

Evaluation of Functional Outcome Following Operative Management of Extraarticular Fractures of Distal Tibia by Mippo Technique with Precontoured Medial Distal Tibial Locking Compression Plate

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Abstract: MIPPO (minimally invasive percutaneous plate osteosynthesis) is a method of fracture fixation which has gained wide popularity in patients sustaining high velocity trauma due to RTA with distal tibial extra-articular fractures. In this study 3.5 mm precontoured medial distal tibial locking compression plate (LCP) was used for fixation to analyse the functional and radiological outcome and complications. 23 patients (15 male and 8 female) aged 24 to 70 years (mean age 49.4 years) with extra articular distal tibia fractures (19 patients with associated fracture of fibula) were operated during the period of 1st November 2014 to 31st March 2016 and followed up prospectively for a period of 6 months by Olerud and Molander functional assessment. Most of our patients were males and radiological union occurred at an average of 18.913 weeks (SD 5.459). The mean Olerud and Molander score was 43.913 at the first month of follow up. It was 68.47 and 86.087 at third and sixth month of follow up respectively (p value <0.001). We had 20 (86.8%) patients with excellent and good results, 1 with poor functional and 2 patients had fair outcome. To conclude functional outcome following LCP plating with MIPPO technique for extra articular distal tibial fractures has shown excellent outcome with minimal complications.

Keywords: MIPPO, distal tibia fractures, Olerud & Molander functional assessment, LCP

1. Introduction

In the recent years, road traffic accidents (RTA) have emerged as one of the leading causes of morbidity in the age group of 15-45 years[1]. In patients sustaining high velocity trauma due to RTA, tibial fractures are most commonly encountered in which distal tibial fractures have second highest incidence after middle third tibial fractures [2]. Extra articular distal tibial fractures are difficult to treat as they extend within approximately 4 cm of the tibial plafond i.e., involving metadiaphyseal and metaphyseal region which present with severe comminution and soft tissue injury[3],[4].

Anatomic and physiologic features of distal tibia like subcutaneous location, precarious blood supply and high incidence of open fractures make management of distal tibial fractures difficult. Further, the presence of neighbouring hinge joint allows for little rotational malalignment after fracture union. Fracture pattern, soft tissue status, bone quality, age and activity level of patient affect the selection of treatment methods[5]. The choice of treatment modality is hence controversial and not clear.

Various treatment options for treating extra articular distal tibial fractures are conservative with cast immobilization or by calcaneal pin traction, external fixation in case of open injuries, intramedullary nailing and open reduction and internal fixation with plate osteosynthesis by conventional method or through minimal soft tissue dissection[6].

Open reduction techniques with rigid fixation have resulted in poor operative outcomes ranging from wound infections to decreased fracture consolidation and non-union. Therefore better techniques of osseous fixation with minimal soft tissue handling have evolved, to produce the biological fracture fixation with minimally invasive techniques.

MIPPO (minimally invasive percutaneous plate osteosynthesis) is a method of fracture fixation which has gained wide popularity because of reduction of surgical trauma with excellent functional results. The advantages of MIPPO include limited soft tissue dissection; reduced wound related complications, preservation of osteogenic fracture hematoma and improved union rates[5]. The subcutaneous anatomy of the distal tibia has led to the development of anatomically precontoured implants which preserve the biology of bone and provide good clinical results.

In this study, 3.5 mm precontoured medial distal tibial locking compression plate (LCP) for fixation was used. Though enormous literature from global orthopaedic research on outcome of MIPPO in extra articular distal tibial fractures is available, Indian evidence is still growing. This study was carried out to analyse the functional and radiological outcome and complications following medial distal tibia plating with precontoured LCP through MIPPO technique for extra articular fractures in our population.

2. Methods

This study included all the patients who was operated with locking compression plate for extra-articular fractures of distal tibia in Department of Orthopaedic Surgery in Southern Railway Headquarters Hospital, Ayanavaram, Chennai during the period of 1st November 2014 to 31st March 2016 and were followed up prospectively for a period of 6 months. Inclusion criteria were patients in the age group of 18-70 years, who require surgical intervention for extra articular distal tibial fractures by MIPPO with LCP. Exclusion criteria were patients with open fractures or pathological fractures or intra articular fractures and revision surgery cases. Functional outcome was assessed by Olerud and Molander scoring[7] at 1st , 3rd and 6th month after surgery with further follow-up at every 3 months for cases of delayed union.

3. Results

The age group of the patients in our study ranged from 24 years to 70 years (mean 49.4 years). Most of the patients belonged to an elderly population (50% above the age of 50years) indicating the need to use LCP in these elderly people. Most of our patients were males (66.70%). 12(52.1%) cases were due to RTA and 9 (39.1%) cases were due to fall from ground level (low velocity), and 2(8.6%) cases were due to direct injury. Based on AO classification, 15 cases belonged to 43A1, 5 cases belonged to 43A2 and 3 cases belonged to 43A3. In our series all patients had fracture of distal tibia; none of them were amenable to treatment by intramedullary nailing. Radiological union occurred at an average of 18.913 weeks (SD 5.459) in our study with earliest union occurring at 13weeks and one case with delayed union at 38weeks. Most common complications

encountered were superficial infection and delayed union. There was no case of implant related complications like screw loosening, screw, implant prominence, implant failure and malunion. Based on Olerud and Molander functional assessment, cases were graded as excellent, good, fair and poor after 6 months from surgery. There was no change in functional scoring after 6 months.

Table 1: Grading of our results according to Olerud and Molander scoring

Grading	No. of cases	Percentage
Excellent	12	52.17%
Good	8	34.70%
Fair	2	8.69%
Poor	1	4.34%

Table 2: Descriptive analysis of functional outcome using Olerud and Molander scoring system after every follow-up:

	Functional outcome	No of patients
First Month	Poor	8
	Fair	15
	Good	0
	Excellent	0
Third Month	Poor	3
	Fair	6
	Good	14
	Excellent	0
Sixth Month	Poor	1
	Fair	2
	Good	8
	Excellent	12

Post op follow up at 1 month, we observed that functional scores were distributed with in poor and fair. These scores improved as patients were made to walk with gradual weight bearing till fracture union.

Table 3: Comparison of Olerud and Molander score during the follow-up period in study population

	Mean	Std. Deviation	95% Confidence Interval for Mean		Minimum	Maximum	p Value
			Lower Bound	Upper Bound			
First Month	43.913	14.53495	37.6277	50.1984	20	60	<0.001
Third Month	68.4783	21.28992	59.2718	77.6847	25	90	
Sixth Month	86.087	17.51341	78.5136	93.6603	30	100	
Total	66.1594	24.85465	60.1887	72.1302	20	100	

The mean Olerud and Molander score was 43.913 at the first month of follow up. It was 68.47 and 86.087 at third and sixth month of follow up respectively. The differences in the

mean values of the score during the different follow up periods were statistically significant (p value <0.001). ANOVA test was used to assess the statistical significance.

Table 4: Association between complications and outcome in study population

	Functional outcome						Total	p Value
		Poor	Fair	Good	Excellent			
Complication	YES	Count	1	1	2	2	6	0.263
		% within Complication	16.70%	16.70%	33.30%	33.30%	100.00%	
	NO	Count	0	1	6	10	17	
		% within Complication	0.00%	5.90%	35.30%	58.80%	100.00%	
	Total	Count	1	2	8	12	23	
		% within Complication	4.30%	8.70%	34.80%	52.20%	100.00%	

The proportion of subjects with excellent outcome was lesser in people who had developed any of the complications (16.70% vs 83.30%), when compared with subjects who had complication-free post-operative period.

But the difference in the proportion of subjects with various outcomes between the two groups was not statistically significant. Chi square test was used to assess statistical significance.



The main aims of MIPPO were to minimize biologic damage to soft tissue and to decrease the rates of infection and non-union. MIPPO requires only realignment of tibial mechanical axis and clear exposure of fracture is not necessary.

23 patients with fracture of distal tibia (19 patients had associated fracture of fibula) were studied. All patients were treated with MIPPO technique. For the fractures of associated tibia fibula fracture, we first checked under fluoroscopy for the reduction of distal tibia, if found satisfactory, proceeded with tibia fixation alone. Fibula fixation was first done by open reduction and internal fixation prior to MIPPO if closed reduction fails. Results were evaluated and compared with various other studies utilizing different modalities of treatment. Our analysis was as follows.

Table 5: Comparison of our demographic variables with various similar studies

Study name	Total no of pts	Average age (in years)	M:F ratio (Males %)	Commonest study of injury in their Study	% of 43A(AO) type of fracture
Dhakar et al [10]-2016	50	41	34/16 (68%)	RTA	100%
Bingol et al [11]-2015	30	44.26	13/17 (3.3%)	RTA	76.60%
Devkota P et al [12] (2014)	53	51	31/22 (58.49%)	RTA	49.05%
Paluvadi et al [13]-2014	50	36	35/15 (62%)	RTA	90%
Ahmad et al [14]-2012	18	43.5	11/7 (61.11%)	RTA	100%
Shabbir G et al [6]al (2011)	73	37.2	63/10 (86.3%)	RTA	100%
Gupta RK et al [15] al (2010)	79	36	63/16 (79.74%)	RTA	86.07
Neeraj et al [16]-2008	20	36	14/6 (70%)	RTA	100%
Bahari S et al [17]-2007	42	35	31/11 (73.8%)	RTA	35.71%
Present study - 2016	23	49.4	15/8 (65.2%)	RTA	100%

4. Discussion

Periosteal blood supply diaphyseal- metaphyseal region of distal tibia is under high risk. MIPPO technique preserves the hematoma in the fractured area while at the same time it prevents iatrogenic soft tissue injury and retains the osseous vascular supply[8]. This technique involves attaining axial alignment to maintain the mechanical axis without reduction of each intermediate fragment i.e. alignment of proximal and distal joint line. This method is indirect reduction and immobilization by internal fixator. That is, it uses plates and screws internally in a similar way to the principles of external fixator which has the advantage of minimal damage to the periosteum due to minimal contact to the bone. As per the current concepts, the fracture fixation aims to give sufficient stability for early functional treatment at the same time permitting instability for speeding up the healing process[9].

Age distribution

There was a bimodal distribution of age. There was a group of patients in the 20s and 30s due to road traffic accidents and a second group in the 60s due to trivial falls. The average age in our series was 49.4 years with the maximum number of patients in the sixth decade.

Average age in studies conducted by **Bingol et al** and **Devakota P et al** were 44.26 years and 51 years respectively which was comparable to our study.

Sex distribution

There was a male preponderance in the present study with 15(65.2%) of the patients being males. This was consistent with the study conducted by **Dhakar et al** which reported 80% occurring in males.

Mode of injury:

Majority of the fractures were sustained due to road traffic accidents i.e. 12(52.1%) patients followed by accidental fall from height. This was consistent with the study conducted by **Dhakar et al** and **Bingol et al** which reported majority of the fractures were due to RTA.

Type of fracture:

The large number of studies with extra-articular, 43A fractures indicates that these were quite common and associated with frequent complications of non-union, malunion and postoperative wound complications.

Fracture union:

Radiological union, as assessed by complete cortical bridging between proximal and distal fragments on X-rays, was found to be at an average of 18.9 weeks.

The fractures treated with MIPPO technique showed healing by callus formation leading to an early solid bony union; except in one case. There was a mean time for fracture union at 18.9 weeks in our study. All fractures in our series united with two fractures (8.69%) going for delayed union of which one fracture united at 28 weeks and the other united at 38weeks. **Gupta RK et al** reported radiological union at an average period of 19 weeks which was closest to our series. **Dhakar et al** and **Bingol et al** showed results with union occurring over a longer period of 19-21 weeks. In the study conducted by the **Devkota P et al**, radiological union was reported at an average of 25 weeks.

Complications:

Delayed union(2):

In our study, there were two cases; both were proximal at the metaphyseal-diaphyseal junction; out these one united at 28 weeks and the other at 38 weeks. On analysis of the radiographs; the probable causes for the delayed union were a small gap at fracture site and the rigidity of fixation. **Dhakar et al** and **Ahmad et al** reported delayed union of 2 and 3 cases respectively in their studies.

Superficial infection (2)

There were two cases of superficial infection involving the skin and subcutaneous tissues, which healed with oral antibiotics. But infection had no effect on fracture union time. **T W Lau et al[18]** in 2007 studied the complications following 48 cases of distal tibia treated with MIPPO and reported an infection rate of 15%[18].

Deep infection (1)

There was one case of deep infection, this patient had abrasions at the fracture site at the time of injury and a calculated risk was taken to fix the fracture to avoid further soft tissue damage and fracture displacement. The wound healed with wound debridement, irrigation and closure. The discharge from the depth of the wound was taken for culture and sensitivity. The appropriate IV antibiotics were given for 2weeks; till skin suture removal. **Bahari et al** reported a case of similar complication for which pus culture sensitive antibiotics were given and later implant removal was done after fracture united.

Complex regional pain syndrome (1) :

One patient developed pain with trophic skin changes around the operated site two months post operatively which was considered as complex regional pain syndrome which was treated with analgesics, anti-inflammatory drugs and aggressive physiotherapy. But patient had persistent symptoms. **Devkota P et al** reported a case of complex regional pain syndrome which well responded to physiotherapy with mild residual pain.

In our study, there were no non-union, malunion, hardware failure and implant prominence. This is consistent with the studies by **Dhakar, Neeraj et al (2008)**³⁰ and **Shabbir et al** which reported similar results.

Table 6: overall results obtained in various studies

Study	Sample size	Method of treatment	Time to union (weeks)	Overall union (Patients %)	No. of patients with excellent/good functional scoring
Dhakar et al -2016	50	MIPPO (LCP)	20.96	48 (96%)	33 (66.66%)
Bingol at al (2015)	12	MIPPO (LCP)	19.8	27 (90%)	18 (60%)
Devkota P et al -2014	53	MIPPO (LCP)	25	51 (96.22%)	53 (100%)
Paluvadi et al -2014	50	MIPPO (LCP)	21.4	50 (100%)	50 (100%)
Ahmad et al (2012)	18	MIPPO (LCP)	23.1	16 (88%)	12 (92%)
Shabbir G et al -2011	73	(NARROW TIBIA DCP)	13	73 (100%)	68 (93.15%)
Gupta RK et al -2010	79	MIPPO (LCP)	19	76 (96.2%)	25 (31.64%)
Neeraj et al (2008)	20	MIPPO (one third tubular plate)	12.7	20 (100%)	14 (70%)
Bahari S et al -2007	42	MIPPO (LCP)	22.4	42 (100%)	36 (85%)
Present study-2016	23	MIPPO (LCP)	18.9	23	12 (52.17%)

Table 7: Complications in various studies

Study	Sample size	Superficial infection	Deep infection	Ankle stiffness	Prominent implant	Complex regional pain syndrome	Delayed union	Nonunion	Malunion
Dhakar et al-2016	50	2	2	3	0	0	2	0	0
Bingol et al (2015)	12	1	0	0	0	0	0	0	1
Devkota P et al -2014	53	5	0	0	0	1	0	0	2
Paluvadi et al -2014	50	5	1	0	8	0	0	0	1
Ahmad et al -2012	18	1	1	0	1	0	3	1	0
Shabbir G et al -2011	73	2	0	0	0	0	0	0	0
Gupta et al (2010)	79	1	2	0	0	0	7	3	2
Neeraj et al (2008)	20	2	0	0	1	0	0	0	0
Bahari et al (2007)	42	2	1	0	5	0	0	0	0
Present study-2016	23	2	1	0	0	1	2	0	0

In our study, functional scoring was done using Olerud and Molander scoring system which showed an average score of 86.08 at the end of six months. There were 20 (86.8%) patients with excellent and good results out of 23 patients in our series. Poor functional outcome in one patient was due to delayed union at the fracture site who was osteoporotic and also a smoker. 2 patients had fair outcome one with complex regional pain syndrome and other with delayed union.

There was a significant improvement in functional score over a period of 6 months, which shows that patients of all age groups tend to well over a period of time following surgery after patients were started on physiotherapy for ankle range of movements and partial weight walking at 6 weeks post operatively. Implant removal was not done in any patient as no patient had implant prominence. This is due to the fact that all the plates used were anatomically precontoured. This is consistent with the results published by **Bingol et al** which reported 0% implant removal and 0% implant prominence in patients treated using precontoured LCP. 52% patients underwent implant exit in study conducted by **T W Lau et al**, implant prominence being the most common reason[18].

Delayed union and final healing in 58 year old male

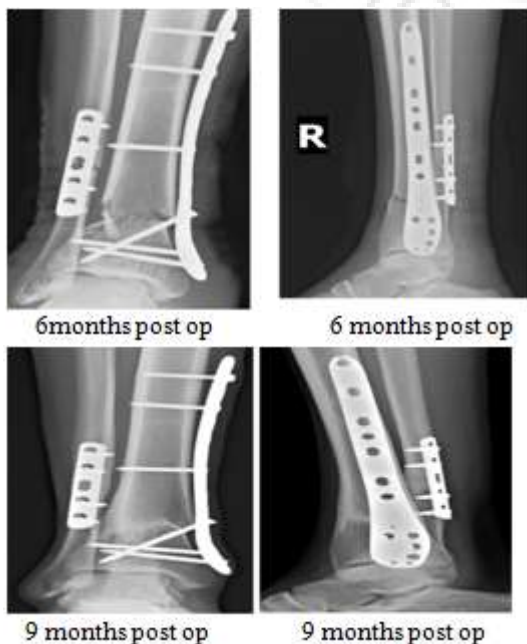


Figure 2: Clinical pictures of complications encountered in our study



Figure 3: 63 year, female patient with complex regional pain syndrome of left leg with normal bony union

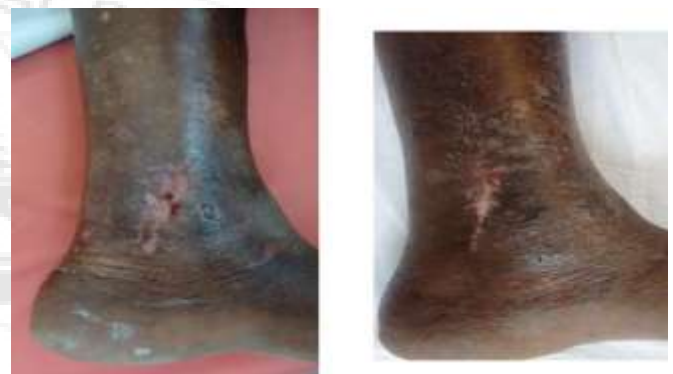


Figure 4: 65 year old male patient; superficial infection healed with oral antibiotics.

5. Conclusion

We conclude from our study that the functional outcome following precontoured locking compression plate fixation by MIPPO of extra articular distal tibial fractures in adults produced excellent results in majority of cases with a few complications with no additional need for implant removal after union.

6. Limitation

Statistical evaluation was limited due to the small sample size and heterogeneity of subgroups. Hence the conclusions drawn from this analysis cannot be extrapolated in a generalized manner. Similar studies using similar implants and with longer period are required to arrive at a consensus.

7. Recommendations

It was found that the locking screws had excellent hold even in the osteoporotic bones. Therefore we recommend using LCP in elderly population.

It was noticed that there was excellent hold even with 2 bicortical screws when locking screws were used, which has its importance in fractures at the ends of long bones where other implants are of little value. So we suggest using this precontoured LCP which has got 6 distal LHS for sufficient hold in small distal fragment.

Drilling the holes for the locking head screw should always be through a screw in drill sleeve since the locking head screws are to be inserted at predetermined angle to the plate.

It was noted that there was a strong bony bridging callus across the fracture site even in non comminuted fractures which were fixed with elastic fixation using the MIPPO technique by preserving osteogenic fracture hematoma which drives us to suggest that MIPPO can be used even in transverse fractures of distal tibia besides its advantage in spiral, oblique and comminuted fractures.

We suggest delaying surgery till soft tissue edema settles and biological fixation with minimal soft tissue handling through MIPPO technique for distal tibia extra articular fractures to avoid post-operative wound complications.

We also suggest that the proper understanding of the biomechanics of the LCP and the general principles guiding its application before actually venturing into its clinical use.

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