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Dr. Avinash Parthasarathy
M.S. Ortho, M.Ch. Ortho (UK), Professor in Orthopaedics, Sanjay Gandhi Institute of Trauma and Orthopaedics, Bengaluru, Karnataka, India

Dr. Appasab Jaipal Murugunde
Resident in Orthopaedics, Sanjay Gandhi Institute of Trauma and Orthopaedics, Bengaluru, Karnataka, India

Dr. TH Prakashappa
D' Ortho, M.S. Orthopaedics, Professor and Head, Department of Orthopaedics, Sanjay Gandhi Institute of Trauma and Orthopaedics, Bengaluru, Karnataka, India

Dr. Anilkumar SN
Resident in Orthopaedics, Sanjay Gandhi Institute of Trauma and Orthopaedics, Bengaluru, Karnataka, India

Corresponding Author:
Dr. Appasab Jaipal Murugunde
Resident in Orthopaedics, Sanjay Gandhi Institute of Trauma and Orthopaedics, Bengaluru, Karnataka, India

A prospective study of minimally invasive percutaneous plate osteosynthesis using LCP for surgical management of distal tibia fracture

Dr. Avinash Parthasarathy, Dr. Appasab Jaipal Murugunde, Dr. TH Prakashappa and Dr. Anilkumar SN

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Abstract
Background: Management of distal tibia fracture is challenging because of wound infections and poor wound healing due to precarious blood supply. Various methods of surgical treatment had been tried, such as closed intramedullary nailing, open reduction and internal fixation with conventional plate osteosynthesis and external fixation however most of them have a high complication rate than a good functional outcome. The newer technique of distal tibia fractures fixation using MIPPO involves less soft tissue handling and minimal periosteal stripping resulting in a lower infection rate and faster healing.
Materials and Methods: In this study, 25 patients with distal tibia extra articular fractures and intra articular fractures with or without associated fibula fractures were treated with MIPPO using medial LCP. The present study was conducted in the department of Orthopaedics at a tertiary care hospital and followed up for a period of 2 years.
Results: The mean follow up period ranged from 6 weeks to 2 years. All the fractures were united at an average of 16 weeks and mean AOFAS score at the end of 1 year was 85.64. There were two superficial wound infections which were treated with oral antibiotics and there was one deep infection and another with persistent ankle pain.
Conclusion: Minimally invasive percutaneous plate osteosynthesis is a reliable method of fixation not only extra articular, but also intra articular fractures of distal tibia. MIPPO technique for the distal tibia fractures offers a biological advantage by preserving the blood supply and decreases chances of delayed or non-union. Patients treated by MIPPO technique have a much lesser rate of deep infection and excellent radiological union. MIPPO technique helps in initiating early mobilization and reduces the risk of ankle stiffness.

Keywords: Medial LCP, MIPPO, AOFAS score

Introduction
The fractures of the distal tibia metadiaphyseal region are routinely seen as a result of road traffic accidents, twisting injuries, fall from height and other high energy injuries. These fractures constitute of about 10% of the distal third tibia fractures [1]. The Distal tibia fracture have certain peculiarities which make this fracture vulnerable to end up in complications. These are distal part of the locomotive system and which is subcutaneous in whole extent with minimal soft tissue cover, blood supply is poor. Most of the time these fractures are associated with breech in the soft tissue.
These fractures are usually associated with very bad soft tissue injury and demand surgical management, ideally reduction with internal or external fixation. Due to the subcutaneous location of distal tibia, open fractures are more when compared to other long bones [2, 3]. Management of distal tibia fractures are more complex, because large soft tissue injury and frequently interrupted vascularity of the fracture site leading to increase rate of complications (infection, non-union or delayed union).
Minimally invasive percutaneous plate osteosynthesis (MIPPO) is a technique which aims to reduce iatrogenic soft tissue injury, damage to bone vascularity as well as preserving the osteogenic fracture haematoma. So our aim is to evaluate the functional outcome, union time and complications of MIPPO using medial LCP for distal tibia fractures [4].

Aim and Objectives

To study functional outcome in patients with distal tibia fractures treated by MIPPO technique using medial LCP.

Methodology

Source of data

Patients with distal tibia fractures admitted in Sanjay Gandhi Institute of Trauma and Orthopaedics, Bangaluru. This is a prospective study where in consecutive cases of distal tibia fractures, which presented to Sanjay Gandhi Institute of Trauma and Orthopaedics, Bangaluru between the period of November 2018 to September 2020 were included. Permission from the institutional Ethics committee was obtained.

Sample size

25 cases of distal tibia fractures were taken up for the study at Sanjay Gandhi Institute of Trauma and Orthopaedics, Bangaluru.

Inclusion criteria

1. Adults of (18-60) years.
2. Patients with closed and type 1 open (according to Gustilo and Anderson's classification) fractures.
3. Extra articular fracture of distal tibia AO 43A
4. Distal tibia fractures Ruedi and Allgower classifications type 1 and 2
5. Ability to understand the content of the subject information/informed consent form and to be willing to participate in the clinical investigation.

Exclusion criteria

1. Open fractures type 2 and 3
2. Pathological fractures
3. Old ankle fractures
4. Fractures in osteoporotic bone
5. Intra articular fracture of the distal tibia Ruedi and Allgower classifications type 2

Patients admitted with distal tibia fractures after meeting the inclusion and exclusion criteria were selected for the study. After prior informed consent, a pre-operative anesthetic evaluation was done. Pre-op planning of fixation was made.

Under anesthesia, subjects were put in supine position on a standard operating table. Closed reduction with minimal invasive percutaneous plate osteosynthesis (MIPPO) with locking compression plate was done under c arm guidance, standard medial approach was used. In all the cases of associated fibula fracture fixation was done using open reduction/closed reduction with plate, k wires or screws. Tibia fixation was always performed after fibula fixation.

Depending upon the strength of fixation, in a few patients a below knee slab was applied for 2 weeks and adviced non weight bearing mobilisation. Suture removal was done on 14th day. Weight bearing was started depending on the fracture configuration, callus response and associated injuries. Assessment was done at OPD following postoperative visits at 3 months, 6 months and at 1 year. At follow-up visit, patient was evaluated clinically for pain score and soft tissue status and radiologically (alignment, fracture reduction and union) Complications were noted. Based on these data the final outcome was assessed according to American orthopedic foot and ankle society score (AOFAS).

Fig 1: Incision site is marked

Fig 2: Medial approach

Fig 3: Plate was inserted and fixed to tibia with multiple K wires.

Fig 4: Final fixation of plate with screws

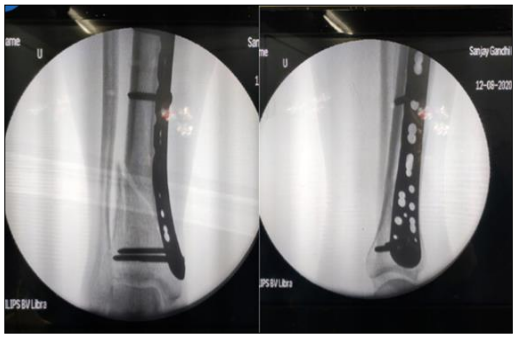

Fig 5: Fluoroscopic images

Fig 6: Wound closure

Observation and Results

A prospective study of 25 distal tibia fractures treated by locking compression plate with MIPPO technique was undertaken. Results were analyzed in terms of functional outcome of postoperative range of movement after union, time for fracture union, early and post-operative complications.

Table 1: Showing age distribution

Age distribution among study patients			
Variable	**Category**	**n**	**%**
Age	21-30 yrs.	3	12%
	31-40 yrs.	10	40%
	41-50 yrs.	10	40%
	>50 yrs.	2	8%
		Mean	SD
	Mean & SD	39.48	7.62
	Range	22 - 54	

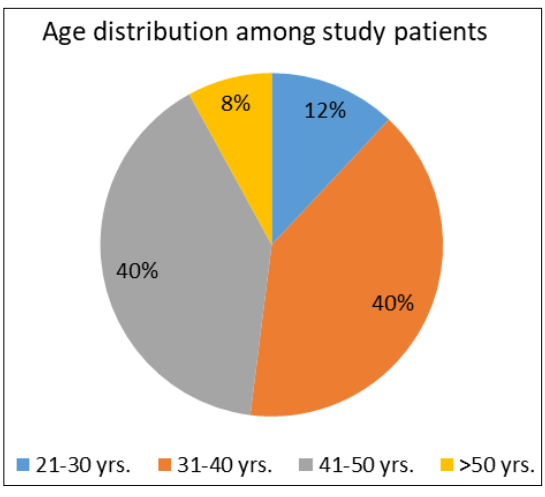

Fig 7: Graph showing age distribution

Mean age was 39.48 (SD ± 7.62).
Distal tibia fracture is more common in younger population.

Table 2: Gender distribution

Gender distribution among study patients			
Variable	Category	n	%
Gender	Males	15	60%
	Females	10	40%

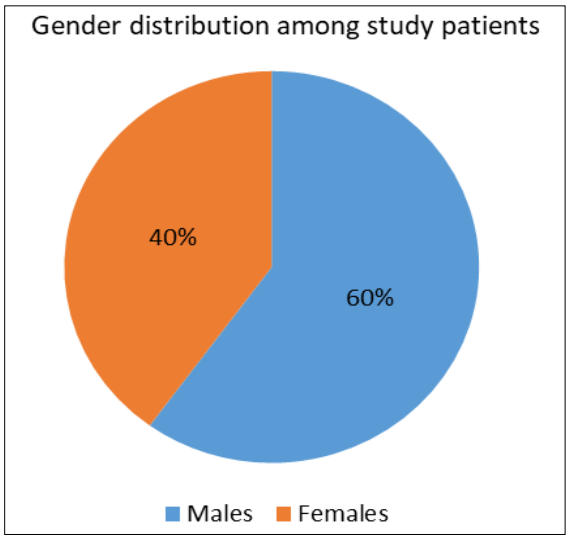

Fig 8: Graph showing gender distribution

Males were the majority patients in the study group with 60%.

Table 3: Distribution of type of injury

Distribution of nature of fracture among study patients			
Variable	Category	n	%
Fracture	Open	6	24%
	Closed	19	76%

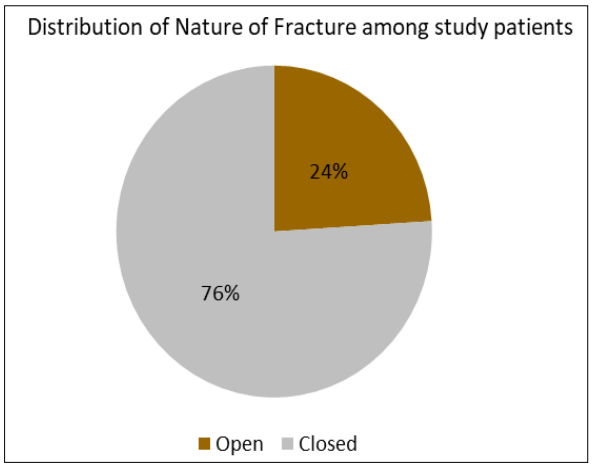

Fig 9: Distribution of type of injury

Majority of the fractures in the study group were of closed type with 76% of the study group and 24% were of type 1 open fracture (Gustilo Anderson).

Table 4: Incidence of fibula fracture

Distribution of incidence of fibula fracture among study patients			
Variable	Category	n	%
Fibula	Yes	17	68%
	No	8	32%

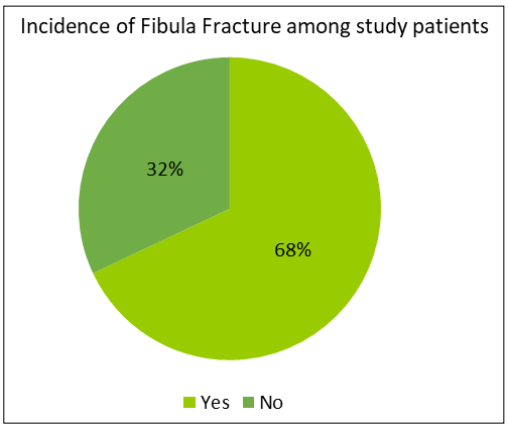

Fig 10: Incidence of fibula fracture

68% of the distal tibia fractures were associated with distal fibula fracture.
Every fibula fracture was fixed prior to tibia fixation.

Table 5: Distribution of tibia plafond fracture subtypes

Distribution of type of fracture among study patients			
Variable	Category	n	%
Type of fracture	Type A1	4	16%
	Type A2	4	16%
	Type A3	4	16%
	Type B1	2	8%
	Type B2	1	4%
	Type B3	0	0%
	Type C1	6	24%
	Type C2	4	16%
	Type C3	0	0%

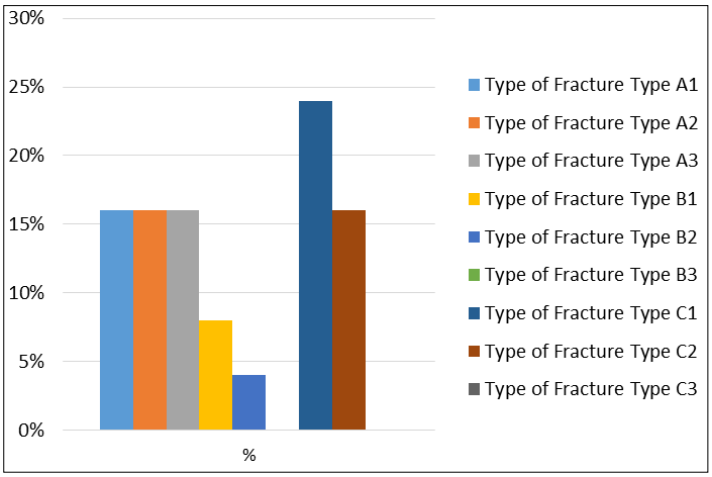

Fig 11: Distribution of tibia plafond fracture subtypes

Majority of the fracture patterns in the study were AO type 43C1

Table 6: Distribution of complete radiological union of fractures

Distribution of radiological union of fracture among study patients			
Variable	**Category**	**n**	**%**
Radiological union of fracture	<8 weeks	0	0.0%
	9-12 weeks	3	12.0%
	13-16 weeks	12	48.0%
	17-20 weeks	9	36.0%
	21-24 weeks	1	4.0%

Majority of the fractures were united between 13-16 weeks (48%)

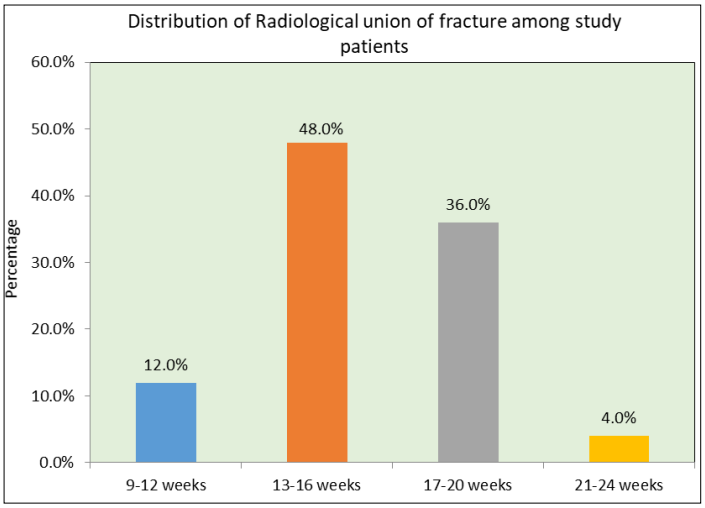

Fig 12: Distribution of complete radiological union of fractures

Mean time for union was 16 weeks.

Table 7: Distribution of American orthopedic foot and ankle (AOFAS)

Comparison of mean AOFAS scale scores between different time intervals using repeated measures of ANOVA test						
Time	**N**	**Mean**	**SD**	**Min**	**Max**	***P*-value**
3 month	25	72.16	8.72	56	85	<0.001*
6 month	25	78.72	8.27	60	91	
1 year	25	85.64	7.09	69	96	

*Statistically significant

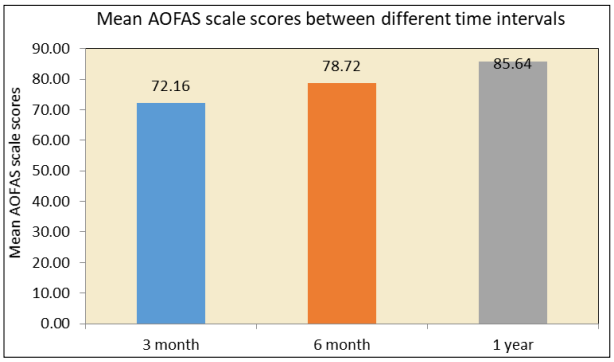

Fig 13: Distribution of American orthopedic foot and ankle

Distribution of complications

Table 8: Distribution of complications

Incidence of post-op complications among study patients			
Variable	Category	n	%
Complications	Yes	4	16%
	No	21	84%

Table 9: Complications

Complications	Number of cases	Percentage
Superficial wound complications	2	8%
Deep wound complications	1	4%
Post traumatic arthritis	1	4%

Fig 14: Images showing distal tibia and fibula fractures. Pre-operative, post-operative, at 6 week follow-up and 3 months follow-up

Fig 15: Images showing distal tibia and fibula fractures. At 6 months follow-up and clinical photos of ankle dorsiflexion and planter flexion and weight bearing photos

Discussion

Ours was a prospective observational study consisting of 25 consecutive cases of distal tibia fractures, which were selected after satisfying the inclusion and exclusion criteria and operated with distal tibia medial LCP fixation by MIPPO technique at Sanjay Gandhi institute of trauma and orthopaedics from November 2018 to September 2020. The functional outcome was assessed using An 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.

Age

Mean age of the patients in our study was 39.48 years, ranging from 22 years to 54 years which was similar in other studies. Vidovic D *et al.* [5] and Duckworth AD *et al.* [6] reported a mean age was 40.1 and 42 respectively. This shows that distal tibia fractures are more common in the active, working, middle aged population.

Sex

We had 15 (60%) male patients and 10 (40%) female patients with distal tibia fractures, with definite male preponderance. This finding is similar to other studies such as Rafiq Bhat *et al.* [7] who reported 76% of male preponderance and Hong J *et al.* [8] who had 66% male patients. This could be because males are attributed to higher physical activity, thereby predisposing them to the injury.

Type of fracture

Most of our cases were closed fractures 19 (76%) whereas 6 (24%) were open type 1 fractures. Hong J *et al.* [8] in their study on 26 patients with distal tibia fractures, encountered 12 open fractures (type 1) and 10 closed fractures.

Associated fibula fracture

Most of the distal tibia fracture were associated with fibula fractures [9] where the fracture was within 7 cm from the tibia plafond, it requires fixation [10]. The first principle of management of distal tibia fractures as stated Ruedi and Allgower was restoration of fibular length which remains vital to obtaining good results. The goal of fibula fixation was restoration of limb length, to prevent varus tilt, maintain rotation and mechanical alignment. In our study 68% [11] patients had an associated fibula fracture, which was 7 cm from the tip of lateral malleoli therefore fibula was fixed before distal tibia in all these cases. All the fibula fractures united without any complications.

In our study AO type 43C1 (complete intra articular without comminution) was the most common fracture pattern consisting of 6 cases (24 %) followed by 4 cases (16%) each types 43A1, 43A2, 43A3 43C2 fractures. There were 2 cases (8%) of type 43B2 and 1 case (4%) of 43B2. Our present study could not be compared with the other studies in this regard as we included all subtypes of fractures i.e, extra articular (43A), partial articular (43B) and intra articular types (43C).

Radiological union

The average time for radiological fracture union in our study was 14-18 weeks with a mean 16 weeks. Rafiq Bhat *et al.* [7] who studied closed distal tibia fractures treated using the MIPPO technique showed fracture union at an average duration of 16.8 weeks ranging from 12 to 30 weeks. Sonnet MM *et al.* [12] showed a mean union time of 15.42 weeks and Lau TW [13] showed a mean union time of 18.7 weeks. In spite of having 10 intra articular fractures, all our cases were united between 14 to 18weeks.

AOFAS score

AOFAS score in our study was consistent with multiple studies. Final score was calculated after complete union at a minimum of 12 month of follow-up. Mean AOFAS score improved from 72.16 (at 3 month) to 78.72 (at 6 month) and 85.64 (at 1 year).

Sonnet MM *et al.* [12] reported that the AOFAS score at 1 year was 87.5. Chen DW *et al.* [14], Bhat R and Duckworth AD [6] noted a mean AOFAS score of 87.8, 83.6 and 76.2 at the end of 1 year. Therefore the final AOFAS score at the end of 1 year in our study was similar with the previous reported studies.

Complications

In our study 21 cases had fracture union without any complications.

Superficial wound complication infections were reported in 2 (8%) cases, 1 patient had post-operative blebs, another had superficial infection which responded to culture specific intravenous antibiotics and daily non-adhesive dressing. There was one incidence of deep surgical site infection which resulted in exposure of implant after post-operative day 8. This was treated with local flap cover and 3 weeks of culture sensitive antibiotics. Another patient had persistent ankle pain and was diagnosed as post traumatic arthritis after 18 month follow up which was treated with NSAIDS, and physiotherapy

The study by Duckworth AD [6] had similar complications rate of 8% each of superficial and deep wound infections. Howard JL *et al.* [15] had 5-17 % superficial wound infections and Carbonel Escobar *et al.* [15] study had 13% superficial wound infections, 10% nonunion and 13% secondary arthritis. Ayeni JP *et al.* [16] and Bourne RB showed 0-16% of secondary arthritis.

Conclusion

Minimally invasive percutaneous plate osteosynthesis is a reliable method of fixation not only extra articular, but also intra articular fractures of distal tibia. MIPPO technique for the distal tibia fractures offers a biological advantage by preserving the blood supply and decreases chances of delayed or non-union. Patients treated by MIPPO technique have a much lesser rate of deep infection and excellent radiological union. MIPPO technique helps in initiating early mobilization and reduces the risk of ankle stiffness.

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