.45±11.71	72.5±28.76	88.30±15.30	94.63±15.34	**0.023***
30-39	37.66±13.66	69.54±14.90	86.35±30.44	92.40±31.93	**0.019***

40-49	36.71±12.05	66.42±17.49	85.14±16.54	91.28±17.42	**0.010***
50-59	35.20±5.75	64.36±17.49	83.10±12.30	89.54±13.42	**0.036***
P value ANOVA	**0.01789**	**0.02817**	**0.1834**	**0.190**	

***- statistically significant**

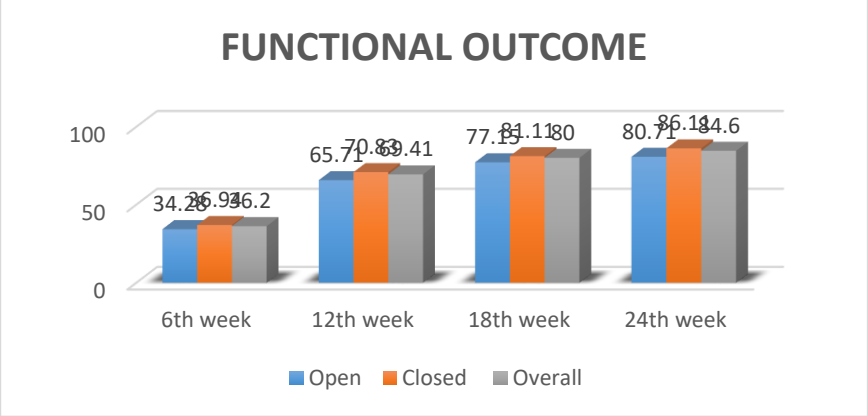

Figure I :OLERUD MOLANDER SCORE from 6th to 24th week of follow-up.

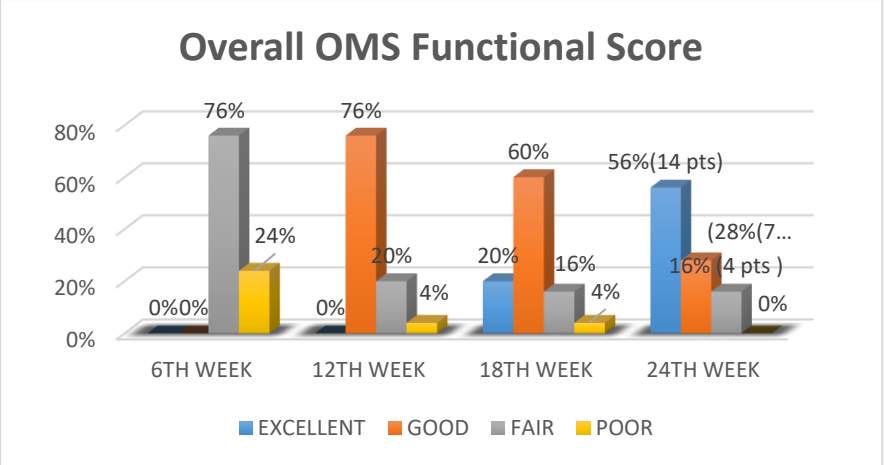

Figure II: Showing overall OMS functional score.

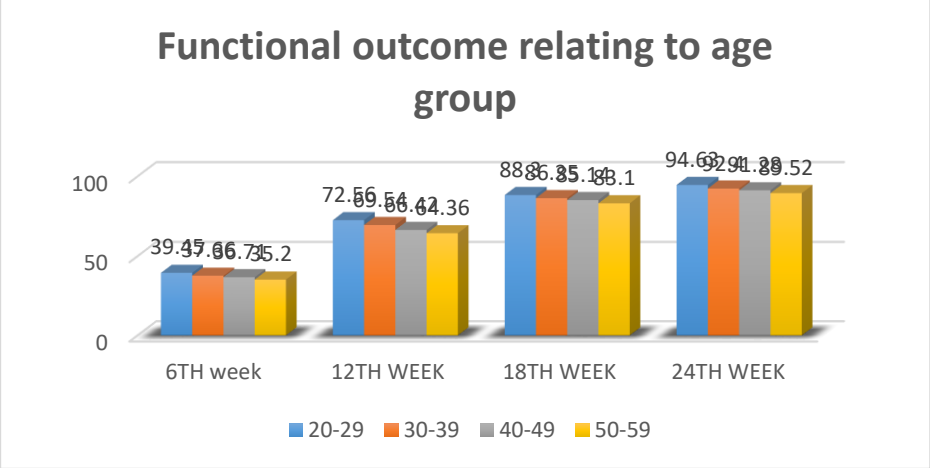

Figure III: Graph Showing Functional Score According To Age Group.

10. DISCUSSION

25 patients were included in our study had mean age of 34.16 ± 10.99 years (Range 20-56 years) with majority of the patients in the age group of 20-29 years old (44%) followed by 30 – 39 years age group (28%) and 40-49 years age group (24%) and 3 patients (12%) in 50-59 age group. The age group in our study is similar to a study conducted by Jose RL et al.[19] on treatment of distal tibia fracture treated by IMIL nailing had age group of patients ranging from 24 to 60 years. The majority of patients were between the age group of 31 and 45 years. Similarly, a study by Vallier HA *et al.*[16] showed the age group was between 16 years and 77 years with an average of 39.1 years. PNVSV Prasad et al.[15] in his study had patients with range of 23-65 years with mean age of 38.96 years. This clearly signifies that the middle age group involved in outdoor occupation has higher incidence of tibia fractures.

Amongst the 25 patients in our study, 18 patients were male (72%) while remaining 7 were female (28%) [Figure 1]. Arora KK et al.[20] observed that there were more male patients (N=19, 76%) as compared to females (N=06, 24%) in his study on distal tibia fractures. It was also in line with Thanigaimani et al.[21] who in his study of treatment of distal tibia fracture with IMIL nailing noted that the male incidence was 69.5% and female incidence of 30.46%. This is possibly due to male dominance in outdoor activities and association of distal third tibia fractures with RTA and other high energy trauma. In our study, 19 the patients had high energy injury (76%) while only 6 (24%) patients had low energy fracture. This is similar to the findings of Jose RL et al.[19] who reported 55% patients with high-energy RTA followed by others having low-energy injuries such as fall from height, fall of object, and self-fall. Vallier HA *et al.* [16] in his prospective comparison of plating and IMIL nailing on distal tibia fracture had 51% patients of high energy trauma and 49% of low-energy injuries. Though Shrestha *et al.* [26] had an equal number of patients with high- and low-energy injuries. In our study population, 18 patients had closed type of fracture (72%) while only 7 patients (28%) were cases of open fractures. Jose RL et al.[19] in his study reported similar findings with 81% patients of closed distal tibial fractures and 19% patients with open type fracture. It was also comparable to another study conducted by Vallier HA *et al.*[16] had 70% cases of closed fracture and 30% of open fractures. This signifies the high amount of open fracture associated with distal one third tibia fracture because of the poor soft tissue cover around distal tibia and highlights the importance of IMIL Nailing in such fractures as it avoids further soft tissue dissection.

PNVSV Prasad et al.[15] in his study of management of distal tibia fracture by IMIL nailing had 78 (53.06%) type of 43A1 fracture, 39 cases (26.53%) cases of 43A2 type fracture and 30 cases (20.40%) of 43A3 type of fracture. Shrestha *et al.*[22] study there were 60% of 43A1 type and 20% of 43A2 type and 10% of 43A3 and B1 type each. This was comparable to our study, where there were 11 patients (44%) who sustained AO type 43A1 fracture and 9 patients (36%) with AO type 43A2 and 5 patients (20%) with AO type 43A3 type of fracture tibia. The radiographic assessment in our study revealed that in 21 cases (84%) bony union was seen at 3 months (12th week) of follow up. 4 patients (16%) had delayed union but all 4 of them had achieved union till 24 weeks post operatively. One case achieved union at 18 weeks of follow-up and three cases at 24 weeks of follow-up. The mean time for fracture union was 15.12 ±7.20 weeks (Range 12-24 weeks). Non-union was not seen in any cases of our study. We observed that cases of bony union were more in closed fractures and delayed union was seen more in open fracture, this difference was statistically significant amongst both the type of fracture. (p=0.0223) PNVSV Prasad *et al* [15] conducted a study on IMIL nailing of distal tibia fracture and found union time to be of average 18 weeks with range of 16-22 weeks. Vallier *et al*.[16] in their study had found mean time to tibia fracture union for all patients at 4.7 months (Range 2.5–14 Months). Our findings were in agreement with the study by Beytemur O. et al.[23], who reported mean union time of 16.5±2.8 weeks (range 12 to 24 weeks). Nath R. et al.[24] also reported a mean union time of 18±2.45 weeks .Similarly, Tyllianakis et al [25] reported union in 73 patients within 4.2 months on average in a study

with average follow-up of 34.2 months. Bajaj s et al [26] showed the average time to fracture union being 16.7 weeks; which was comparable with the studies conducted by Katsenis et al [27] who had average time to fracture union of 16.3 weeks.

We reported no cases of Non-union which was in agreement to similar studies on distal tibia IMIL nailing done by PNVSV Prasad et al [15] and Nork SE et al [28] which too showed no cases of non-union in their study. Vallier et al [16] also reported in his study that open fractures are associated with increased rates of infection, non-union and mal-union than closed fractures. This finding correlates with our study where he had more cases of delayed union in open fractures compared to closed fractures. The overall mean OMAS at 24th week was 84.6±19.78. We observed a significant increase in the overall functional outcome over the follow up interval from 6th week to 24th week ($p = 0.0010$) [Table 7] .Also ,there was no significant difference in the in the functional outcome between open and closed type of fracture between any 6th , 12th ,18th and24th week interval ($p>0.05$).We observed that older age group (50-59 years) had significantly lower functional outcome score ($p<0.05$) as compare to 20-29 and 30-39 years age group and non-significant as compared to 40-49 years age group at 6th,12th and 18th week. However, at 24th week, no significant difference was observed in the functional outcome of any age group [Table 8]. It was observed that females had lower score during all follow up interval periods as compared to males. However, the difference is not significant during any follow up period.

Similar to our findings, Beytemür O et al [23] reported mean OMAS of 88±8.24 in functional results with a Mean follow-up time of 31.9±9.8 months (Range 13 to 50 months). The relationships between age, sex, wound status, smoking status, history of infection, and the number of screws and the OMAS were not significant ($p>0.05$). Katsenis DL et al [27] also reported the mean OMAS was 92.8/100 (range: 80–100) for an average 42 months follow up. The authors also showed that there was no statistically significant difference between the fracture type and the functional outcome. Thadiparthi VK et al [29] reported an average OMAS of 80.62 at a follow up period of 9 months. We observed two cases (8%) of superficial infection in our study and both of the cases were open fracture. They were managed by regular dressing and prolonged course of I.V. Antibiotics. Both of them recovered uneventfully. We had one case of implant pain over 1 distal screw due to medio-lateral screw prominence. The screw was removed post fracture healing. PNVSV Prasad et al [15] in his study of 147 distal tibia fracture treated with IMIL nail also found similar result with just 3 cases of superficial infection. All of the cases were open fractures just like we found in our study. Nork et al [28] in his study of IMIL nailing of distal tibia found just 1 case of deep infection that too in a case of open fracture that responded to local debridement and I.V antibiotics. Katsenis et al.[27] never encountered infection in 50 patients treated with IMIL nailing.

11. LIMITATIONS

The present study is a single centre study with limited sample size of 25 patients over a study period of 2 years. We did not compare intramedullary interlocking nailing outcomes with other surgical options (plating) for these fractures. A small sample size reduces generalizability and data obtained is usually insufficient for significant correlation. Multiple surgeons performed these surgeries with individual surgeons decision making based on fracture pattern and experience and surgeon discretion. We recommend for the larger multi-centric studies with long term follow-up period and comparing the various methods of surgical treatment in patients with distal one-third tibia fractures.

12. CONCLUSION

DTF treatment has always been challenging to the orthopaedic surgeon with treatment complications ranging from delayed union, non-union, wound infection and wound dehiscence. IMIL nailing has emerged as the standard treatment for such fracture, as it causes minimal soft tissue damage and, non-disruption of fracture haematoma which is one of the biggest concerns following plate fixation. Nailing is beneficial because of load sharing biomechanics, greater biological fixation, minimally invasive, early rehabilitation and fewer tissue complications. This technique allows early bony union rate, lesser incidence of infection and implant irritation and failure which makes it a preferable choice for fixation of distal tibial fractures.

We recommend that intraoperative reduction should be near anatomic as possible and maintained while passing guide wire, reaming and inserting nail to prevent any mal angulation. We attribute this low misalignment to the meticulous surgical technique and bi-planar locking of nail in distal tibia fracture, use of poller K -wires where required and removed immediately after locking. We conclude that intramedullary nailing is a better way to treat distal extra-articular fractures of the tibia.

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Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent

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