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Original Research Article

A prospective comparative study of functional outcome of distal extra articular tibia fracture fixed with intramedullary nail versus locking compression plate

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ABSTRACT

Background: Distal tibia fractures are one of the most common long bone fractures and their management presents with a series of problems due to the soft tissue surroundings and even more at risk due to their proximity to ankle joint. In our paper we showed functional outcome of distal extra articular tibia fracture while comparing its management between intramedullary nailing and locking compression plate.
Methods: There were 40 patients from November 2019 to November 2020 with distal extra articular tibia fracture. Patients were divided into 2 groups, first group included 20 patients managed with intramedullary nail and the second group included 20 patients managed with locking compression plate. Patients were followed preoperatively, intraoperatively and postoperatively for functional outcome and assessed clinically using AOFAS score and radiologically using X-ray.
Results: Out of the 40 cases treated in this manner, all cases were available for the follow up for a period of 1 year. Overall results by 1 year follow up showed excellent in 7 cases (35%) good in 13 cases (65%) in nailing group and in plating group showed excellent in 4 cases (20%), good in 12 cases (60%), fair in 3 cases (15%) and poor in 1 case (5%).
Conclusions: All fractures united well. Complications were encountered in 4 patients, 2 patients had superficial wound infections,1 patient had deep infection and another had persistent ankle pain in plating group and 2 patients had superficial wound infection in nailing group. No cases showed malunion or nonunion in both plating as well as nailing group.

Keywords: Distal extra articular tibia fracture, Locking compression plate, Intramedullary nail

INTRODUCTION

The fractures of the distal tibia metadiaphyseal region are routinely seen because of road traffic accidents, twisting injuries, fall from height and other high energy injuries. These constitute of about 10% of the fractures of the distal tibia.[1,2] Muller defined the distal tibial metaphyseal region by constructing a square with the size of length defined by the widest portion of the tibial plafond or within 4 cm of the tibial plafond to be the distal metaphyseal injuries and defined non articular fractures as those with no extension of a fracture line into the plafond.[3]

The mechanism of injury and its prognosis are different from pilon fractures and their proximity to ankle joint makes surgical treatment complicated.[4] Most of these fractures are associated with fracture displacement, comminution, and injury to soft tissue envelope.[5] Distal tibial metaphyseal fractures of Arbeitsgeminschaft fur Osteosynthesefragen (AO) type 43A1, 43A2 and 43A3 are

of tibia is particularly prone for delayed and non-union because of their precarious blood supply.[2]

Their management has certain peculiarities which make this fracture vulnerable to end up in complications.

These are distal part of locomotive system, its inherent instability, bone is subcutaneous in whole extent with minimal soft tissue cover often comminuted, blood supply is poor, fracture is often associated with breech of soft tissue, salvage procedure have high failure rates.

These fractures are usually associated with very bad soft tissue injury, demand surgical management, ideally reduction with internal or external fixation. Due to subcutaneous location of distal tibia, open fractures are more complicated to manage when compared to other long bones.[6-10] Management of distal tibia fractures are more complex, because large soft tissue injury and frequently interrupt vascularity at fracture site which leading to increase rate of complications (infection, non-union or delayed union).[11]

Locking compression plate (LCP) of tibial fractures was first described in the 1880‟s by Hansmann in Germany. Karlstrom in 1972, in treating 135 tibial fractures showed 90% good results with plating. It has been accepted since then but gained popularity with introduction of dynamic compression plate by AO group. Ideal fractures are transverse fractures and should be preferably done away from subcutaneous surface of tibia.

Plating is the most difficult of the four main methods (circlage wiring, screw fixation (interfragmentary screw fixation), plates and screws, intramedullary nailing) of treating tibial fractures. It requires open surgery and the location of the incision and careful handling of the soft tissues are vital to minimize complications. No matter how much care is taken, however, soft tissue damage and periosteal stripping is inevitable and this is a particular problem in comminuted or open fractures. It is more important to remember that the popularity of plating preceded the widespread use of free flaps and local fasciocutaneous flaps. Thus, surgeons often resorted to direct closure or healing by secondary intent after plate fixation. It is therefore not surprising that the results of plating severe open fractures were uniformly poor.

In recent years, plates have been developed as that they have less periosteal contact. There is laboratory evidence that these may be advantageous when compared with the traditional dynamic compression plates. The recent development of locking plates has potentially increased the scope of plating as treatment for proximal and distal tibial fractures. These plates will mainly be used for extraarticular plateau and plafond fractures rather than for diaphyseal fractures, but as the definition of an extra-articular metaphyseal fracture becomes a diaphyseal fracture is a little vague, their use will be described. In these plates, the screws are locked into the plate by a screw mechanism. They undoubtedly provide superior fixation in osteopenic bone, as all the screws must loosen for the plate to fail. They are therefore particularly useful in treating proximal tibial fractures in the older patients. The plates can be used with unicortical or bicortical screws, the latter is more useful in elderly patients.

Intramedullary nailing (IMN) is the most accepted surgical treatment modality. Healing is rapid with abundant callus. These are load sharing devices hence implant induced osteopenia is not encountered. Intramedullary nails, such as Lottes and Ender nails, used without reaming, have been employed successfully in the treatment of open tibial fractures and have been associated with low rates of post-operative infection. They are, however, contraindicated for comminated fractures, as there tends to be shortening or displacement of such fractures around these small nails. The locking of intramedullary nails to the major proximal and distal fragments decreases the prevalence of malunion of comminated fractures. Until recently, however, all interlocking intramedullary nailing involved reaming, which destroys the endosteal blood supply. The rate of infection after treatment of open tibial fractures with intramedullary nailing with reaming has been relatively high, causing most investigators to discourage the use of this technique for grade III open tibial fractures.

The study was conducted to illustrate functional outcome of distal extra articular tibia fracture while comparing its management between intramedullary nailing and LCP.

METHODS

This was a prospective where in consecutive cases of distal tibia fractures, which presented to Sanjay Gandhi Institute of Trauma and Orthopedics, Bengaluru between the period of November 2019 to September 2021 were included. After obtaining permission from the institutional ethics committee.

Sample size

We estimated based on the outcome, the mean AOFAS score at follow up as 96.3±2.8 (92-100) among patients with distal tibia extra articular fracture from the study by Guo et al.[21] Considering SD of 2.8 at 5% alpha error and at 95%. Confidence level of sample size of 85 was obtained and will be included in the study.

Formula used

$$Sample\ size = \frac{Z1 - \alpha/2SD2}{d^2},$$

where,

Z1-a/2=standard normal variate as mentioned in previous section, SD=standard deviation of variable; value of standard deviation can be taken from previously done study or through pilot study, D=absolute error or precision

as mentioned in previous section z- at 15% alpha error=1.96,

SD=2.8

d=1% error,

N=40.

Hence 40 subjects were included in the study.

20 cases of distal tibia fractures for each LCP fixation and IMN fixation were taken up for the study at Sanjay Gandhi Institute of Trauma and Orthopedics, Bengaluru.

Inclusion criteria

Patients aged more than 18 years in either sex; patients with closed distal extra articular fracture of tibia as per AO classification (43A1, 43A2, 43A3);[3] patients willing for written informed consent were included in the study.

Exclusion criteria

Patients with pathological fracture, open fracture, fracture with implant failure, old neglected fractures, fracture associated with other ipsilateral fracture limb; patients not willing to give written consent were excluded from the study.

RESULTS

During the period between November 2019 to September 2021, 40 cases were studied in which 20 patients were treated with locking compression plate and 20 patients were treated with intramedullary nailing for distal tibia fractures. Out of the 40 cases treated in this manner, all cases were available for the follow up for a period of 1 year.

Table 1: Comparison of the mean age between the groups using independent sample t test.

Groups	N	Minimum	Maximum	Mean	S.D	Meandiff	P value
Nail	20	23	72	42.2	11.879	1.4	0.71
Plate	20	29	75	49.1	11.187		

Table 2: Distribution of the subjects based on gender.

Gender		Groups		Total
		Nail	Plate	
Female	Count	6	8	14
	%	30.0	40.0	35.0
Male	Count	14	12	26
	%	70.0	60.0	65.0
Total	Count	20	20	40
	%	100.0	100.0	100.0

Chi-square value- 0.44, p value-0.507

Table 3: Distribution of the subjects based on fibula involvement.

Fibula		Groups		Total
		Nail	Plate	
No	Count	17	5	22
	%	85.0	25.0	55.0
Yes	Count	3	15	18
	%	15.0	75.0	45.0
Total	Count	20	20	40
	%	100.0	100.0	100.0

Chi-square value-14.54, p-0.00*.

An average age of the study patients was 49.1 years for plating group and 42.2 years for nailing group (Table 1).

In our study, plating group consisted of 12 (60%) were male patients and 8 (40%) were of female patients and nailing group consisted of 14 (70%) were male patients and 6 (30%) were of female patients associated with distal tibia fractures (Table 2). Road traffic accident was the most common mode of injury (85%) for plating group and (95.0%) for nailing group. All the cases were of closed fractures. 15 (75%) cases were associated with fibula fracture in plating group and 3 (15%) cases in nailing group (Table 3). Average duration of surgery was 96 minutes for plating and 69 minutes for nailing. Mean radiological union was at 15.95 weeks for plating and

15.60 for nailing (Table 4, 5). Most of cases had mild pain after complete radiological union i.e., 11 (55%) in plating and 18 (90%) in nailing group. The mean AOFAS score was 83.7 for plating and 88.5 for nailing at final follow up of 1 year (Table 6).

Table 4: Comparison of the duration of surgery between the groups using independent sample t test.

Groups	N	Minimum	Maximum	Mean	SD	Mean diff	P value
Nail	20	60	90	69.00	9.119	9.00	0.14
Plate	20	70	120	96.00	17.889		

Table 5: Comparsion of the duration for radiological union between the groups using in dependent sample t test.

Groups	N	Minimum	Maximum	Mean	SD	Mean diff	P value
Nail	20	12	22	15.60	2.836	-1.85	0.037*
Plate	20	12	22	15.95	2.892		

*Significant

Table 6: Comparsion of the AOFAS between the groups using independent sample t test.

Time intervals	Groups	Minimum	Maximum	Mean	SD	Meandiff	P value
3 months	Nail	65	84	77.35	4.671	-0.30	0.85
	Plate	66	84	75.35	5.393		
6 months	Nail	72	94	82.5	4.85	0.35	0.83
	Plate	68	88	79.05	5.042		
1 year	Nail	80	96	88.5	4.594	-0.50	0.81
	Plate	68	96	83.7	7.753		

Complications were encountered in 4 patients, 2 patients had superficial wound infections, 1 patient had deep infection, and another had persistent ankle pain in plating group and 2 patients had superficial wound infection in nailing group. No cases showed malunion or nonunion in both plating as well as nailing group. Overall results by 1 year follow up showed excellent in 7 cases (35%), good in 13 cases (65%) in nailing group and in plating group showed excellent in 4 cases (20%), good in 12 cases (60%), fair in 3 cases (15%) and poor in 1 case (5%).

DISCUSSION

Our study was a prospective observational study, consists of 40 consecutive cases of distal tibia fractures after satisfying inclusion and exclusion criteria and operated with distal tibia medial LCP and intramedullary nailing at Sanjay Gandhi institute of trauma and orthopaedics from November 2019 to September 2021. Functional outcome was assessed using American orthopedic foot and ankle society score (AOFAS).

Distal tibial fractures plan of management depends on the fracture pattern, patient co-morbidity, soft tissue injury, fixation resources, and surgical experience.

In our study mean age of the patients was 42 years for plating and 49 years for nailing, ranging from 23 years to 72 years for plating and 29years to 75 years for nailing which was similar with other studies. Vidovic et al mean age was 40.1, Duckworth et al mean age was 42.[12] Hence, we conclude that distal tibia fractures were more common on middle aged population.[13]

In our study, plating group consisted of 12 (60%) were male patients and 8 (40%) were of female patients and nailing group consisted of 14 (70%) were male patients and 6 (30%) were of female patients associated with distal tibia fractures, which male preponderance which similar with other studies In Bhat et al study 76% of male preponderance and in Hong et al were 66% male patients.[14] These because males are attributed to the higher physical activity, thereby predisposing them to the injury.[15]

The mode of injury was RTA for 17 (85%) cases, 3(15%) cases had history of self-fall in plating group and RTA for 19 (95%) cases, 1 (5%) case had history of self-fall in nailing group. Almost all the literature on distal tibia fractures points towards road traffic accident as the most common mode of injury.

Most of the distal tibia fracture is associated with fibula fractures.[16] If the fracture within 7 cm from tibia plafond, requires fixation.[17] The first principle of management of distal tibia fractures by Ruedi and Allgower was restoration of fibular length which remains vital to obtaining good results. In our study 75% (15) in plating group and 15% (3) in nailing group patients with distal tibia fractures were associated with fibula fracture, which means 7 cm from the tip of lateral malleoli and fibula was fixed before distal tibia. All the fibula fractures were united without any complications. In our study AO type 43A2 was most common in plating group, 10 (50%) and

43A1 was most common in nailing group, 13 (65%) followed by 9 (45%) 43A3 type and 1 (5%) 43A1 type in plating group and 7 (35%) 43A2 type in nailing group.

Average surgical procedure timing was 96 minutes (range 70-120 minutes) for plating group and 69 minutes (range 60-90 minutes) for nailing group in our study. In Bhat et al study showed 76 minutes.[18] In CW study showed 86 minutes.[19]

The average time for radiological fracture union in our study was 15.95weeks in plating group and 15.60 weeks in nailing group. Bhat et al study on closed distal tibia fractures treated with LCP.[18] In this study all the fractures united at an average duration of 16.8 weeks ranging from 12 to 30 weeks. In Sonnet et al study showed mean union time as 15.42 weeks and Lau showed mean union time as 18.7 weeks.[20,21]

AOFAS score in our study was consistent with multiple studies. Final score was calculated after complete union at minimum 12 month of follow up. Mean AOFAS score improved from 75.35 (at 3 month) to 79.05 (at 6 month) and 83.7 (at 1 year) for plating group and for nailing group it was 77.35 (at 3 month) to 82.5 (at 6 month) and 88.5 (at 1 year). Sonnet et al AOFAS score at 1 year was 87.5.[20] Chen et al mean AOFAS score at the end of 1 year 87.8 and Bhat 143 study showed 83.6.[22] Duckworth study had showed 76.2 at the end of 1 year.[13] The final AOFAS score at the end of 1 year was similar with the previous studies.

In our study 16 cases treated with LCP and 18 cases treated with IMN had fracture union without any complications.

Superficial wound complication infections were reported in 2 (8%) cases, 1 patient had post- operative blebs, another 1 had superficial infection which responded to culture specific intravenous antibiotics and daily nonadhesive dressing. There was 1 incidence of deep surgical site infection resulted in exposure of implant after post-operative day 8 which was treated with local flap cover and 3 weeks of culture sensitive antibiotics. Another patient had persistent ankle pain and diagnosed as post traumatic arthritis treated with NSAIDS, and physiotherapy. Superficial wound complication is the most common post-operative complication in LCP fixation as pointed out by multiple studies. To comment accurately on secondary arthritis long term follow-up is required.

2 out of 20 (10%) patients in IMN group had superficial infection which responded to culture specific intravenous antibiotics and daily non adhesive dressing. Duckworth (14) study had similar complications that is 8% of study group had each superficial and deep wound infections.

CONCLUSION

According to this study, 40 patients with distal extra articular tibia fracture have undergone plate osteosynthesis and IMN (20 patients each). The age group of the patients in this study were above 18 years, ranged from 23 to 75 years average being 45 years. Most patients (36 out of 40) sustained fracture following RTA. Average operating time time was 90 minutes for IMN and 120 minutes in LCP. Post operatively physiotherapy was started and partial weight bearing was started within 6-8 weeks, full weight bearing at 12 weeks depending on radiological union, there was no malunion in plating and nailing group, there was superficial wound infection in patients in nailing group and patients in plating group. Although there is no significant difference was seen between IMN and LCP fixation group with regards to the union rate, union time, operation time, post-operative complications such pain, malunion, superficial and deep wound infections. Plating is superior to nailing in preventing malunion and intramedullary nailing is inclined in reducing wound complications. Though plate fixation helps to achieve anatomical fixation and widely used in past years, but this method requires extensive exposure with soft tissue and periosteal damage and IMN group was associated with lesser duration of surgery, earlier weight bearing and union rate, lesser incidence of infection and implant irritation which makes it a preferable choice for fixation of extra-articular distal tibial fractures.

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REFERENCES

1. Fan CY, Chiang CC, Chuang TY, Chiu FY, Chen TH. Interlocking nails for displaced metaphyseal fractures of the distal tibia. Injury. 2005;36:669-74.
2. Ovadia DN, Beals RK. Fractures of the tibial plafond. J.Bone Joint Surg Am. 1986;68, 543-51.
3. Müller ME, Nazarian S, Koch P, Schatzker J. The Comprehensive Classification of Fractures of Long Bones. Verlag Berlin Heidelberg Springer Verlag Berlin Heidelberg. 1990.
4. Sarmiento A, Latta LL. 450 closed fractures of the distal third of the tibia treated with a functional brace. Clinical orthopaedics and related research. 2004;(428):261-71.
5. James FKLA. AO Principles of fracture management 2nd ed. Thomas PR RE, Christopher GM, ed, editor: Thomas PR, Richard EB, Christopher GM, ed. 2007.
6. MV N. Textbook of orthopedics and traumatology. 7th ed: Wolter kulwer health (India). 2011.
7. Court-Brown CM< Christie J, McQueen MM. Closed intramedullary tibial nailing. Its use in closed and type I open fractures. J Bone Joint Surg Br 1990;72:605-11.
8. Williams TM. External fixation of tibial plafond fractures: is routine plating of the fibula necessary? J Orthop Trauma. 1998;12:16-20.
9. Dogra AS, Ruiz AL, Thompson NS, Nolan PC. Dia-metaphyseal distal tibial fractures--treatment with a

shortened intramedullary nail: a review of 15 cases. Injury. 2000;31:799-804.
10. Nork SE. Intramedullary nailing of distal metaphyseal tibial fractures. J Bone Joint Surg Am. 2005;87:1213-21.
11. Egol KA. Does fibular plating improve alignment after intramedullary nailing of distal metaphyseal tibia fractures? J Orthop Trauma. 2006;20:94-103.
12. Duckworth AD, Jefferies JG. Type C tibial pilon fractures: short- and long-term outcome following operative intervention. Bone Joint J. 2016;98-B(8):1106-11.
13. Kumar A, Charlebois SJ, Cain EL. Effect of fibular plate fixation on rotational stability of simulated distal tibial fractures treated with intramedullary nailing. J Bone Joint Surg Am. 2003;85:604-8.
14. Hong. Posteromedial anatomical plate for the treatment of distal t ibial fractures with anterior soft tissue injury. Orthopedics. 2011;34(6):161.
15. Blick, Ray A, Stern R. The extensile approach for the operative treatment of highenergy pilon fractures: surgical technique and soft-tissue healing. J Orthop Trauma. 2007;21(3):198-206.
16. Koval KJ, Lurie J, Zhou W, Sparks MB, Cantu RV, Sporer SM, et al. Ankle fractures in the elderly: What you get depends on where you live and who you see. J Orthop Trauma. 2005;19(9):635-9.
17. Kumar A, Charlebois SJ, Cain EL. Effect of fibular plate fixation on rotational stability of simulated distal tibial fractures treated with intramedullary nailing. J Bone Joint Surg Am. 2003;85:604-8.
18. Bhat R1, Wani MM, Rashid S, Akhter N. Minimally invasive percutaneous plate osteosynthesis for closed distal tibial fractures: a consecutive study based on 25 patients.Eur J Orthop Surg Traumatol. 2015;25(3):563-8.
19. Sönmez MM, Gülabi D. Minimal invasive fixation of distal tibial fractures does not result in rotational malalignment: A report of 24 cases with CT imaging.Ulus Travma Acil Cerrahi Derg. 2017;23(2):144-9.
20. Bisaccia M. Management of distal extra articular tibia fracture “between 2009-2015 on 81 patients.
21. Guo JJ, Tang N, Yang HL, Tang TS. Aprospective, randomized trial comparing closed intramedullary nailing with percutaneous plating in treatment of distal metaphyseal fractures of tibia. J Bone Joint Surg Br. 2010;92-B:984-8.
22. Ayeni JP. Pilon fractures of the tibia: a study based on 19 cases. Injury. 1988;19(2):109-14.

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