Minimally Invasive Percutaneous Plate Osteosynthesis (MIPO) for Distal Tibial Metaphyseal Fracture: A Better Option

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Abstract

Objective: The objective of this study was to evaluate the radiological and functional outcomes for treatment of fracture distal tibial metaphysis fixed with pre-contoured anatomical locking compression plate using minimally invasive percutaneous plate osteosynthesis (MIPO) technique.

Method: This was a prospective study conducted at Department of Orthopedic Surgery, Services Hospital, Lahore. Total of 58 closed distal tibial metaphyseal fractures (AO classification 43A) included in the study. All patients were operated using anatomical LCP with MIPO technique. The functional outcome was assessed by Tenny & Wiss criteria at 6 weeks intervals with final scoring at 24th week. Functional outcome was graded as excellent, good, fair and poor. Similarly, radiological outcome was also assessed at 6 weeks intervals using Hammer et al criteria and grade 3 labelled as union.

Results: We observed excellent functional outcome in 48 patients (82.6%) and good outcome in 6(10.34%) at last follow-up. Radiological union was achieved in 100% (58) patients at 24th week. The average time of union was 16.5 weeks with a range of 12 to 23 weeks. Three patients (5.17%) developed superficial wound infection which was successfully managed with antibiotic therapy and no surgical site deep infection reported.

Conclusion: Results of this study advocate that treatment of distal tibial metaphyseal fractures with LCP by MIPO technique is an effective modality resulting in less complication, high bone union and good functional outcome.

Keywords: Locking compression plate, minimally invasive percutaneous plate osteosynthesis

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Introduction

Tibial fractures occur due to high and low energy trauma. It has annual incidence of 17 per 100,000 population.[1] Treating distal tibial metaphyseal fracture is a difficult conundrum even for the experts. Various factors which guide the surgical plan includes pattern of fracture, extent of soft tissue involvement and quality of bone.[2,3] Four commonly used methods include casting or bracing, external fixation, internal fixation with plates and intra-medullary fixation. Conservative management with POP casting is associated with complications of ankle stiffness, loss of reduction, mal-union and non-union. External fixation is challenging and is associated at time with inaccurate reduction, spanning of the ankle joint, stiffness, and infection at pin tracts. Intramedullary nailing is troubled with less stability because of short distal segment.[4,5] Soft tissue viability and periosteal injury in distal fracture fixation poses complication risk with conventional methods of internal fixation using open technique. Secondarily the loss of precious fracture hematoma by soft tissue dissection done to attain anatomical reduction and periosteum stripping can cause

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delayed union or even non-union. To avoid these complications and the soft tissue devitalization,[6] minimally invasive plate osteosynthesis techniques has evolved. This method preserve the helpful biological environment to promote union by decreasing the surgical insult. But the use of dynamic compression plating for these metaphyseal fractures led to metalwork failure, angular deformities and non-union.[7] All these ideas led to the evolution of the new plating system being broader distally to include more screw options for the small distal segment leading to better purchase of implant. The biomechanics of locking plates are designed to decrease the compressive forces between the plate and bone therefore decreasing the damage to periosteal blood supply. In contrast to the shear force with DCP these new plates convert axial loading into compression forces. Therefore locking plates are superior implants having better biomechanics especially in elderly osteoporotic bone and metaphyseal bone.[8] Another advantage of these LCP is the achievement of indirect reduction and use in bridging mode without compression. Percutaneous application of LCP causes less periosteal blood supply disruption and enhance early union. Hence pre-contoured anatomical locking plates for distal tibial fractures applied by MIPO technique results in higher union rates decreased wound complications and show better functional outcome.[10]

The motive of this study was to ascertain the radiological and functional outcome of distal tibial metaphyseal fractures treated by pre-contoured locking compression plates using minimally invasive percutaneous osteosynthesis (MIPO).

Material and Method

This was a prospective study conducted in the Department of Orthopedic Surgery, Services Hospital, Lahore from 2016 to 2018. We included 58 patients with closed distal tibial fractures according to AO classification 43A (A1, A2, A3) of either gender. Patients with associated vascular diseases, pathological fractures and compartment syndrome were excluded from the study. Review board of the hospital granted ethical approval for the study. Procedural benefits and risk were explained to the patients and informed written consent was obtained.

Initial management included fracture splinting, limb elevation and analgesia. All the patients underwent surgery by same surgical team using minimally invasive percutaneous plate osteosynthesis (MIPO) under image intensifier. Fracture reduction was done under C-arm with point reduction clamps. A 3cm incision was given medially distal to fracture site and with the help of periosteal elevator a tunnel was made for plate. Second incision was made around the proximal part of plate. **(Fig-1)** A minimum of 4 screws were placed proximal to fracture site. Anatomically pre-contoured locking compression plate was used in all cases. Anatomical reduction was achieved after plate insertion and screws placed by stab incisions. Range of movement exercises at ankle and knee initiated on 1st day after surgery. All patients were discharged to home by 3rd post-operative day. All patients were followed up after 2 weeks of surgery for wound examination and removal of stitches. Patients were later followed up at 06 weekly interval for assessment of bone union and functional outcome. Though range of motion exercises were started immediately post operatively, but weight bearing was commenced only after visualizing callus bridging fracture site. Functional outcome assessed by Tenny & Wiss criteria 100 points. Scores were graded as Excellent (>92), Good (87-92), Fair (65-87) and Poor (<65). Hammer et al criteria for bone union was used for radiological union. The criteria had five grades depending on the stage of bone union. Grade 5 fracture shows no callus or sign of union whereas Grade 1 denote Homogeneous bone formation with obliterated fracture line. We regarded Grade 3 as a minimum acceptable criterion for labelling union. **(Fig-2)**

The data was compiled and analyzed using SPSS version 19.0. Descriptive statistics was used. Quantitative data was like age, union time was presented as mean and standard deviation. Qualitative data like gender was presented as frequencies distribution. For categorical data Chi square test was applied and p-value <5 was taken significant.

Fig-1: *MIPO Technique*

Post operative AP & Lat view

Radiological union achieved

Fig-2: *X-Rays showing fracture distal tibia fixed with MIPO technique.*

Results

A total 58 patients with closed distal tibial metaphyseal fractures (43A AO classification) were enrolled. There were 46 (79.3%) male patients and 12 (20.7%) female patients. The male to female ratio was 4:1. Minimum age of the patients was 25 years whereas maximum age was 45year, with mean age of 34.12 years ± SD 5.98 years. Regarding the mechanism of injury 46 (79.3%) fractures were because of road traffic accident and 12 (20.7%) had history of fall. (Table-1) Functional outcome according to Tenny & Wiss 100 points Criteria was evaluated at 6 weeks intervals. Results were graded as Excellent > 92 points, Good 87 – 92 points, Fair if points 65- 87 and below 65 was graded as Poor outcome. The scores improved significantly after 6th week; 37 63.79%) patients achieved excellent and 18(31.03%) had good outcome at 12th week. At 24th week final follow-up 48 (82.75%) patients had excellent, 06 (10.35%) had good and 04 (6.90%) patients had fair outcome. (Table-2) In this study radiological outcome was assessed with the help of Hammer et al criteria. Grade 3 or apparent bridging of the fracture line was minimum requirement to be labelled united. At 24th week 49 patients had Grade-I, 7 patients had Grade-II and 2 patients radiological union was at Grade-III. The average time for union was 16.5 weeks with a range of 12 to 23 weeks. A 5 degree or more angulations in any plane (varus, valgus, procurvatum and recurvatum) was regarded as malunion. All the fractures united with acceptable alignment with no malunion.

Three patients developed superficial wound infection and were managed with one-week course of antibiotics. One of these patients was diabetic on oral hypoglycemic drugs with HBA1c level of 8.5. After opinion from Diabetic Management Center, she was shifted to insulin for proper control. Fortunately, infection was controlled in all patients and no further management was required.

Discussion

Table 1: *(General Statistics)*

1	**Age of patients**	**Average: 34.12±5.98** **Range: 25 years to 45 years**
2	Male : Female	4:1
3	Mechanism of Injury	Road Traffic Accident: 46 (79.3%) Fall: 12 (20.7%)

Table 2: *Functional Outcome Tenny & Wiss Criteria*

	6Th Week	12th Week	18th Week	24th Week
Excellent (>92)	0(0%)	37(63.79%)	41(70.69%)	48(82.76%)
Good (87-92 points	0(0%)	18(31.03%)	11(18.97%)	6(10.34%)
Fair (65-86 points)	0(0%)	3(5.17%)	6(10.34%)	4(6.90%)
Poor (<65 points)	58(0%)	0(0%)	0(0%)	0(0%)

Table 3: *Radiological Outcome*

Hammer et al Criteria	6th Week	12th Week	18th Week	24th Week
Grade-I (Excellent)	0(0%)	13(22.41%)	33(56.90%)	49(84.48%)
Grade-II (Good)	0(0%)	36(62.07%)	16(27.59%)	7(12.07%)
Grade-III (Fair)	0(0%)	9(15.52%)	6(10.34%)	2(3.45%)
Grade IV & V (Poor)	0(0%)	0(0%)	3(5.17%)	0(0%)

The ideal management of distal tibial metaphyseal fractures remains a riddle irrespective of extension into the adjacent ankle. The conventional treatment strategies are associated with unacceptable high complication rates. Intra-medullary nailing considered gold standard for diaphyseal fractures but not the best choice in distal metaphyseal fractures of tibia due to extremely short distal segment and mismatch between nail and tibia diameter. Traditional plating requires tremendous soft tissue trauma and periosteal stripping which further disrupt the blood supply. Therefore it was troubled by high risk of non-union, delayed union and wound complications.[11] Similarly, the use of external fixation for these fractures is associated with pin loosening in approximately half of the cases, pin tract infection, joint stiffness and significantly high percentage of mal-union. Evolution of minimally invasive technique (MIPO) had granted biological advantage of preservation of blood supply and decreased soft tissue problems. Pre contoured locking compression plates act synergistically with MIPO tech-

nique to provide a stable construct and bridled the common complications of internal fixation. These anatomically pre contoured plates also help to attain indirect reduction. Insertion of these newer implants requires a small incision and plates are tunneled extra-periostealy on the medial side of tibia. The enhanced screw options for distal fragment increase the stability of this fixed angle device.[12-15]

S. Hazarika reported his experience with MIPO for twenty tibial metaphyseal fractures with main focus on union time and related complications. He extended the indications to include open fractures in his study as well. Eight patients in his open fracture group achieved union within six months, while two cases of non-union were reported. In closed fracture group 7 patients achieved union in 6 months and no reported non-union. In his study 3 patients underwent implant removal because of deep surgical site infection and delayed wound dehiscence.[9] Implant failure was documented in one case at 32 weeks who had a redo surgery with DCP and union achieved. Whereas in our study we had two cases of superficial wound infection but no wound breakdown. Both the cases were successfully managed with oral antibiotics. Also, all our patients achieved union without any further intervention. Abid Mushtaq in a similar study used LCP with MIPO to fix twenty one distal tibial metaphyseal fractures. Average union time reported was 22 weeks (range 3–13 months). One case in his study required second surgery for non-union and finally union documented. Functional outcome was good in his 17 patients. Although two of his subject had superficial wound infection but no surgical intervention was required and fractures united.[6] The union time in our study was significantly lower 16.5week (range 12 – 23 weeks). The rate of infection in our study was 5.0% as compared to 10% in this study. In another study B Ganesh Bahadur Gurung union rate was reported to be 100% by 24th week. Full weight bearing was allowed in 93% cases at 24th week. Surgical site infection complicated two cases while another required bone grafting and fibulectomy.[16] The findings of this study match our results.

In his study Syah Bahari reported mean union duration of 22.4 weeks. Union rate was 100% with no case of non-union or mal-union. Infection troubled his three patients, deep in one while superficial in remaining two cases.[17] He utilizes SF 36 and AOFAS score to determine functional outcome. At 19th month follow-up mean SF 36 score was 85 whereas 90 was mean AOFAS score in his patients. These results are consistent with the results of our study with 54 patients (93.10%) showing excellent or good results at 24th week. Tenny and WISS criteria is 100 point system similar to AOFAS score with 50 point for pain and remaining 50 for the functional assessment, checking every aspect of functional outcome in complete detail.

The results of our study are comparable in fact better than other studies. The difference in union time among the studies could be because of the different criteria used for defining union. Functional outcome was excellent or good in > 90% cases irrespective of which scale they used. The soft tissue complications and malalignment risks encountered with other fixation techniques are minimized. These plates can be applied as neutralizing, compression or bridging implant. The choice mainly guided by the fracture geometry. For non-comminuted simple fractures reduction followed by lag screw and application in neutral mode or using plate as compression device. However there use as a bridging implant is more suitable for complex comminuted fractures. Rationale decision making and judicious use of pre-contoured LCP by MIPO increases the probability of union and are associated with fewer side effects.

Conclusion

In conclusion, MIPO using low profile pre contoured LCP for distal tibial metaphyseal fracture is a better implant choice due to high bone union and less complications. The newer implants and techniques have achieved this by minimizing the surgical insult, preserving precious periosteal blood supply and osteogenic fracture hematoma.

Conflict of Interest None

Funding Source None

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Authors Contribution

MA: Conceptualization of Project
MTJ: Data Collection
RDN: Literature Search
SAQ: Statistical Analysis
OIC: Drafting, Revision
SR, OA: Writing of Manuscript