Original article

Soft tissue complications in distal tibial fractures managed with medial locking plates: A myth or reality?

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ABSTRACT

Background: Distal tibial fractures are common injuries that are prone to complications and require careful management. The use of medial periarticular locking plates is an established modality in the treatment of these fractures. These plates are inserted using the minimally invasive plate osteosynthesis (MIPO) or open technique. Our study looks at the soft tissue complications associated with the use of medial locking plates in the management of these fractures.

Methods: This was a retrospective study carried out at a tertiary care university hospital in an urban setting. Forty four patients with distal tibia fractures treated with periarticular locking plates during a three year period were included in the study. Both closed and open fractures were included while those with an established non-union were excluded. Patient data related to inpatient stay, outpatient visits as well as readmissions was extracted from hospital records and analysed. Spanning external fixation was done if necessary and definitive fixation was done using medial locking plates with either MIPO technique or open reduction and internal fixation (ORIF) with biological technique. The sub cohort of patients with soft tissue complications was compared to the parent group.

Results: The study group included 44 patients (28M:16F) with 45 fractures with a median age of 42.6 years (range 18–65 years) followed up for a mean of 9.2 months (range 5–20 months). Domestic falls were the cause of injury in 61.4% (n = 27) of the fractures. The average time to union was 26.2 weeks (range 12–66 weeks). Out of these 45 fractures, soft tissue complications were seen in 22.2% of cases (n = 10) with road side accidents seen in 60% (n = 6) of cases. In four patients, there was difficulty in achieving primary wound closure and in five other cases wound dehiscence with exposure of implant was seen within 12 to 30 days of surgery. One patient required secondary suturing after readjustment for malreduction. No statistically significant difference was found in the parent cohort and the sub cohort with soft tissue complications with respect to the use of spanning external fixator, MIPO/ORIF technique or fibular fixation.

Conclusion: The incidence of soft tissue complications with the use of medial locking plates in distal tibial fractures may be more than what is currently reported in literature and further studies are required to shed more light on this subject.

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1. Introduction

Fractures of the distal tibia present a unique challenge to the treating surgeon. These injuries include the extra-articular distal shaft fractures as well as the tibial plafond and intra-articular fractures. The precarious soft tissue envelope is vulnerable to injury by incident trauma as well as surgical intervention. Locked plating and intramedullary nailing (IMN) are established

modalities in the treatment of these fractures. Intramedullary nailing is used in extra-articular fractures but is associated with malunion, nonunion and ankle pain.^{1,2} The use of medial locked plate with minimally invasive plate osteosynthesis (MIPO) technique has gained popularity. Locked plates offer improved stability and ability to maintain alignment during the healing of short segment periarticular fractures.³ Plating by conventional open technique entails extensive soft tissue dissection with consequent periosteal injury even in expert hands. Although more biological, MIPO technique requires indirect reduction techniques and is technically demanding. Complications associated with medial locked plating include superficial and deep wound

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infection (both early and delayed), prominent hardware, implant failure and nonunion.

Contemporary literature has shown excellent results with the use of medial locked plates especially when used with MIPO technique.^{4,5} Studies have also found no difference in complication rates when medial locking plates using MIPO technique are compared to intramedullary nailing.^{6–8} However, a few recent studies have reported a high complication rate associated with the use of these plates.^{9–12} This fact prompted us to study the results of these plates in our institution and our study looks at the soft tissue complications associated with the use of medial locked plates in distal tibia fractures. The factors contributing to these complications are also discussed.

2. Methods

This is a retrospective study carried out at a tertiary care university hospital in North India after approval from the Institutional Ethics committee. The patients with fractures of distal tibia (both extra-articular and intra-articular) managed with periarticular medial locking plate system during a three year study period were included in the study. Both closed and open fractures were included in our study. Patients with established non-union were excluded. The patient records including inpatient file, operation notes, discharge summary, outpatient visits and readmission records were retrieved and analysed. The variables extracted from these records included demographic variables, mode of injury, condition of wound at presentation, remarks on post operative wound dressings, number and frequency of dressing changes and details of primary or secondary procedures performed. The definition of soft tissue complication included those cases that required another procedure either during definitive fixation or later for soft tissue related problems. Wound dehiscence after fracture union was not included as a soft tissue complication. The study yielded 49 patients managed with distal tibial medial locking plates during the study period. Out of these, complete record was not available for four patients and one patient died during follow up due to unrelated factors leaving 44 patients with 45 fractures for analysis.

At the time of presentation, soft tissue condition was assessed and internal fixation was delayed if the soft tissue condition was not appropriate for fixation. Spanning external fixator or posterior splintage was given in such cases. The definitive fixation was performed by one of the six consultants of our department. Distal tibial medial locking plate system was used for fracture fixation using either MIPO technique or open reduction and internal

fixation (ORIF) with biological techniques. The choice of technique used for tibial fixation as well as the option of fibular fixation depended on the fracture geometry, displacement pattern and preference of the treating surgeon. Plate contouring was done both in MIPO technique as well as ORIF wherever necessary. Fibular fixation when required was done by plating with open technique or elastic nail or K wire.

Post operatively, limb elevation was done and quadriceps exercises, knee bending and ankle mobilization were started within 24 h of surgery. The patients were given posterior splintage if protection of fixation was desired in comminuted fractures. Ambulation with a walker was commenced on second or third postoperative day once the pain and swelling subsided. Toe touch weight bearing was allowed if the fixation construct permitted otherwise the patient was kept on non weight bearing ambulation till radiological evidence of bone union. Intravenous antibiotics were continued for four days in closed injuries followed by oral antibiotics till suture removal at two weeks. In open fractures, intravenous antibiotics were continued till the wound condition necessitated the same. Wound inspection was done daily or on alternate days depending on the condition of the wound. Patients were followed up clinically and radiologically in the outpatient clinic at monthly intervals till one year or till bone union whichever was later. Progressive weight bearing was allowed according to the callus formation as assessed in follow up radiographs. Full weight-bearing was permitted only after clinico-radiological evidence of union.

3. Results

Our study included 44 patients (28 males and 16 females) with 45 fractures of distal tibia treated with locking plates with mean age of 42.6 years (range 18–65 years). Domestic falls contributed to 61.4% (n = 27) of the injuries whereas road side accidents were the cause of injury in 38.4% (n = 17) patients. Open fractures were seen in ten patients and 16 of the patients had associated injuries to other body systems.

The patients were followed up period for an average period of 9.2 months (range 5–20 months). Bone union was seen in 93.3% (n = 42) of fractures with an average time to union of 26.2 weeks (range 12–66 weeks). Bone grafting was required to achieve union in three cases which included a case of implant failure where revision fixation with bone grafting was done.

Out of these 45 fractures, soft tissue complications were seen in 22.2% of cases (n = 10). This patient sub group had seven males and three females with an average age of 45.3 years (range 30–65

Table 1
Patient characteristics of parent cohort and sub cohort with soft tissue complications.

Parameter	Parent cohort	Complication Cohort
Included fractures	45	10
Average age in years (range)	42.6 (18–65)	45.3 (30–65)
Male: Female	28:16:00	07:03
Road side accidents	38.4% (n = 17)	60% (n = 6)
Open fractures	22.2% (n = 10)	30% (n = 3)
Time to bone union in weeks (range)	26.2 (12–66)	17.8 (12–22)
Average follow up period in months(range)	9.2 (5–20)	7.7 (5–10)
Nonunion	6.7% (n = 3)	Nil
AO Classification		
43A	29	5
43C	9	1
42A	2	1
42C	5	3
Spanning external fixation	17.8% (n = 8)	30% (n = 3)
MIPO	37.8% (n = 17)	50% (n = 5)
ORIF Fibula	17.8% (n = 8)	20% (n = 2)

years). Road side accidents were the cause of injury in six cases in this sub-cohort and all of these were two wheeler accidents. Open fractures were seen in three patients. Table 1 gives a comparative evaluation of the parent cohort and the sub-cohort with soft tissue complications.

In four of the 10 patients, there was difficulty in achieving primary wound closure at the time of definitive fixation. For this, soft tissue release and split skin grafting was done in three cases [S no. 1, 2 and 9 and Fig. 1(a)–(d)] and transposition flap was required in one case (S no 7) (Table 2). In five other cases, wound dehiscence with exposure of implant was seen within 12 to 30 days of surgery. Four of these patients required a local rotation flap [S no 5, 6, 8 and 10 and Fig. 2(a)–(c)] while one case had a superficial infection for which secondary closure was done after a course of intravenous antibiotics (S no 4). One patient had a malreduction for which readjustment of the fixation was done two days after fixation. Secondary suturing was done in this case to achieve wound closure four days after the second surgery (S No 3). Overall, five cases each in this sub cohort were treated with MIPO and ORIF techniques. All cases in this cohort with soft tissue infections went on to achieve union with average time to bone union of 17.8 weeks (range 12–22 weeks).

4. Discussion

The treatment of distal tibial fractures continues to evolve. These injuries include both extra-articular tibial shaft fractures which are usually due to torsional load as well as pilon fractures which involve the periarticular region and are caused due to axial loading. With the increase in high energy trauma and osteoporosis, the incidence of open fractures as well as complex fracture patterns involving a large segment of distal tibia has increased.^{1,13}

The soft tissue envelope over the distal tibia is thin with limited vascularity and is prone to complications like wound dehiscence and infection. The management of these fractures is dictated by the condition of the soft tissues and a two staged approach with initial spanning external fixation is often necessary. Intramedullary nails have shown good results for the management of extra-articular distal tibial shaft fractures but are associated with malunion and antecedent ankle pain.^{1,2} Also, nailing is not suitable for distal fractures which are near the joint or extend into the joint surface. The use of low profile precontoured locking plates has allowed stable fixation of fractures with very short distal fragments. Minimally invasive plate synthesis (MIPO) has been advocated to minimize soft tissue complications as well as preserve the vascularity of the fracture fragments.^{4,5,14,15}

Many studies have shown good results of locked plating with MIPO technique in distal tibial fractures with complication rates comparable to intramedullary nailing.^{6–8} However, a few studies in recent literature have shown a high rate of soft tissue complications associated with the use of locked plates in distal tibial fractures.^{9–12} Viberg et al. in their series of 71 patients reported a complication rate of 69%, the majority of which were soft tissue complications. This multicentric study divided the complications into two categories – minor and major and concluded that their results may be more representative for centres where locking plate with MIPO technique are used less frequently.¹² Ronga et al. in their series of 21 patients reported low complication rates based on the proportion of deep infections (n=3), but they also reported six patients with wound dehiscence thus taking the overall proportion of soft tissue complications much higher.⁹ There is lack of clarity in defining the soft tissue complications in many studies and this could be one of the reasons for possible under-reporting of these complications.^{4,5,12} Some authors have excluded patients with

Fig. 1. (a) Preoperative X-ray of leg anteroposterior (AP) and lateral view showing fracture of distal tibia (Serial No. 2 in Table 2); (b) Intraoperative picture showing release incision to close the incision for plating; (c) Skin grafting done at release incision site; (d) X-ray of leg showing union at final follow up.

Table 2

Details of patient sub cohort with soft tissue complications.

S no	Age (years)	Sex	Mode of Injury	Time of plating after injury(days)	Open/ Closed fracture	AO Classification	Operative technique	Soft tissue complication	Intervention required
1	30	M	RSA	6	Closed	43A	ORIF	Difficulty in primary wound closure	Release incision at primary surgery with split skin grafting
2	35	M	RSA	1	Closed	42C	MIPO	Difficulty in primary wound closure	Release incision at primary surgery with split skin grafting
3	30	M	RSA	14	Open	43A	Spanning external fixator at Day 1 with ORIF at Day 14	Difficulty in wound closure after readjustment of plate to correct malreduction	Secondary suturing
4	48	M	RSA	1	Closed	42C	MIPO	Wound dehiscence at 30 days with superficial infection	Secondary suturing after a course of intravenous antibiotics
5	56	M	RSA	13	Closed	42C	Spanning external fixator at Day 1, MIPO for tibia & ORIF for Fibula with one-third tubular plate	Wound dehiscence at 12 days	Bipedicle transposition flap with SSG
6	62	F	Domestic fall	9	Closed	42A	Spanning external fixator followed by ORIF	Wound dehiscence at 12 days	Rotation flap
7	35	M	RSA	1	Open	43A	MIPO	Difficulty in primary wound closure with exposed implant	Transposition flap at the time of primary surgery
8	65	F	Domestic fall	1	Closed	43A	MIPO	Wound dehiscence at 21 days	Rotation flap
9	57	M	RSA	6	Closed	43C	ORIF for tibia & ORIF Fibula with reconstruction plate	Difficulty in primary wound closure	Release incision at primary surgery with split skin grafting
10	35	F	Domestic fall	1	Open	43A	ORIF	Wound dehiscence at 10 days	Rotation flap

open fractures or soft tissue blistering thus leading to a bias in the overall results.¹⁶ Li et al. in their meta-analysis compared MIPO with conventional fixation techniques (CFT) and found that MIPO had a longer operating time, longer radiation time and higher incidence rate of soft tissue irritation symptoms than those of CFT.¹⁷ There was no significant difference between the two techniques with regard to union time, the American Orthopedic Foot and Ankle Society (AOFAS) score, infection rate and other complications.

Our study also reports a relatively high incidence of soft tissue complications (22.2%) and supports the notion that these complications may be more common than it is currently thought. In our study, the average age, sex ratio and proportion of open fractures of the sub-cohort with soft tissue complications was not significantly different from the parent cohort. In the sub-cohort, road side accidents were seen in 60% (n=6) of the cases. All these injuries involved two wheelers and the direct impact on the distal tibia with subsequent injury to the soft tissue envelope may have contributed to the soft tissue complications. Ninety per cent (n=9) of the fractures in the sub cohort were AO type 42A, 42C or 43A. These were extra-articular fractures with sharp bony spikes either not involving the articular surface or extending into the joint surface without any displacement. The sharp bony spikes may have indented the soft tissue envelope thus leading to complications. Kent et al. in their series also reported that 82% (n=9) of the patients who were readmitted and underwent reoperation had type 43A fractures.¹¹ This is in variance with the expected notion that soft tissue complications are seen more with comminuted intraarticular fractures.

In our sub-cohort with soft tissue complications, MIPO and open reduction were done in five cases each. All surgeries were performed by experienced consultant trauma surgeons. Wenger et al. in their study compared absolute stability using lag screw and neutralisation plate (LSN) with relative stability using bridge plating (BP) in distal meta or diaphyseal tibia fractures.¹⁹ LSN was done with biological mini open technique and bridge plating was

done with subperiosteal dissection using MIPO principles. The authors found that time to union was statistically significant shorter ($p=0.04$) in the LSN group compared to the BP-group. Deep surgical site infections were also less the LSN group as compared to the BP-group. Thus, open reduction may work as well as MIPO if performed carefully while adhering to biological techniques.

In the sub-cohort with soft tissue complications, 50% of cases (n=5) underwent fixation within 24 h of the injury where as in others, fixation was performed after a cooling period ranging from six to 14 days. Spanning external fixation was done in 30% of the cases (n=3) as compared to 17.8% (n=8) in the parent cohort. Thus, the role of spanning external fixation in decreasing the soft tissue complications needs to be defined further.

The proportion of fibular fixation by open reduction was also similar in both cohorts. The role of fibular fixation in distal tibial fractures is still controversial. Torino et al. in their study reported that fibula fixation may improve the ability to obtain and maintain reduction in complex distal tibial fractures; however, the increased stability may also increase rates of non-union. Also, whether fibular fixation adds to soft tissue complications has not been elucidated in the literature.¹⁸

The limitations of our study include its retrospective nature, small sample size and lack of comparison group. A well designed randomized controlled trial with defined role of fibular fixation, spanning external fixation, choice of fixation modality (IMN Vs Plate), fixation technique (MIPO Vs ORIF) and detailed review of soft tissue complications will shed more light on the subject.

The authors would like to put forward and reinforce certain principles and guidelines to minimize soft tissue complications in distal tibial fractures. These are as follows:

1. If the fracture is associated with a significant soft tissue injury, then a cooling period of 5–10 days is required to allow soft tissue swelling to subside. Spanning external fixator should be applied initially and definitive reconstruction done after the appearance of skin wrinkles.

Fig. 2. (a) Intraoperative picture showing wound dehiscence (Serial No. 8 in Table 2); (b) Intraoperative picture showing rotation flap; (c) Healed skin at final follow up.

2. If there is sufficient length of distal segment to allow adequate distal locking, intramedullary nailing can be considered.
3. A detailed preoperative planning can lead to improved results and decrease complications. This includes careful study of the x-rays, templating and drawing of the fracture fragments as well as the desired end result. Skin incision and intraoperative reduction techniques should be planned, including switching to open reduction in case indirect reduction is unsuccessful. A distractor or external fixator should be used to achieve and maintain reduction.
4. Proper contouring of the plate should be done and it is crucial that the plate is positioned very close to the bone, especially at the supramalleolar level, to prevent soft-tissue irritation by the plate.
5. Fibular fixation, if planned, is usually done before the tibial fixation. Fibular reduction must be accurate so that it does not prevent tibial reduction.

5. Conclusion

Distal tibial fractures are challenging injuries to treat which require careful planning and execution of management. The

literature has shown good results with the use of medial locking plates for these fractures with MIPO technique with acceptable complication rates. However, recent studies (including the present study) show that the incidence of soft tissue complications with the use of these plates may be more than what is currently thought off and further studies are required to shed more light on this subject.

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Contribution of each author

Jain D. and Selhi H.S. contributed equally to this work; Jain D. and Selhi H.S. designed the study, collected and analyzed the data and drafted the manuscript; Yamin M. and Mahindra P. provided analytical oversight; Yamin M. supervised the study and offered the technical or material support; Mahindra P. revised the manuscript for important intellectual content; Selhi H.S. provided administrative support; all authors have read and approved the final version to be published.

Conflict of interest

None.

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References

1. Vallier HA. Current evidence: plate versus intramedullary nail for fixation of distal tibia fractures in 2016. *J Orthop Trauma*. 2000;30:S2–6.
2. Guo JJ, Tang N, Yang HL, Tang TS. A prospective, randomised trial comparing closed intramedullary nailing with percutaneous plating in the treatment of distal metaphyseal fractures of the tibia. *J Bone Joint Surg Br*. 2010;92:984–988.
3. Hoenig M, Gao F, Kinder J, Zhang LQ, Collinge C, Merk BR. Extra-articular distal tibia fractures: a mechanical evaluation of 4 different treatment methods. *J Orthop Trauma*. 2010;24:30–35.
4. Bahari S, Lenehan B, Khan H, McElwain JP. Minimally invasive percutaneous plate fixation of distal tibia fractures. *Acta Orthop Belg*. 2007;73:635–640.
5. Hazarika S, Chakravarthy J, Cooper J. Minimally invasive locking plate osteosynthesis for fractures of the distal tibia—results in 20 patients. *Injury*. 2006;37:877–887.
6. Vallier HA, Cureton BA, Patterson BM. Randomized, prospective comparison of plate versus intramedullary nail fixation for distal tibia shaft fractures. *J Orthop Trauma*. 2011;25:736–741.
7. Minhas SV, Ho BS, Switaj PJ, Ochenjele G, Kadakia AR. A comparison of 30-day complications following plate fixation versus intramedullary nailing of closed extra-articular tibia fractures. *Injury*. 2015;46:734–739.
8. Bingol I, Yalcin N, Bici V, Tulunay T, Yuksel K, Kilicarslan K. Minimally invasive percutaneous plate osteosynthesis does not increase complication rates in extra-articular distal tibial fractures. *Open Orthop J*. 2015;9:73–77.
9. Ronga M, Longo UG, Maffulli N. Minimally invasive locked plating of distal tibia fractures is safe and effective. *Clin Orthop Relat Res*. 2010;468:975–982.
10. Lau TW, Leung F, Chan CF, Chow SP. Wound complication of minimally invasive plate osteosynthesis in distal tibia fractures. *Int Orthop*. 2008;32:697–703.
11. Kent M, Mumith A, McEwan J, Hancock N. The service impact of failed locking plate fixation of distal tibial fractures: a service and financial evaluation at a major trauma centre. *Eur J Orthop Surg Traumatol*. 2015;25:1333–1342.
12. Viberg B, Kleven S, Hamborg-Petersen E, Skov O. Complications and functional outcome after fixation of distal tibia fractures with locking plate—a multicentre study. *Injury*. 2016;47:1514–1518.
13. Avilucea FR, Sathiyakumar V, Greenberg SE, et al. Open distal tibial shaft fractures: a retrospective comparison of medial plate versus nail fixation. *Eur J Trauma Emerg Surg*. 2016;42:101–106.
14. Collinge C, Protzman R. Outcomes of minimally invasive plate osteosynthesis for metaphyseal distal tibia fractures. *J Orthop Trauma*. 2010;24:24–29.
15. Gupta RK, Rohilla RK, Sangwan K, Singh V, Walia S. Locking plate fixation in distal metaphyseal tibia fractures: series of 79 patients. *Int Orthop*. 2010;34:1285–1290.
16. Gupta A, Anjum R, Singh N, Hackla S. Outcome of distal both bone leg fractures fixed by intramedullary nail for fibula & MIPPO in tibia. *Arch Bone Jt Surg*. 2015;3:119–123.

17. Li A, Wei Z, Ding H, et al. Minimally invasive percutaneous plates versus conventional fixation techniques for distal tibial fractures: a meta-analysis. *Int J Surg*. 2017;38:52–60.
18. Torino D, Mehta S. Fibular fixation in distal tibia fractures: reduction aid or nonunion generator? *J Orthop Trauma*. 2016;30:S22–S25.
19. Wenger R, Oehme F, Winkler J, Perren SM, Babst R, Beeres FJ. Absolute or relative stability in minimal invasive plate osteosynthesis of simple distal meta or diaphyseal tibia fractures? *Injury*. 2017;48:1217–1223.