ECRONICON OPEN ACCESS

EC ORTHOPAEDICS
Research Article

A Comparative Study of Surgical Management of Distal Tibial Fractures Treated with Locking Compression Plate by Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) and Expert Tibial Nail

Venkatesh Gupta SK[1], Veer Abhishek Goud[2] and Kartavya Chaudhari[2]*

[1]*Professor, Department of Orthopaedics, JJM Medical College, Davangere, Karnataka, India*

[2]*Post-Graduate, Department of Orthopaedics, JJM Medical College, Davangere, Karnataka, India*

***Corresponding Author:** Kartavya Chaudhari, Post-Graduate, Department of Orthopaedics, JJM Medical College, Davangere, Karnataka, India.

Received: May 11, 2018; **Published:** August 31, 2018

Abstract

Background: Distal dia-metaphyseal tibia fractures being unique are one of the most challenging fractures to treat. Factors to be considered for selecting treatment method are location of fracture, comminution, unstable and compound fracture, condition of soft tissue, treatment method and quality of reduction. Numerous treatment options are available like cast, ORIF with plating, intramedullary nail, external fixator etc. in which LCP by MIPPO and expert tibial nail are some of the recent advances.

Methodology: The study was conducted in department of orthopaedics, J.J.M. Medical College, attached to Bapuji hospital and Chigateri General hospital, Davangere between May 2015 to April 2017. There were 56 patients with distal tibia fractures out of which 30 patients were treated with LCP by MIPPO and 26 patients were treated with Expert Tibial Nail and followed up for one year with clinical and radiological assessment based on ankle scoring system (Olerud and Mollander).

Results: During the study period 56 patients were treated with either LCP by MIPPO or Expert tibial nail and followed up at 6 weeks, 12 weeks, 6 months and 1 year with x-ray and ankle scoring system. In patients treated with LCP by MIPPO, complete union was achieved in 28 (93%) cases in less than 20 weeks with ankle score ranging between excellent and good in majority of the patients. Postoperative complications were also seen in 9 patients including 2 delayed union, 3 skin infections, 3 ankle stiffness and 1 anterior angulation of 5°. Hence, 63% had excellent results, 26% had good, 7% had fair and 4% had poor results.

26 patients treated with expert tibial nail were analysed, out of which 22 cases (85%) had union in less than 20 weeks, 4 cases (15%) had delayed union and no cases had non-union. Hence, 54% had excellent results, 27% had good, 11% had fair and 8% had poor results.

Conclusion: LCP by MIPPO is a safe, effective and reliable treatment option to achieve complete union of difficult tibia fracture. But for fracture in distal tibia higher than level of Kveim's/AO square, Expert tibial nail is a better option to prevent plate related complications.

Keywords: *Distal Tibial Fracture; Locking Compression Plate (LCP); Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO); Expert Tibial Nail*

Introduction

Distal dia-metaphyeal tibial fractures with or without intra-articular extension are one of the most challenging fractures to manage [1,2]. Distal dia-metaphyseal tibial fractures are unique because of proximity to ankle joint, subcutaneous location and precarious blood supply. Distal tibia fractures are very close to ankle joint hence there is all chance for fracture line to extend into the joint. Also distal tibia is located subcutaneously with decreased muscular cover and often these fractures are unstable and comminuted fractures. These fractures make about 8 - 10% of all lower extremity fractures [3].

Because of the above mentioned points, distal dia-metaphyseal tibia fractures are one of the most challenging fractures to treat. Outcome depends on factors like type of fracture, condition of soft tissue, method of treatment and quality of the reduction. Treatment options for these fractures ranges from conservative to surgical interventions like using external fixation, closed reduction and intra medullary inter locking (IMIL) nailing or open reduction and internal fixation (ORIF) and plating [4].

Conservative treatment methods have been associated with complications including malunion, nonunion and ankle stiffness, etc. [5,6] Conventional methods of distal tibia fracture fixation like open reduction and rigid internal fixation when used for the management, a high rate of good to excellent results have been reported [7]. However, this technique has not produced consistent outcomes and has a high incidence of complications including infection, poor wound healing and non-union [8]. These fractures are generally not suitable for intramedullary nailing, despite certain reports indicating satisfactory results in some of these fractures [9]. External fixation can be used as either a temporary or definitive method of treatment, especially in fractures with severe soft tissue injury, but malunion and delayed union continue to be the main problems with this method of fixation [10,11].

Conventional plate osteosynthesis with open reduction can therefore further devitalise fragments and lead to higher incidence of nonunion, infection and implant failure [12]. Therefore, minimally invasive osteosynthesis, if possible, offers the best possible option as it permits adequate fixation in a biological manner [13,14]. Compared with a conventional plate, a locking plate imparts a higher degree of stability and provides better protection against primary and secondary loosening of reduction and minimization of bone contact [15,16]. Locking plates have the biomechanical properties of internal and external fixators, with superior holding power because of fixed angular stability through the head of locking screws, independent of friction fit [17]. In addition, it is possible to use these plates in a minimally invasive technique without fear of secondary displacement in the absence of perfect contouring. Due to their biomechanical properties of fixation, locking plates are particularly useful in severely comminuted and fragility fractures [18].

Intramedullary interlocking can be done with closed technique alleviating the drawbacks of plating techniques. Intramedullary nailing has been seen to be an acceptable and effective method of treatment as closed intramedullary nailing has been made possible by image intensifier. Intramedullary interlocking nail is a device which is stiff to both axial and torsional forces. Intramedullary nails such as Lottes and Enders nails, without reaming have been successfully employed for this purpose. But in case of comminuted fractures they are contraindicated as they may cause shortening or displacement of fracture around these small nails.

The advantages are it provides a sleeve around fracture site so that early motion of adjacent joints are made possible and also it causes minimal soft tissue damage. As the nails are locked proximally and distally, length, alignment and rotation of fracture fragment in unstable fractures can be controlled. Intramedullary nailing is associated with minimal soft tissue dissection leading to less disruption of fracture hematoma when compare to other forms of internal fixation.

Expert tibial nail is a newer implant developed as an adaptation of regular tibial interlocking nail specially designed for metaphyseal fractures, for providing additional biomechanical stability than the conventional nails. Expert tibial nails are designed with several technical modifications compared to standard tibial nails. It has several proximal and distal locking options and hence, provides stabilization

of metaphyseal fragments. It has 5 locking options proximally and 4 locking options distally in various planes. It has multiple proximal and distal locking options and hence provides stabilization of metaphyseal fragments and hence can be used in case of complex fracture situations. Angular stability between proximal oblique screw and nail is provided by the end cap. These modifications in the design of the implant gives promising results in achieving stable fixation and hence reducing the risk of secondary malalignment.

Materials and Methods

This study was conducted from May 2015 to April 2017 on patients having distal tibia fractures with or without intraarticular extensions. This study included 56 patients with fracture of distal third tibia above 18 yrs of age and with closed, displaced and unstable fracture presenting to orthopaedics department who were treated with expert tibial nail and LCP by Minimally Invasive Percutaneous Plate Osteosynthesis. This study excluded patients with pathological fracture, compound fracture, tibial shaft fracture, fractures with neurovascular injury, deformities around ankle, fractures leading to compartment syndrome, patients < 18 years (skeletally immature).

X-Rays were taken for all patients and the fractures were classified according to AO/OTA classification. We had 26 patients with fractures of type A2, 23 patients with fractures of type A1, 5 patients with fractures of type A3 and 2 patients with fractures of type C1.

After routine investigations and clinical evaluation and consent for surgery, patients were taken for surgery.

Surgical technique

LCP by MIPPO (Figure 1): After administration of spinal anaesthesia, patients were operated in supine position, on a radiolucent table. For all cases, tourniquets were applied.

We used medial approach to operate these distal tibia fractures. A 2 - 3 cm vertical incision was made starting at a level of medial malleolus. Then we deepened the incision till periosteum and periosteum was preserved. Using bristo elevator a submuscular epiperiosteal tunnel was created along the medial aspect of tibia. Then to medial aspect of distal tibia, a plate was placed and its position was checked by using image intensifier in anteroposterior and lateral views. Plate was fixed temporarily with k-wire and distal and proximal locking was done. Fixation of Fibula is done only if it is within 8 cm from level of syndesmosis [24].

Mobilized with standard walking frame with non-weight bearing on operated limb from the first postoperative day under supervision of physiotherapist. Partial weight bearing was started once callus was visible on x-ray and gradually increased according to clinical and radiological signs. Follow up was done at 6 weeks, 12 weeks, 6 months and 1 year. Olerud and Mollander scoring system was used in this study to assess the results.

Plate insertion with k wire fixation on both ends

Intraoperative images

Wound 2nd postoperative day

Figure 1: *LCP by MIPPO.*

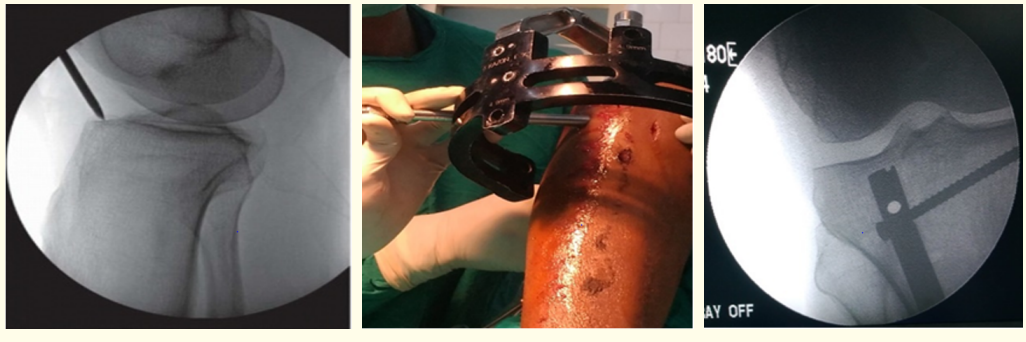
Expert Tibial Nail (Figure 2): All patients were operated under spinal anesthesia, with patient supine on the radiolucent operating table. The affected leg was positioned freely with knee in 90 degree flexion to relax gastrocnemius, soleus and allow traction due to gravity.

In all cases vertical patellar tendon splitting incision was used. In the A.P. view the entry point is parallel with the axis of the intramedullary canal and with the lateral tubercle of the intercondylar eminence. In lateral view the entry point is at the anterior edge of the tibial plateau. After choosing the insertion point, a curved bone awl is used to create an entry point in a curved manner so that its handle comes to be parallel to shaft of tibia. The ball tipped guide wire is passed into the medullary canal of proximal fragment and the fracture fragments is reduced under image intensifier by maintaining longitudinal traction in the line of tibia.

After reduction of fracture, the ball tipped guide wire is adjusted so as to pass in the distal fragment till 0.5 - 1 cm above the ankle joint under C-arm guidance. Medullary canal is then reamed starting from 8 mm reamer size to 0.5 to 1 mm larger than the diameter measured using radiographs. Then the ball tipped guide wire is exchanged with smooth guide wire using the Teflon tube. Next step is to pass an assembled nail into the medullary canal over the smooth guide wire.

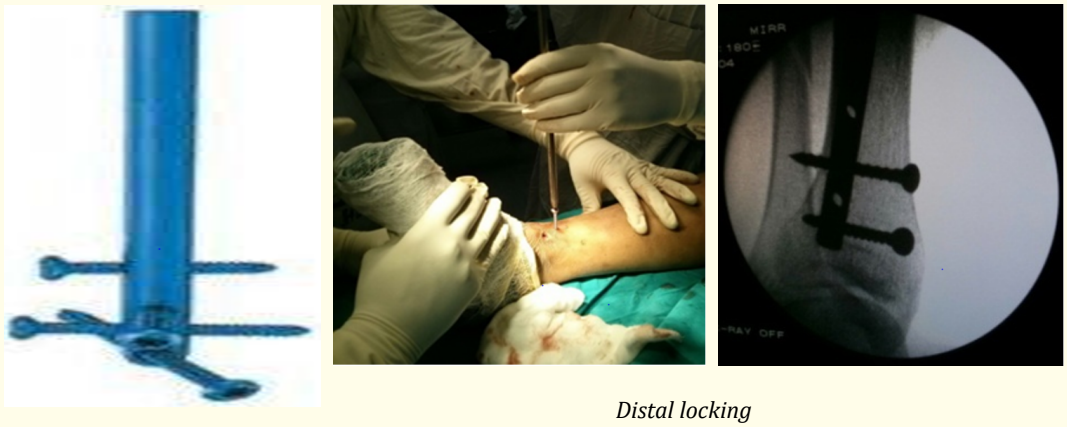
Nail mounted to its jig and is pushed as far as possible over the guide wire. Routinely we prefer proximal locking first, but if gap is present at the fracture site we carried out distal locking first, which enables the use of the rebound technique or back slap technique to prevent distraction and to achieve compression at fracture site.

Distal locking using a free hand technique with an image intensifier which provides a convenient method for targeting the distal locking holes. In Expert tibial nail there are 4 distal locking holes, 2 in medial to lateral plane, 1 in oblique and 1 in anterior to posterior plane.



Entry Point

Proximal locking



Distal locking

Figure 2: *Expert Tibal Nail.*

Results

The present study consists of 56 cases of fracture of the distal dia-metaphyseal end of tibia. 30 cases were fixed using MIPPO with locking compression plate and 26 cases with expert tibial nail. The study period was from May 2015 to April 2017.

The patients were aged 23 - 65 years with fractures being most common during their 4th and 5th decade of life. Majority of patients were males, 37 (66%) and there were 19 (34%) females. Most of the fractures were due to RTA, 32 (57%) and 24 (43%) of patients sustained injuries following fall.

In LCP by MIPPO group, the average duration of surgery was 55.5 minutes [range 41 - 70 minutes]. Fractures united with an average of 19 weeks [range 14 to 24 weeks]. Three patients developed superficial skin infection, which resolved with short course of antibiotic therapy and local wound care. Ankle stiffness was present in 3 cases. The ankle stiffness ranged from restriction of ankle movement from 20 - 40%. There were anterior angulation of 5° in one case. The range of motion and functional scoring was good in the following case. 2 fractures progressed for delayed union and they united by 24 weeks. One case had around 40% ankle stiffness and with a poor functional outcome.

In Expert Tibial Nail group, 22 (85%) cases had solid union in less than 20 weeks, 4 (15%) cases had delayed union and there was no case of non-union. Superficial infection were encountered in 2 cases, ankle stiffness in 2 cases, anterior angulation of 5° in 2 cases and anterior knee pain in 10 cases and implant failure in 1 case.

Age	No. of Patients in LCP by MIPPO	No. of patients in Expert tibial nail
21 - 30	1	1
31 - 40	7	7
41 - 50	11	7
51 - 60	7	6
61 - 70	4	5
Total	30	26

Table 1: *Age distribution.*

Sex	No. of Patients in LCP by MIPPO	No. of Patients in Expert tibial nail
Male	20	17
Female	10	9
Total	30	26

Table 2: *Sex distribution.*

Side	No. of Patients in LCP by MIPPO	No. of Patients in Expert tibial nail
Right	19	15
Left	11	11
Total	30	26

Table 3: *Side affected.*

Mode of Injury	No. of Patients in LCP by MIPPO	No. of Patients in Expert tibial nail	total
RTA (High energy)	18	14	32
Fall (Low energy)	12	12	24
Total	30	26	56

Table 4: *Mode of injury.*

Type	No. of patients in LCP by MIPPO	No. of Patients in Expert tibial nail	Total
Al	10	13	23
A2	16	10	26
A3	3	2	5
B1	0	0	0
B2	0	0	0
B3	0	0	0
CI	1	1	2
C2	0	0	0
C3	0	0	0

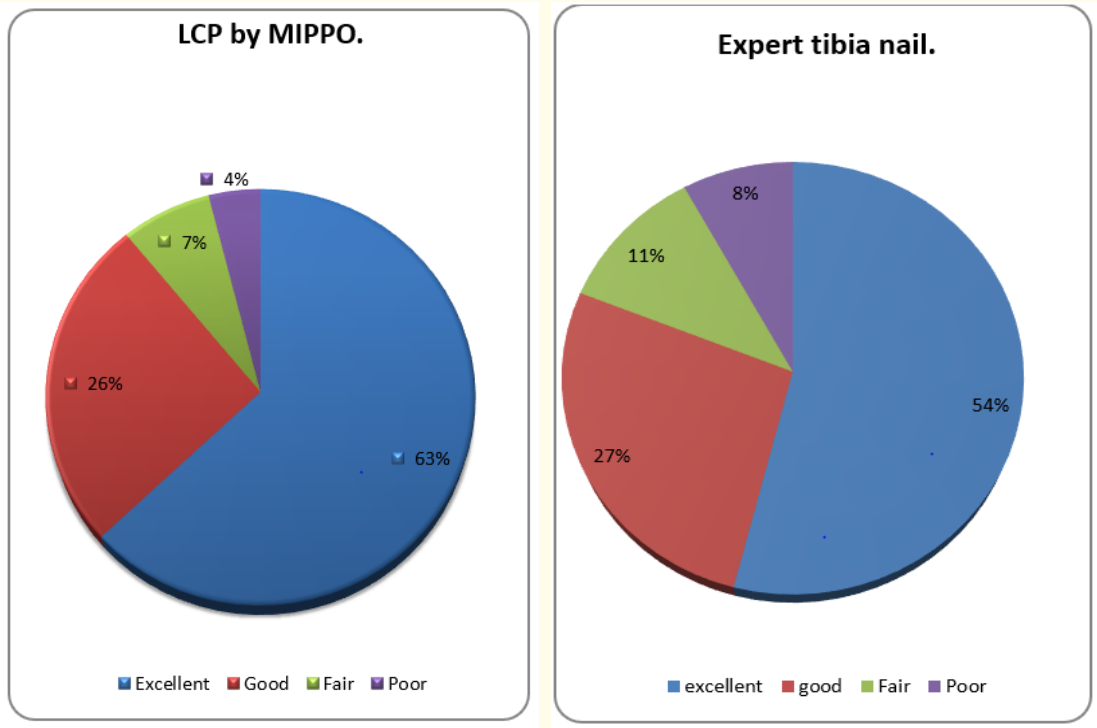
Table 5: *Fracture pattern.*

Duration (in weeks)	No. of Patients in LCP by MIPPO	No. of Patients in Expert tibial nail
14	2	1
16	4	3
18	12	8
20	10	10
24	2	4
Total	30	26

Table 6: *Duration of fracture union.*

Rating	Ankle/subtalar motion	Tibiotalar alignment	Tibial shortening	Chronic swelling	Pronation/supination	Equines deformity
Excellent	> 75% normal	Normal	None	None	Normal	None
Good	50 - 75%	Normal	None	Minimal	Normal	None
Fair	25 - 50%	< 5^0 angulation	< 1 cm	Moderate	Moderate decrease	None
Poor	< 25%	> 5^0 angulation	> 1 cm	Severe	Marked decrease	Present

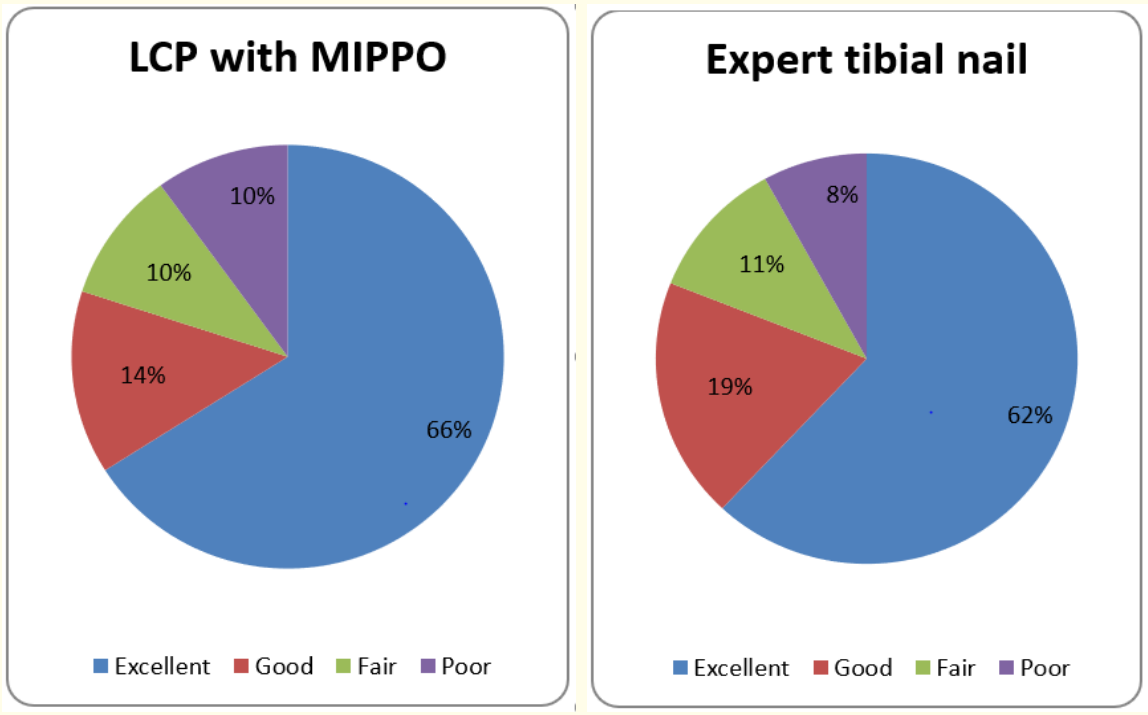
Table 7: *Objective criteria.*



Graph 1: *Objectives results.*

Rating	Pain	Return to work	Recreational activity	Limited walking	Pain medication	Limp
Excellent	None	Same work	Normal	No	None	None
Good	Mild	Same work	Mild modification	No	None	None
Fair	Moderate	Modified	Significant modification	Yes	Non-narcotic	Occasional
Poor	Severe	Unable	None	Yes	Narcotic	Yes

Table 8: *Subjective criteria.*



Graph 2: *Subjective results.*

Complications	No. of patients with LCP by MIPPO	Percentage	No. of Patients with Expert tibial nail	Percentage
Superficial skin infection	3	10%	2	8%
Ankle movement restriction	3	10%	2	8%
> 75%	0		0	
50 - 75%	0		0	
25 - 50%	1		2	
< 25%	2	3%	0	8%
Anterior knee pain	0	0%	10	38%
Anterior angulation 5°	1	3%	2	8%
Delayed union	2	7%	4	15%

Table 9: *Complications.*

Results	No. of patients in LCP by MIPPO	Percentage (%)	No. of Patients in Expert tibial nail	Percentage (%)
Excellent	19	63	14	54
Good	8	26	7	27
Fair	2	7	3	11
Poor	1	4	2	8
Total	30	100	26	100

Table 10: *Objective results.*

Results	No. of patients in LCP by MIPPO	Percentage (%)	No. of Patients in Expert tibial nail	Percentage (%)
Excellent	20	66	16	62
Good	4	14	5	19
Fair	3	10	3	11
Poor	3	10	2	8
Total	30	100	26	100

Table 11: *Subjective results.*

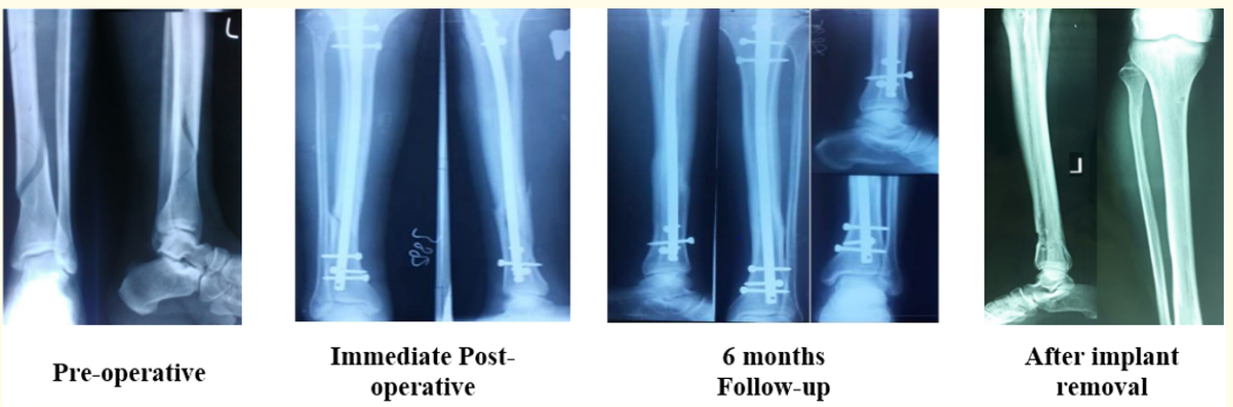


Figure 3: *Expert tibial nail.*

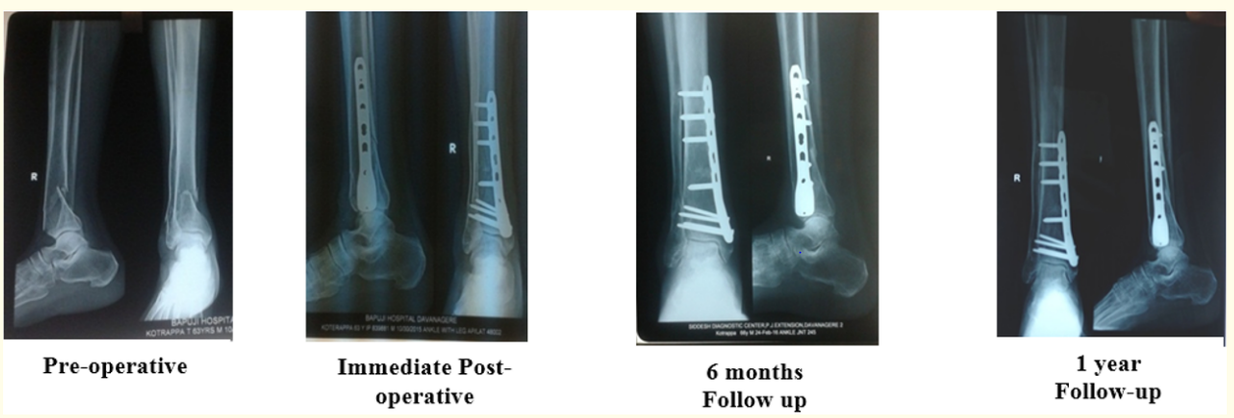


Figure 4: *Locking compression plate.*

Discussion

Distal dia-metaphyseal tibia fractures with or without intra articular extension remain one of the most substantial therapeutic challenges that confront the orthopedic traumatologist with variety of treatment options, but none of the options perfectly fulfill the best treatment modality.

Distal tibia is located subcutaneously with deceased muscular cover. Distal tibia is circular with thin cortex in cross section and the shaft of the tibia is triangular with thick cortex in cross section. So there is a mismatch between the small intramedullary canal in the diaphysis and the broad intramedullary canal in distal tibia. Therefore a distal tibia fracture will not be reduced during nail insertion as is the case in a shaft fracture. Reduction must be achieved before entering the nail in the distal fragment.

Conventional methods of distal tibia fracture fixation like intramedullary nailing techniques and external fixations minimize soft tissue trauma, but this use is complicated by malunion, non-union, implant failure, pin tract infection etc. Hence recommended only for temporary method of stabilization in open fracture with severe soft tissue injury.

As tibia is a subcutaneous bone and periosteum provides outer 2/3rd of blood supply of cortex, ORIF with conventional plate which needs strippers of periosteum has been shown to have highest rate of infection as compared to other methods of treatment. ORIF results in further devascularisation of already compromised supply because of extensive soft tissue dissection and periosteal stripping, which intend results in infection, non-union and implant failure.

Decision making before surgery is mainly dependent on local factors such as fracture configuration, quality of bone (osteoporosis) and soft tissue conditions (including open injuries and loss of skin) to reduce the risk of need for a subsequent operation, as well as costs to the health care system and it will be helpful in the practice of orthopaedics.

Rigid fixation has been shown to reduce the rate of infection, promote healing and fracture rehabilitation of open fibial factures. There is no consensus on the best method of obtaining and maintaining alignment and stability of the tibia.

Minimally invasive percutaneous plating osteogenesis (MIPPO) techniques has been now successfully used for management of fractures of distal tibia because of its technical advantage and satisfactory clinical outcomes. It is minimally invasive, causes less soft tissue disruption and damage to bone vascularity and preserves fracture hematoma and thus providing for more biological repair. MIPPO is one method that is achieved by carrying out the procedure without exposure of the fracture and by introducing the plate in a submuscular, epiperiosteal position with minimal disturbance of the vascularity of the bone fragments. It is based on principles of limited exposure, indirect reduction methods and limited contact between bone and implant. The advantages are, it minimises soft tissue injury, preserves vascular supply to bone and soft tissue, decrease periosteum damage, better healing and high union rate and presents a low complication rate compared to open reduction and internal fixation.

Hazarika., *et al*. [13], studied a series of 20 patients of distal tibial fracture treated using LCP by MIPPO technique that provided 87.5% of good to excellent results and therefore this technique is useful for definitive fixation of high energy, open or closed, peri articular distal tibia fractures with aim to preserve bone biology and minimize surgical soft tissue trauma.

Ronga., *et al.* [20], studied 19 cases of closed distal tibia fracture operated with LCP by MIPPO method with 95% union rate and less complications. So according to study, LCP-DTP by MIPPO is a better option for treatment of distal tibia fractures.

Ozkaya U., *et al*. [21] studied 22 patients treated with titanium locking compression plate by MIPPO for fracture of distal third tibia, found that this technique resulted in prolonged secondary healing both in comminuted and simple fracture patterns with an average AOFAS foot and ankle scores 81 (range 60 to 95). However, shorten shealing time is observed with non-locking contoured plate due to its relative stability.

We studied 30 patients with distal tibia fracture treated with LCP by MIPPO which had resulted in strong and effective stabilization of these fractures, and obtained 63% of excellent and 26% of good results.

Our results are comparable to studies of Hazarika., *et al*. and Ozkaya., et al. but our study has limitation as there are small numbers of cases in this study. Before selection of operative procedure, cost of the implants, availability of surgical equipment, radiation exposure and the skills and limitations of surgeons all are to be considered.

New intramedullary tibial implants have been developed due to the technical limitation of the available implants such as Unreamed Tibial Nail for the stabilisation of distal metaphyseal fractures. Proximal tibial Nail (PTN) was introduced and clinically investigated in 1999 and this nail, which is selected for fixation of proximal tibia fractures, should create enough stability to allow early active postoperative knee motion and it therefore must guarantee stable interlocking in 3 different planes in the proximal fragment.

In addition to standard medio-lateral locking options, proximal multi-directional interlocking of PTN was incorporated in which distally 2 mediolateral, 1 anteroposterior, 1 oblique multifunctional locking option were available.

Prospective multicentric clinical study was conducted in 2004. The prototype nail was modified due to combined results from different study centre by adding a 2° incline to the 8° proximal nail radius, for easies insertion and a better fit in intramedullary canal.

The modified nail became the Expert Tibial Nail and was introduced world-wide in 2005.

Rene Attal., *et al*. [22] in the study to present clinical experience and outcomes of intramedullary nailing of tibia fractures with the expert tibia nail (ETN; synthes GmbH, Switzerland). At 1 year follow up, the percentage of delayed union was 10.5% in distal third cases and the rate of malalignment > 5° in any plane 1 year after surgery was 5.5%.

Vallies HA., *et al*. [23], in his randomized, prospective comparison of plate versus intramedullary nail fixation for distal fibia shaft fractures of one hundred four skeletally mature patients with extra-articular distal tibia shaft fractures with a mean age of 38 years (range 18 - 95 years) concluded that four patients (7.1%) developed non - union after nailing versus two (4.2%) after plating (P=0.25). Primary angular malalignment of 5° or greater occurred in 13 patients with nails (23% of all nails) and four with pates (8.3% of all plates).

Conclusion

With all currently available treatment options, distal dia-metaphysical tibia fracture with or without intraarticular extension are one of the most challenging fractures to treat.

Fracture pattern, concomitant intra-articular extension, condition of soft tissue are to be considered before selection of fixation method. To minimize the complications associated with distal tibia fracture with or without intra-articular extension, fixation should be performed according to proper principles.

In this study, though cases are small in number, shows that LCP by MIPPO is an effective treatment method with better healing, high rate of union and minimum complications by causing less soft tissue disruption and preserving most of periosteal blood supply and fracture hematoma and thus providing for more biological repair in fracture of distal dia-metaphyseal region with intraarticular extension. But for fracture in distal tibia higher than the level of kveims/AO square, expert tibial nail is a better option to prevent plate related complications.

Bibliography

1. Francios J., *et al*. "Percutaneous plate fixation of fractures of the distal tibia". *Acta Orthopaedica Belgica* 70.2 (2004): 148-154.

2. Shreshta D., *et al*. "Minimally invasive plate osteosynthesis with locking compression plate for distal diametaphyseal Tibia fracture". *Kathmandu University Medical Journal* 9.34 (2011): 62-68.

3. Michael Sirkin and Roy Sanders. "The treatment of pilon fractures". *Orthopaedic Clinics* 32.1 (2001): 91-102.

4. Vasu Pai., *et al*. "Minimally invasive plate fixation of the tibia". *International Orthopaedics* 31.4 (2007): 491-496.

5. Ovadia DN and Beals RK. "Fracturs of the tibial plafond". *Journal of Bone and Joint Surgery* 68.4 (1986): 543-551.

6. Digby JM., *et al*. "A study of function after tibial cast bracing". *Injury* 14.5 (1983): 432-439.

7. Ruedi T., *et al*. "Experience with the dynamic compression plate (DCP) in 418 recent fractures of the tibial shaft". *Injury* 7.4 (1976): 252-257.

8. Schutz M and Sudkamp NP. "Revolution in plate osteosynthesis: New internla fixator systems". *Journal of Orthopaedic Science* 8.2 (2003): 252-258.

9. Janssen KW., *et al*. "Treatment of distal fractures: plate versus nail: A retrospective outcome analysis of matched pairs of patients". *International Orthopaedics* 31.5 (2007): 709-714.

10. Dickson KF., *et al*. "High energy plafond fractures treated by a spanning external fixator initially and followed by a second stage open reduction internal fixation of the articular surface - preliminary report". *Injury* 32.4 (2001): SD92-SD98.

11. Pugh KJ., *et al*. "Tibial pilon fractures: A comparison of treatment methods". *Journal of Trauma* 47.5 (1999): 937-941.

12. Fisher WD and Hamblen DL. "Prolbmes and pitfalls of compression fixation of long bone fractures: A review of resutls and complications". *Injury* 10.2 (1978): 99-107.

13. Hazarika S., *et al*. "Minimally invasive locking plate osteosynthesis for fractures of the distal tibia - results in 20 patients". *Injury* 37.9 (2006): 877-887.

14. Redfern DJ., *et al*. "Fractures of the distal tibia: minimally invasive plate osteosynthesis". *Injury* 35.6 (2004): 615-620.

15. Egol KA., *et al*. "Biomechanics of locked plates and screws". *Journal of Orthopaedic Trauma* 18.8 (2004): 488-493.

16. Kaab MJ., *et al*. "Locked internal fixator: sensitivity of screw/plate stability to the correct insertion angle of the screw". *Journal of Orthopaedic Trauma* 18.8 (2004): 483-487.

17. Ronga M., *et al*. "Minimally invasive osteosynthesis of distal tibial fractures using locking plates". *Orthopedic Clinics of North America* 40.4 (2008): 499-504.

18. Frigg R. "Development of the locking compression plate injury". *Injury - International Journal of the Care of the Injured* 34.2 (2003): B6-B10.

19. Paige A Whittle and George W Wood II. "Fractures of lower extremity". 10th edition. In: Campbell's Operative Orthopaedics". Terry S Canale, ed. Philadelphia: Mosby, Elsevier 1 (2008): 2754-2757.

20. Ronga M., *et al*. "Minimally invasive locking plating of distal tibia fractures is safe and effective". *Clinical Orthopaedics and Related Research* 468.4 (2010): 975-982.

21. Ozakaya U., *et al*. "Minimally invasive treatment of distal tibial fractures with locking and non-locking plates". *Foot and Ankle International* 30.12 (2009): 1161-1167.

22. Attal Rene., *et al*. "A multicentre case series of tibia fractures treated with the Expert Tibia Nail (ETN)". *Archives of Orthopaedic and Trauma Surgery* 132.7 (2012): 975-984.

23. Vallier Heather A., *et al*. "Randomized. Prospective Comparison of Plate versus Intramedullary Nail Fixation for Distal Tibia Shaft Fractures". *Journal of Orthopaedic Trauma* 25.12 (2011): 736-741.

24. L Busnelli., *et al*. "To fix or not to fix? The role of fibular fixation in distal shaft fractures of the leg". Injury 45.2 (2014): 408-411.

Volume 9 Issue 9 September 2018
©All rights reserved by Kartavya Chaudhari., *et al*.