

ORIGINAL RESEARCH

Study of clinical outcome of supracutaneous locking compression plate in compound fractures of distal third tibial meta-diaphyseal fractures as external fixator

¹Dr. Likith Kumar D, ²Dr. Vineeth Varma, ³Dr. Shreesha T, ⁴Dr. Mahidhara S.N

¹Senior Resident, Department of Orthopaedics, Karwar Institute of Medical Sciences, Karwar, Karnataka, India

^{2,3}Assistant Professor, Department of Orthopaedics, Karwar Institute of Medical Sciences, Karwar, Karnataka, India

⁴Associate Professor, Department of Orthopaedics, Karwar Institute of Medical Sciences, Karwar, Karnataka, India

Corresponding Author

Dr. Mahidhara S.N

Associate Professor, Department of Orthopaedics, Karwar Institute of Medical Sciences, Karwar, Karnataka, India

Received: 02Sept, 2023

Accepted: 25Sept, 2023

ABSTRACT

Supracutaneous plating using a locking compression plate (LCP) as an external fixator in compound periarticular areas of distal third tibia is facilitated by the development of anatomical plates. The soft tissue around the distal tibia is easily compromised by trauma and subsequent operative fracture treatment posing a definitive challenge in the distal tibia compound fractures.

Twenty patients with compound distal third tibial meta-diaphyseal fractures were studied and followed up for a period of 12 months. All twenty patients were treated by supracutaneous LCP fixator and were regularly followed up for 12 months at regular intervals. All the fractures were consolidated at an average of 18 to 20 weeks and plate was removed by average of 20 weeks in all patients. All patients were fully weight bearing by mean duration of 16 weeks. Three patients developed screw tract infections and two developed superficial compound wound infection which resolved with oral and intra-venous antibiotics respectively. One patient developed malunion with anterior angulation, but still had a good functional outcome, this was due to non-compliance with physiotherapy regimen. The functional outcome was assessed by AOFAS scoring system which showed a mean score of 84.55 with 7 (35%) excellent, 11 (55%) good, 1 (5%) fair, 1 (5%) poor result.

Key words: Compound fractures, meta-diaphyseal, locking compression plate, external fixators

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-Non Commercial-Share Alike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

INTRODUCTION

Treatment for distal tibial fractures accompanied by soft tissue damage might be difficult for orthopaedic surgeons. Due to decreased soft tissue coverage, a higher risk of infection, non-union, mal-union, joint stiffness, and potential amputations, these injuries are linked to severe morbidity. This bone is subcutaneous on its antero-medial surface and possesses weight bearing joints on both sides. This necessitates a maximum anatomical reduction and careful soft tissue care to achieve early union with maximum function.

Therefore, surgery is a valid treatment option for distal tibial fractures¹.

However, the procedure frequently resulted in problems such skin breakdown and infections in open reductions and internal fixations because of the subcutaneous antero-medial surface and high velocity trauma². In order to preserve the biology of soft tissue and bone, surgical techniques evolved to fix these fractures with the least amount of invasiveness³.

Closed interlocking nails made it simple to repair distal tibial meta-diaphyseal fractures, but choosing the right implant and surgical method to avoid

damaging previously traumatised soft tissue presented a challenge^{4,5}. MIPPO technique and low profile anatomical locking compression plating reduced the risk of skin breakage and infections to some extent with promising results⁶, however some studies show unacceptably high incidence of implant prominence and late infections⁷.

Standard external fixators and ring fixators kept the biology in place but were large and burdensome for patients. In the two rounds of surgery, the fractured tibia is stabilised using a bridging external fixator to allow the soft tissues to heal and recover, and the meta-diaphyseal fractures are fixed definitively for reconstruction. However, this is more expensive than conventional open techniques. Therefore, some orthopaedic surgeons recommended external fixation utilised alone or with minimal internal fixation as the definitive treatment for lower extremity fractures with impaired soft tissue envelope⁸.

Supracutaneous plating was a new approach to treating these fractures. In the therapy of open tibial fractures, the anatomically pre-contoured locking plate as external fixator has been used without joint spanning^{9, 10}. The anatomically contoured LCP with angular stable screws as an external fixator applied supracutaneously in this method, maintaining stabilisation without impairing soft tissue biology.

This method is straight forward, biological, and patient-friendly because it uses low-profile external fixators, has no radiological silhouette, and allows for the removal of implants in an outpatient setting. The therapeutic effectiveness of supracutaneous locking compression plates for compound fractures in distal third tibial meta-diaphyseal fractures is assessed in this study, with the merits and demerits associated with procedure.

METHODOLOGY

STUDY DESIGN

Prospective Clinical Study.

SAMPLE SIZE CALCULATION

The total sample size was 20.

SAMPLING METHOD

Convenience Sampling.

INCLUSION CRITERIA

- Patient aged above 18 years, both male and female.
- Distal third tibial compound meta-diaphyseal

fractures.

- Grade 1 and 2 Gustilo and Anderson classification of open fractures.
- Grade 1, 2 and 3 of Tscherne classification of soft tissue injury.
- Written consent from patient for treatment.

EXCLUSION CRITERIA

- Patient age less than 18 years.
- Compound fractures without adequate soft tissue coverage.
- Grade 3 of Gustilo and Anderson classification of open fractures.
- Grade 4 of Tscherne classification of soft tissue injury.
- Fractures with severe periosteal stripping.
- Pathological fractures.
- Patient unfit for surgery.
- Patient not willing for surgery.

Patients on admission, a careful history was elicited and/or attenders to reveal the mechanism of injury and severity of the trauma. The patterns were then assessed clinically to evaluate their general condition and local injury and radiologically confirmed distal third tibial meta-diaphyseal compound fractures, and were eligible for the study according to the above-mentioned eligibility criteria were included in the study after informed consent from the patient.

MANAGEMENT OF OPEN FRACTURES

Patients with open fractures were graded accordingly using Gustilo and Anderson classification for open fractures. Antibiotics were started immediately for all patients. Injection Tetanus immunoglobulin 500 IU IM and single dose of tetanus toxoid was given.

After obtaining the necessary radiographs, Type I and II open fractures were treated by cleaning of the wound with copious amount of normal saline and hydrogen peroxide, followed by painting of the skin around the wound with Povidine iodine and surgical spirit. This was followed by primary wound closure. The limb was then immobilised in an above knee Plaster Of Paris slab till definite fixation was done.

RESULTS

The radiological outcome was assessed in the study based on the duration required for union of fracture on radiological examination. The mean duration for radiological union among the subjects was 19.20 ± 3.14 weeks.

Table 1: Radiological outcome measure of the procedure among the study subjects

	Mean	SD	Median	Minimum	Maximum
Radiological Union (in weeks)	19.20	3.14	19.00	12.00	26.00

The subjective outcome was assessed in the study based on the duration required by the subjects for bearing complete body weight. The mean duration for

full weight bearing among the subjects was 16.70 ± 2.32 weeks.

Table 2: Subjective outcome measure of the procedure among the study subjects

	Mean	SD	Median	Minimum	Maximum
Full Weight Bearing (in weeks)	16.70	2.32	16.50	12.00	21.00

The clinical outcome was confirmed in the study among the subjects. The mean duration for plate based on the duration required to remove the plate removal among the subjects was 20.20 ± 3.24 weeks.

Table 3: Clinical outcome measure of the procedure among the study subjects

	Mean	SD	Median	Minimum	Maximum
Plate Removal (in weeks)	20.05	3.12	20.00	13.00	28.00

The functional outcome was assessed in the study (55.0%). The next majority was excellent (20.0%) based on AOFAS Ankle-Hindfoot Score. The outcome was fair and poor in 1 each individual of Accordingly, the procedure was successful in the study. The mean score was 84.55 ± 11.51 achieving good final outcome in majority cases

Table 4: Distribution of the study subjects based on the functional outcome

Functional Outcome (AOFAS Score)		Frequency (N)	Percentage (%)
	Poor	1	5.0%
Fair	1	5.0%	
Good	11	55.0%	
Excellent	7	35.0%	

	Mean	SD	Median	Minimum	Maximum
AOFAS Ankle-Hindfoot Score	84.55	11.51	85.00	50.00	97.00

INTRA-OPERATIVE COMPLICATIONS: There were no cases of intra-operative complications noted.

POST-OPERATIVE COMPLICATIONS: In the study, majority of the subjects did not develop any sorts of complications (70.0%). Among the remaining subjects who had experienced complications, pin tract

infection was observed in 3 individuals and superficial compound wound infection in 2 cases, who were treated with oral and intravenous antibiotics respectively. While remaining 1 individual showed anterior angulation malunion but had a good functional outcome.

Table 5: Distribution of the study subjects based on the complications

Complications		Frequency (N)	Percentage (%)
Absent		14	70.0%
Present	Pin Tract Infection	3	15.0%
	Superficial Wound Infection	2	10.0%
	Malunion with anterior angulation	1	5.0%

On analysing the association between the socio-demographics such as age and gender of the study subjects with the final outcome based on AOFAS

score, the study found no significant relation, thereby suggesting that age and gender made no difference in the final outcome among the subjects.

Table 6: Association of socio-demographics of the study subjects with the final outcome

		Results								p-value [#]
		Poor		Fair		Good		Excellent		
		N	%	N	%	N	%	N	%	
Age group	31 to 40 years	1	100.0%	0	0.0%	4	36.4%	2	28.6%	0.192
	41 to 50 years	0	0.0%	0	0.0%	3	27.3%	2	28.6%	
	51 to 60 years	0	0.0%	0	0.0%	4	36.4%	2	28.6%	
	>60 years	0	0.0%	1	100.0%	0	0.0%	1	14.3%	
Gender	Male	0	0.0%	1	100.0%	9	81.8%	4	57.1%	0.257
	Female	1	100.0%	0	0.0%	2	18.2%	3	42.9%	

Chi-square test

Table7: Association of severity of fracture with the final outcome

		Results								p-value [#]
		Poor		Fair		Good		Excellent		
		N	%	N	%	N	%	N	%	
GA	Grade I	0	0.0%	1	100.0%	3	27.3%	5	71.4%	0.144
	Grade II	1	100.0%	0	0.0%	8	72.7%	2	28.6%	
AO/OTA	A1	0	0.0%	1	100.0%	2	18.2%	3	42.9%	0.407
	A2	0	0.0%	0	0.0%	5	45.5%	2	28.6%	
	A3	1	100.0%	0	0.0%	4	36.4%	0	0.0%	
	C1	0	0.0%	0	0.0%	0	0.0%	1	14.3%	
	C2	0	0.0%	0	0.0%	0	0.0%	1	14.3%	

Chi-square test

On analysing the association between the severities of fracture based on either Gustilo Anderson classification or AO/OTA classification with the final outcome based on AOFAS score, the study found no

significant relation, thereby suggesting that severities of fracture made no difference in the final outcome among the subjects.

Table 8: Comparison of different outcome measures with the final outcome

		Radiological Union (in weeks)			Full Weight Bearing (in weeks)			Plate Removal (in weeks)		
		Mean	SD	Median	Mean	SD	Median	Mean	SD	Median
Results	Poor	26.00	-	26.00	21.00	-	21.00	28.00	-	28.00
	Fair	19.00	-	19.00	18.00	-	18.00	20.00	-	20.00
	Good	19.64	2.84	20.00	17.36	1.50	18.00	20.27	2.49	20.00
	Excellent	17.57	2.57	18.00	14.86	2.27	15.00	18.57	2.70	19.00
p-value [#]		0.063			0.014*			0.027*		

One Way ANOVA

* Statistically significant

DISCUSSION

The radiological outcome was assessed in the present study based on the duration required for union of fracture on radiological examination.

The average time of fracture union in various studies conducted was 12-26 weeks. Our study had an average fracture union rate of 19.2 weeks which were better and comparable with studies conducted using locking compression plate as external fixator and using hybrid external fixators.

The subjective outcome was assessed in the present study based on the duration required by the subjects for bearing complete body weight on affected limb. On comparing with the observations made from the previous literatures, the full weight bearing in the present study was the earliest.

The clinical outcome was confirmed in the present study based on the duration required to remove the plate among the subjects. The mean duration for plate removal among the subjects was 20.20 ± 3.24 weeks. This is quite better compared to the study by Gupta SK *et al.*¹⁰, where the plate removal was done after an average duration of 24 weeks, Ching-Hou Ma *et al.*¹¹ *et al.*¹² stated the removal by average of 13 weeks.

In the present study, majority of the subjects did not develop any sorts of complications (70.0%). Among the remaining subjects who had experienced complications, pin tract infection was observed in 3 individuals, superficial wound infection in 2 cases, while remaining 1 individual showed malunion with

anterior angulation. However, various studies have different kinds of complications but in minimal proportions.

In a study by ma *et al.*⁵⁰, noted a complication rate of 40% such as pin tract infection, delayed union, mal union of >5 degrees and limb shortening of more than 1 cm noted. Qiu *et al.*¹³, in 2014 showed a very low complications associated with their study results. Gupta SK *et al.*¹⁰, noted nil complications with the procedure. Wu *et al.*¹⁴, in their study showed a 31% complication rate such as superficial and deep infection, delayed union and deep vein thrombosis in 5 cases. In a recent study by Ma *et al.*¹⁵, 2017 showed a 37% complications like, 7 cases of pin tract infection, >5 degrees of malunion in 2 cases, shortening of >1cm in 2 cases, screw loosening in 5 cases and screw breakage in 3 cases.

The study conducted by Guadinez *et al.*¹⁶ in management of communitied tibial plateau fractures by hybrid external fixators showed high chances of pin tract infections and varus malignment, and Baebieri *et al.*, managed by external fixator also demonstrated major complications like pin tract infections, non-union, loss of reduction and requirement of realignment and post traumatic arthritis of ankle with stiffness.

The functional outcome was assessed in the present study based on AOFAS Ankle-Hindfoot Score. Accordingly, the procedure was successful in achieving good final outcome in majority cases

(55.0%). The next majority was excellent (20.0%), thereby depicting 75.0% successful results. The outcome was fair and poor in 1 each individual of the study. The mean score was 84.5. This is better than the mean score of 88 in a study by Zhang *et al.*¹⁷, which had also used AOFAS Ankle-Hindfoot Score to assess the final outcome, other feasible criteria had been used in many this study. Kalia S *et al.*,¹⁸ showed an 81.9 AOFAS score at their final follow up. The results were found to be excellent to good in majority of the previous studies, which is comparable to present study.

In study of Ma *et al.*¹⁵, in 2011 showed 100% union rate with 21 patients having excellent result and good in 4 patients. In 2014 Qiu *et al.*⁵¹, had a good ROM with excellent to good results in all cases. Wu *et al.*⁵², in 2013 had good ROM in ankle and knee at the final follow up.

At Mei *et al.*¹⁹, had 100% union rate, using Johner-Wruhs criteria showed 89% of excellent to good results and fair in 2 patients. Study by Lian and Hanget *al.* (55) 2015, showed 96% union rate, and had 15 cases of excellent result, 8 patients had good results and good and poor in 1 patient each.

Barbieri *et al.*²⁰, showed complications in majority of cases and yielded poor results with also need of frame revision.

Further on analyzing the association between the various outcome measures such as radiological union, full weight bearing and plate removal among the study subjects with the final outcome based on AOFAS score, the present study established the synchronicity between the few outcome measures with respect to the final outcome among the subjects.

CONCLUSION

This technique in the compound diaphyseal fractures are well tolerated by patients and addresses the challenging problems of compound wound healing, non-union, and infections with a good union rate and less financial burdens to rural population. This being more biological, easy to carry out the surgery, patient friendly with minimal complications.

REFERENCES

- Jensen JS, Hansen FW, Johansen J. Tibial shaft fractures. A comparison of conservative treatment and internal fixation with conservational plates or AO compression plates. *Acta Orthop Scand.* 1977;48(2):204-12.
- Philip A, McCann, Jackson M, Steve T *et al.* Complications of definitive open reductions and internal fixation in tibial pilot fractures. *Intl. Orthop* 2011 Mar;35(3):413-418.
- Perren SM. Evolution of the internal fixation of long bone fractures. The scientific basis of biological internal fixation: choosing a new balance between stability and biology. *J Bone Joint Surg Br.* 2002 Nov;84(8):1093-110.[pubmed].
- Borrelli J Jr, Prickett W, Song E, et al. Extraosseous blood supply of the tibia and the effects of different plating techniques: a human cadaveric study. *J Orthop Trauma.* 2002 Nov-Dec;16(10):691-5.[pubmed].
- McCann PA, Jackson M, Mitchell ST, et al. Complications of definitive open reduction and internal fixation of pilon fractures of the distal tibia. *Int Orthop.* 2011 Mar;35(3):413-8. doi: 10.1007/s00264-010-1005-9. Epub 2010 Mar 30.[pubmed].
- Luo P, Xu D, Wu J, et al. Locked plating as an external fixator in treating tibial fractures: A PRISMA-compliant systematic review. *Medicine (Baltimore).* 2017 Dec;96(49):e9083. doi: 10.1097/MD.0000000000009083.[pubmed].
- Gupta PI, Tiwari AI, Thora A, et al. Minimally Invasive Plate Osteosynthesis (MIPO) for Proximal and Distal Fractures of The Tibia: A Biological Approach. *Malays Orthop J.* 2016 Mar;10(1):29-37. doi: 10.5704/MOJ.1603.006.[pubmed].
- Marsh JL, Bonar S, Nepola JV et. al. Use of an articulated fixator for fractures of tibial plafond. *J Bone Surg (AM),* 1995;77:1498-509.77(5):661-673.
- Kloen P. Supercutaneous plating: Use of a locking compression plate as an external fixator. *J Orthop Trauma.* 2009;23:72-75.
- S.K. Venkatesh Gupta, Shyam Prasad Parimala. Supracutaneous locking compression plate for grade I and II compound fractures of distal tibia-A case series. *Open journal of orthopaedics,* 2013,vol.02.(02),pp.106-109.
- Ching-Hou Ma, Shang-Won Yu, Yuan-Kun Tu, Cheng-Yo Yen, James Jih-His Yeh and Chin-Hsien Wu (2010) Staged external and internal locked plating for open distal tibial fractures, *Acta Orthopaedica,* 81:3, 382-386, DOI: 10.3109/17453674.2010.487244.
- Arash Arfa, Seyed Mohammad Javad Mortazavi, Mohammad Javad Dehghani Firoozabadi, and Mohammad Zarei: External Fixation by Locking Plate as a Definitive Treatment of Tibial Distal Metaphyseal Fractures. *J Orthop Spine Trauma.*e14327.
- Qiu XS, Yuan H, Zheng X, et al. Locking plate as a definitive external fixator for treating tibial fractures with compromised soft tissue envelop. *Arch Orthop Trauma Surg* 2014;134:383-8.
- Wu G, Luo X, Tan L, et al. [Comparison study on locking compress plate external fixator and standard external fixator for treatment of tibial open fracture. *Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi* 2013;27:1291-5.
- Ma C-H, Wu CH, Jiang JR, *et al.* Metaphyseal locking plate as an external fixator for open tibial fracture: clinical outcomes and biomechanical assessment. *Injury* 2017;48:501-5.

16. Gaudinez RF, Mallikar, Szporn M. Hybrid external fixation in tibial plafond fractures. *Clin Orthop* 1996 Aug;329-223-232.
17. Kalia S, Sharma S, Sehgal M., Kanwar S. Supracutaneous plating in tibial metadiaphyseal fractures with compromised soft tissue using LCP as an external fixator. *Surgical Update: I*.
18. Kalia S, Sharma S, Sehgal M., Kanwar S. Supracutaneous plating in tibial metadiaphyseal fractures with compromised soft tissue using LCP as an external fixator. *Surgical Update: Int. J Surg.Orthopedics*. 2019;5(2):110-115.doi:10.17511/ijoso. 2019.i2.08.
19. Mei ZF, Fan SW, Zhao FD, et al. [Locking plate external fixator for the treatment of middle and distal tibial fractures]. *Zhongguo Gu Shang* 2014;27:458–60.
20. Barbieri R, Scbenk R, Koval K, Aurori B. Hybrid external fixation in treatment of tibial plafond fractures. *Clin Orthop* 1996;332:16-22.