



OUTCOMES OF MINIMALLY INVASIVE PLATE OSTEOSYNTHESIS (MIPO) FOR DIAMETAPHYSEAL DISTAL TIBIA FRACTURES AT KOSHI ZONAL HOSPITAL

Roshan Yadav*¹, Shambhu Sah¹, Nabin Subedi¹, Yagya Kharel¹, Mahendra Mahato¹,
Shilabant Sen Sribastav¹, Diwas Raj Bhandari²

1. Department of Orthopedics, Koshi Zonal Hospital, Biratnagar, Nepal.

2. Department of Anesthesiology, Koshi Zonal Hospital, Biratnagar, Nepal.

ARTICLE INFO	ABSTRACT	ORIGINAL RESEARCH ARTICLE
<p>Article History Received: Dec' 2018 Accepted: Jan' 2019 Keywords: Minimally Invasive Plate Osteosynthesis, Internal Fixation, Distal Tibia Diametaphyseal Fractures.</p> <p>Corresponding author*</p>	<p>Introduction: Lower limb trauma is a common presentation in our day to day clinical practice. Distal diametaphyseal tibia being subcutaneous bone is one of the common fracture sites. Open reduction and internal fixation (ORIF) could further endanger their circulation adding iatrogenic trauma. Closed reduction and minimally invasive plate osteosynthesis (MIPO) with pre-contoured locking plate on basis of biological osteosynthesis (BO) is an alternative treatment option. The aim of this study is to estimate hospitalization period, fracture union period and complications of MIPO with pre-contoured locking plate on diametaphyseal distal tibia fracture.</p> <p>Objective: Evaluation of outcomes after MIPPO in distal diametaphyseal fractures managed by using distal tibial pre-contoured locking plate at Koshi Zonal Hospital.</p> <p>Methodology: Twenty-seven patients with close distal tibia diametaphyseal fracture were treated with MIPO technique between May 2016 to June 2018 in Koshi Zonal hospital.</p> <p>Results: There were 27 patients with mean age 43.83 years (range: 18-70 years). The average duration of hospital stay was 11.94 days (range: 6-25 days). Average fracture union duration was 21.05 weeks (range:17-27weeks); among them, two cases got a superficial infection. There was no angulation and no implant failure. Eight patient complained implant prominence and pain around ankle after fracture healed.</p> <p>Conclusion: MIPO with pre-contoured locking plating in distal tibia diametaphyseal fracture is a rational choice with short union time, few complications and early rehabilitation.</p>	

1. Introduction

The treatment of distal tibia fractures remains controversial. Previous modalities were open-reduction internal fixation (ORIF) with a plate, an interlocking intramedullary nail (ILIMN), and hybrid or ring external fixators. These stabilizations had their own benefits and complications. Evidence shows that ORIF can

often be complicated by infection, wound dehiscence, delayed union or non-union. External fixation and ILIMN could minimize soft tissue disturbances but complications of external fixation may occur such as pin tract infection, pin loosening, and malunion with rotation, axial misalignment, and non-union. Secondary procedures like bone grafting may

be required^{1,2}. Minimally invasive plate osteosynthesis (MIPO) offers biological advantages and is gaining popularity nowadays. MIPO involves preservation of vascular integrity of the bone and preserves osteogenic fracture hematoma. Another biological osteosynthesis like ILIM nailing has reported a high rate of malunion due to mismatch of the different diameter of intramedullary canal in the diaphyseal and metaphyseal site of the distal tibia and difficult to achieve two distal screw and nail propagation into the ankle joint. MIPO is one of the useful treatment for distal tibia fracture and can be used more effectively.^{3,4,5}

Methodology

We conducted a cross-sectional study of twenty-seven patients managed by MIPO technique for closed diaphyseal distal tibia fractures in Koshi Zonal Hospital from May 2016 to June 2018. All patients had signed informed consent to undergo the surgical treatment. Patients with closed diaphyseal distal tibia fractures having fracture patterns like transverse, oblique, spiral and comminuted were included in the study. We did not include compound fractures with significant soft tissue damage, compartment syndrome with impaired circulation, intra-articular fractures and pathological fractures in our study. All data were tabulated in Microsoft Excel and results were analyzed.

Management protocol

Our protocol in the management of distal tibia fracture included immediate immobilization with below knee POP slab and elevation of the leg until definitive fixation. Those patients who had gross swelling and blisters were managed with ice compression and puncturing blisters with sterile needle followed by the non-adhesive dressing. Patients were kept under analgesics for the management of pain and antibiotics for soft tissue injuries and prevention of secondary infection till swelling subsided.

Operative technique

Preoperatively we planned that at least 3-4 screws were proximal and distal away from the fracture site. Intra-articular fracture extensions and associated fibular fracture were also noted. All patients under spinal anesthesia were positioned supine on the radiolucent table

with thigh tourniquet. Routine preparation and draping of the injured limb were performed.

Direct or indirect reduction techniques were used under fluoroscopy guidance, depending upon the nature and pattern of fracture with the help of manual traction, reduction forceps, towel clamps or K-wire as a joystick or temporarily fixation as required. Associated fibular fractures were not fixed unless necessary for accurate reconstruction of length and ankle mortise; if needed, was fixed with either closed reduction with intramedullary K-wire or open reduction with plate fixation before tibia fracture fixation. With the aid of fluoroscopy, an appropriate pre-contoured locking buttress plate was selected based on its length and curve. According to plate location longitudinal incision, 1-3 cm was made in the skin beneath the two ends of the plate. One incision was at the midline of the medial malleolus, the other was made along the medial aspect of the tibia located the proximal end of the plate. The appropriate length of the plate was determined by placing a plate along the anterior aspect of the leg and adjusting it under fluoroscopy. An extraperiosteal, subcutaneous tunnel was created between these two incisions using blunt dissection. The great saphenous vein and nerve were protected and then the plate inserted percutaneously from distal to proximal. The assistant applied traction to the operated leg to restore length and alignment under fluoroscopy and once reduction achieved, the pre-contoured plate was fixed to the bone. With fractures extending into the ankle joint, careful attention was paid to the restoration of articular surface continuity. Further screw use depended upon the characteristics of fracture such as a lag screw which was inserted across the fracture via the plate in order to reduce the fracture gap and add to the rigidity of the fixation. It was not necessary to place screws through all of the remaining holes in the plate as this does not further increase the strength or rigidity of fixation construct. Wound closure was achieved with absorbable suture material for the deep layers and skin sutured with non-absorbable suture material. Below the knee, plaster slab was applied till suture out and incision site healed^{6,7}.

Post-operative protocol

The operated limb was elevated in the post-op period with intravenous antibiotic therapy according to wound condition. The first dressing was done on the 3rd postoperative day. Most of them were discharged depending upon wound conditions such as swelling, blisters and wound discharge. Second dressing time was informed to the patient depending upon the condition of the wound.

Follow up

All patients were kept on non-weight bearing ambulation with crutches. Patients were reviewed in the outpatient department at 11-14 postoperative days for wound infection and stitches removal. Below the knee, plaster slab was removed according to the condition of

soft tissue healing around the fracture site and incision site to initiate physiotherapy. They were then reviewed at intervals of 6-7 weeks. Weight-bearing was allowed after radiological and clinical union.

Results

Twenty-seven patients were included in the study, mean age 43.83 (range 18-70) years, the average duration of hospital stay was 11.94 (6-25) days, pre-operative hospital stay mean 6.33 (range 3-17) days till swelling, blisters and soft tissue condition improved, postoperative hospital stay was mean 5.61 (range 3-14) days. Among 9 fibula fractures, 4 were left as such, 4 for closed reduction and internal fixation with K-wire and 1 for ORIF with plating.

Table 3: Demographics age, male, female, full-weight bearing, and bone healing

Age total (mean and range) years	43.83 (18-70)
Age male (mean and range)years	42.58 (18-70)
Age female (mean and range) years	46.33 (35-61)
Duration of surgery (mean and range) minutes	57.77 (50-80)
Full weight bearing (mean and range) weeks	11.5 (8-15)
Bone healing time (mean and range) weeks	21.05 (17-27)
Associated fibula fracture (number)	9
Fibula fixed	5 (4 k-wire and 1 plating)
Post- operative Superficial or deep infection	2 (superficial infection)
Hardware prominence and pain around the ankle	8 patients

Depending on soft tissue conditions and plate fixation we removed posterior plaster slab for physiotherapy with partial weight bearing on the mean 3.44 weeks (range 3-6 weeks). Full weight bearing (walking) mean 11.5 (range 8-

15) weeks was based on our clinical and radiological fracture healing and clinical union or fracture healing time was mean 21.05 (range 17-27) weeks.

Table 4: Duration of Hospital stay

Admission to surgery (mean-range) days	6.33 (3-17)
Surgery to discharge (mean-range) days	5.61 (3-14)
Total hospital stay (mean-range) days	11.94 (6-25)

One patient had severe swelling with blister and deformity along with superficial skin infection. The leg of this patient was placed in the slab for 8 days with an aim to correct the deformity. After 8 days deformity correction was not achieved so the patient was subjected to calcaneal traction. Thus MIPPO of distal

tibia fracture along with ORIF with plating of the fibula was performed after 17 days of hospital stay.

Another one had contra-lateral type one compound proximal tibia fracture; in such case, 1st surgery MIPPO in distal tibia and after a week MIPPO in proximal tibia was performed.

Table 5: Distribution of age, sex, and laterality of leg

Age (year)	Male		Female		Total n %
	RT	LT	RT	LT	
18-40	5	2	4	2	13 (48.14)

41-60	6	3	1	1	11 (40.74)
61-80	1	1	1	0	3 (11.11)
Total	12	6	6	3	27

Some minor complications during follow-up in the outpatient department were seen such as pain around ankle especially medial malleolus, prominent hardware, and light stiffness. No complications during follow-up in the outpatient department were seen such as delayed union, nonunion and obvious malangulation.

Discussion

The treatment of distal tibia fractures can be challenging because of limited soft tissue, the subcutaneous location of the bone and poor vascularity around distal tibia. Shrestha RP.⁸ found that delayed union, non-union, and infection were seen in ORIF and malunion in MIPPO. Several studies reported that MIPPO technique could reduce periosteum damage, provide a favorable microenvironment for fracture healing, improve indirect bone healing, and reduce fracture healing time. Cheng W.⁹ considered that the MIPO technique is an efficient method for treating distal tibia fracture and found no significant differences in MIPO and ORIF. MIPO is more challenging because of management under x-ray control; ORIF still considering better than MIPO and ILMN. Intramedullary nailing (IMN) offers a minimally invasive option; however, concerns have been raised regarding the biomechanical stability of fixation and risk of malunion or nonunion. However, when the fracture line is less than 5 cm proximal to the ankle joint, intramedullary nailing (IMN) is not applicable. Baral R.¹⁰ found that IMN is a high demanding procedure as compared to plate osteosynthesis because of difficult to maintain reduction and control distal segment during insertion of IMN. If proper reduction fails, malalignment or nail propagation into ankle joint can occur. Natarajan GB.¹¹ found that MIPO and IMN interlocking nail are equally effective methods for distal tibia fracture in terms of union rates and final outcomes; fibular fixation can minimize the incidence of malunion with IMN. The minimally invasive plate osteosynthesis (MIPO) technique has gained prevalence in recent years. The key point in the management of distal tibia fracture is to recognize the

importance of soft tissue component. Failing to appreciate the soft tissue condition will invariably complicate the fracture with infection, wound dehiscence or non-union.

MIPO is technically more demanding and requires high exposure to radiation because of indirect reduction. The surgeon is dependent on intraoperative fluoroscopy to confirm an adequate reduction and screw fixation. MIPO preserves most vascularity and fracture hematoma which help more biological repair, decrease the incidence of delay union, non-union, bone grafting, and infection¹². Interfragmentary compression osteosynthesis of all fragments in a comminuted fracture is not recommended but careful reduction without diastasis between the main fracture fragments. However interfragmentary compression screw in plate accelerates fracture healing and the plate protects the screw from bending, shearing and rotational forces. Locking screws enable the plate to act mechanically as an internal fixator and do not rely on the bone/plate friction effect to achieve primary stability thus preserving the surrounding periosteal blood supply and reducing bone resorption underplate. The triple screw anchorage and monobloc aspect of the construct enhance stability and improve the pullout strength. When the fracture is healed, the physically active patient might experience stress-related pain at the plate ends especially malleolar skin irritation, which can be treated by plate removal through the original small incisions. Other indications for plate removals are difficulty in wearing shoes and cosmetic concern because of prominent hardware in thin patients.^{13,14} Orthopedic surgeon always faces hazards in operation theater such as radiation, infections, surgical smoke, noise, chemicals, and tiredness. Overuse of C-arm fluoroscopy may increase the chances of cancer, infertility, sterility, birth defects, leukemia, and radiation sickness.¹⁵ LORPPO (limited open reduction percutaneous plate osteosynthesis) technique can be done in case of malfunction of C-arm fluoroscopy during MIPO.¹⁶ In all of our patient's fracture reduction, alignment and

angulation were maintained. Acceptable tibial alignment was 5 degree of varus, recurvatum or procurvatum. Fracture healing is defined as mature callus formation seen on plain radiograph with pain-free full weight bearing. Our results are comparable to other studies using the MIPO techniques. These MIPO results are better than ORIF, interlocking nail, and external fixation. Implant removal depends on patient demand and complications.

Conclusions

MIPO with pre-contoured locking buttress plate in diaphyseal distal tibia fracture shortened both the union time after surgery and the period of rehabilitation. Our study found encouraging results in cases of distal tibia fractures treated with MIPO technique like a short hospital stay, few complications, fairly good ankle range of motion.

Recommendations

With our study results, we recommend pre-contoured locking plating in the distal tibia (DT-LCP) diaphyseal fracture can be the standard method of management of distal tibia fracture.

Limitation of the study:

Our study was single-center study and had the small sample size, so we recommend a larger sample size and multi-centric study with longer follow up.

Conflict of interest:

The authors declare no financial support or potential conflict of interest.

Acknowledgment:

We are very grateful to Dr. Roshan Pokhrel (Medical Superintendent), Dr. Mukund Dahal (HOD, Orthopaedic Department), Mrs. Anjula Karki (OT-Incharge), Dr. Kanak Khanal and Dr. Sailoj Jung Dangi (Department of Anesthesiology) from Koshi Zonal Hospital for their support in this study.

References

- Yip WH, Lee KB, Shen WY. Early experience of metaphyseal plating by the minimally invasive plate osteosynthesis technique for close distal tibia fractures. *Hong Kong J Ortho Surg.* 2006;10(1):22-27. [Google Scholar]
- Syah B, Brian L, Hamad K, John P. Minimally invasive percutaneous Plate fixation of distal tibia fractures. *Acta Orthop. Belg.* 2007; 73(5):635-640. [Google Scholar]
- Shrestha D, Acharya BN, Shrestha PM. Minimally invasive plate osteosynthesis with locking compression plate for distal diaphyseal tibia fracture. *Kathmandu Univ Med J.* 2011;34(2):62-8. [Google Scholar]
- Redfern DJ, Syed SU, Davies SJM. Fractures of the distal tibia: minimally invasive plate osteosynthesis. *Injury.* 2004; 35(6): 615-620. [Google Scholar]
- Zou J, Zhang W, Zhang CQ. Comparison of minimally invasive percutaneous plate osteosynthesis with open reduction and internal fixation for the treatment of extra-articular distal tibia fractures. *Injury.* 2013;44(8):1102-1106. [Google Scholar]
- Li M, Zhang X, Liu X, Jing Y. The recent development of MIPO in long bone fracture. *Open Journal of Orthopedics.* 2012;2:159-165. [Google Scholar]
- Helfet DL, Shonnard PY, Levine D, Borrelli J. Minimally invasive plate osteosynthesis of distal fractures of the tibia. *Injury.* 1997;28: A42-A48. [Google Scholar]
- Shrestha RP, Ghale TM. MIPPO Vs ORIF with Plate in Distal Tibial Fractures. *Journal of Gandaki Medical College - Nepal, Jan - June 2014, Vol. 7, Issue 1.* [Google Scholar]
- Cheng W, Li Y, Manyi W. Comparison study of two surgical options for distal tibia fracture minimally invasive plate osteosynthesis vs. open reduction and internal fixation. *International orthopedics.* 2011 May 1;35(5):737-42. [Google Scholar]
- Baral R, Raj Kandel P. A preliminary comparison between the intramedullary interlocking nail and minimally invasive plate osteosynthesis in extra-articular distal tibia fractures: a retrospective study. *South African Orthopaedic Journal.* 2017;16(4). [Google Scholar]
- Natarajan GB, Srinivasan DK, Vijayaraghavan PV. Comparison of clinical, radiological, and functional outcome of closed fracture of distal third tibia treated with nailing and plate osteosynthesis. *African Journal of Trauma.*

- 2014 Jul 1;3(2):68. [Google Scholar]
 - Sidhu AS, Brar BS, Mann HS, Bakshi AS, Tanwar YS, Sidhu GDS. Minimally invasive plate osteosynthesis for proximal and distal tibia fractures. *Pb Journal of Orthopaedics*. 2010;12(1):14-17. [Google Scholar]
 - Ehlinger M, Adam P, Bonnomet F. Minimally invasive locking screw plate fixation of non-articular proximal and distal tibia fractures. *Orthopaedics & Traumatology: Surgery & Research*. 2010;96(7):800-809. [Google Scholar]
 - Borg T, Larsson S, Lindsjo U. Percutaneous plating of distal tibial fractures preliminary results in 21 patients. *Injury*. 2004;35(6):608-614. [Google Scholar]
 - Sah S, Bikash KC, Dangi SJ, Khanal K, Basnet R. Risk for the surgical team during orthopedic surgeries. *Journal of Society of Anesthesiologists of Nepal*. 2017 Jun 28;4(1):29-34. [Google Scholar]
 - Sah S, Bikash KC, Dangi SJ, Rai RK, Yadav R. Limited Open Reduction and Percutaneous Plate Osteosynthesis-Alternative Option to Minimally Invasive Plate Osteosynthesis in Management of Distal Tibia Fractures. *Journal of the Nepal Medical Association*. 2017 Oct 1;56(208). [Google Scholar]
-