MIPO IN DISTAL TIBIAL METAPHYSEAL FRACTURES A COMPARISON AMONG DCP, LCP AND PRE-CONTOURED DT-LCP

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ABSTRACT

Objective: To compare the results with three types of plates in treatment of comminuted distal tibial metaphyseal fractures with minimally invasive plate osteosynthesis (MIPO).
Study Design: Retrospective non randomized comparative study.
Place and Duration of Study: Department of Orthopaedic Surgery, CMH Multan, Muzaffarabad and Rawalpindi from Mar 2007 to Oct 2012.
Patients and Methods: Total 51 patients were managed by MIPO technique. A 4.5mm Narrow Dynamic Compression Plate (DCP) was used in 16 cases, 4.5mm Narrow Locking Compression Plate (LCP) in 12 and 3.5 mm pre-contoured distal tibial LCP (DT-LCP) in 23 cases. Assessment was done monthly until radiological union and quarterly thereafter.
Results: There were 37 males, 14 females, mean age of 33 years: (Range 14-66 years). Primary union achieved in 14 of 16 cases (87.5%) with DCP and 2 (12.5%) went on secondary union after bone grafting. 10 of 12 cases (83.33%) with LCP went into primary and two into secondary union (16.66%). Primary union occurred in all case treated by DT-LCP. One case of superficial infection occurred in each group. Functional results were "excellent to good" in 14 (87.5%) in DCP group, 11 ((91%) in LCP and 22 ((95.6%) in DT- LCP group. Time to union and functional outcome in the three groups was insignificant (p>0.05).
Conclusion: MIPO may be used successfully, with different plates, for distal tibial metaphysial fractures because of less disturbance to soft tissue and blood supply.

Keywords: Comminuted fractures, Distal Tibia, DCP, LCP, DT-LCP, MIPO.

INTRODUCTION

Multi-fragmentary distal tibial fractures are challenging to manage because of thin soft tissue coverage and easily compromised blood supply[1,2]. They are only 1- 10% of lower extremity fractures[3]. Different operative techniques have been used for treatment of these fractures but none of these is considered ideal[4]. The goal of the techniques is to apply stable fixation while maintaining the fracture biology and minimizing the soft tissue problems[5-7]. Conventional open reduction internal fixation results in additional insult to already bruised skin as well as periosteal stripping thus leading to further vascular compromise[5]. It is difficult to control alignment in meta-hyseal fractures with I/M nails, especially if comminution is there[8,9]. Minimally invasive plate osteosynthesis (MIPO) allows plate fixation with minimal skin incision and little periosteal stripping[10]. MIPO has gained popularity with the development of LCP[11]. It is based on principles of indirect functional reduction, relative stability and biological union. Different implants have been used for MIPO from 4.5mm narrow Dynamic compression plate (DCP), 4.5 mm locking compression plate (LCP) to pre-contoured distal Tibial LCP (DT-LCP). DCP and LCP require on table contouring whereas in pre-contoured plates this is not required. Locking plates give superior fixation than DCP but are more expensive. We compared the results with these three implants to find the advantage of one over the other.

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MATERIAL AND METHODS

This was a retrospective non-randomized comparative study carried out at CMH Multan, CMH Muzaffarabad and CMH Rawalpindi from March 2007 to October 2012. A total of 51 cases of distal tibial fractures operated at CMH Multan, CMH Muzaffarabad and CMH Rawalpindi were included in the study. Approval from the ethical review board was taken. Inclusion criterion was all closed extra articular distal tibial fractures operated by MIPO technique. Open fractures, those with articular involvement and fractures treated by open reduction and internal fixation were excluded.

All patients were admitted from the emergency department where initial treatment such as splinting and analgesics were given. Radiographs were carried out and skin condition was assessed. Patients were taken for surgery once skin condition was favourable. Pre contouring of plates was important in case of DCP and LCP whereas it was not required with DT-LCP. The distal end was curved externally about 15 degrees and the right limb plate was given a counterclockwise contortion of about 20 degrees (clockwise contortion for the left limb) to adapt with the distal anatomical shape of tibia. Contoured template from normal side was used as guide. The plates were placed over the medial aspect of bone in all cases. The fracture was reduced by closed manipulation supplemented with use of percutaneous pointed reduction clamps where required. The intra operative use of C-arm helped in reduction. The main fragments were held by percutaneously placed lag screws through stab incisions where found feasible. One incision 2-3 cm was given distal to fracture and a subcutaneous tunnel was made with the help periosteal elevator without stripping of periosteum. Other incision of similar length was given proximal to the fracture and plate adjusted at the required length. Usually 4 holes proximally were considered enough. At the distal end at least two screws were aimed. After adjusting the plate and achieving functional reduction, screws were placed by stab incisions. Fibula was fixed with 1/3rd tubular plate if fracture was within 5 cm of ankle joint and in highly comminuted fractures to restore ankle mortise. Examples are shown in fig-1, 2 & 3.

Post operatively the patients were followed clinically and radiologically monthly till fracture union was achieved and three monthly afterwards. Weight bearing was started once fracture union was visible however range of motion exercises at knee and ankle were started on 1st postoperative day. Clinical union was consi-dered once patient was pain free and there was no movement at the fracture site. Radiological union was declared when bridging callus was seen among the fracture fragments. Significant malunion was defined as more than 5 degrees of varus or valgus, anterior-posterior or rotational deformity. Ankle function was assessed at last follow up using the functional assessment criteria[12] reported earlier by one of the authors in another study (table-I). The maximum score was 16, more than 14 was considered excellent, 11-14 good, 8-11 fair and less than 8 was considered poor.

Statistical Analysis and citations: Data was analysed with statistical package for social sciences (SPSS version 17). Comparison between variables was done using paired "t" test. A *p*-value of less than 0.05 was considered as significant. End Note 6 was used for compilation of references.

RESULTS

A total of 51 cases were included in the study out of which 16 were managed by DCP, 12 by LCP and 23 by DT-LCP. Mean age was 33 years with a range of 14-66 years. Male to female ratio was 37:14. Regarding mechanism of injury 41 were because of road traffic accidents and 10 because of direct blows. Fractures were classified by AO classification and 08 were A2 and 43 were A3 fractures. In 44 cases only tibia was fixed and in 07 cases both tibia and fibula were fixed. Average duration of surgery was 50 minutes range 40-125 minutes. Average stay in hospital was 3 days range 2 to 12 days (table-II).

Primary union was achieved in 14 out of 16 (87.5%) cases in DCP group and 2 (12.5%) required cancellous bone grafting and then went

on secondary. 10 out of 12 cases (83.33%) in LCP groups went into primary union and two required bone grafting before secondary union (16.66%). Primary union was achieved in all case prominence and skin irritation was not observed in any case. Insignificant, less than 5 degrees, radiological malalignment was seen in 8 (50%), 3 (25%) and 4 (17.3%) cases in the three respective

Figure-1: Fracture fixation with DCP using MIPO technique. (a) A3 fracture distal tibia.(b): Contouring of DCP. (c): Introduction of plate through distal incision. (d): Drilling through stab incision. (e): Distal incision and stab wounds. (f): Post operative radiograph showing plate in place with good reduction.(g & h): Union at 24 weeks.

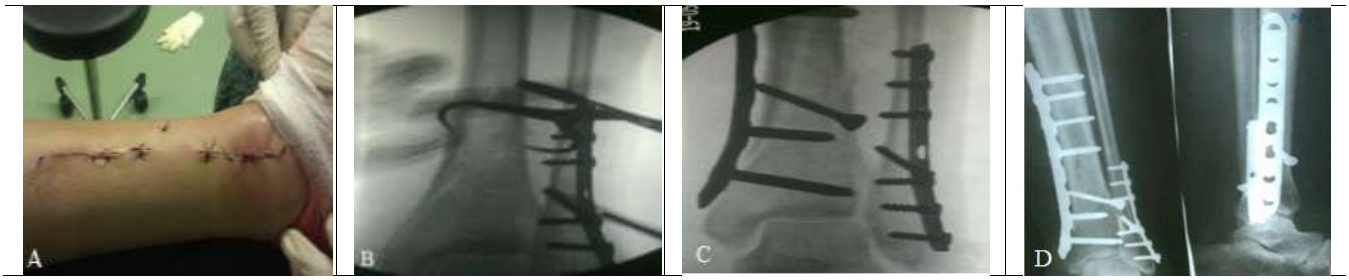

Figure-2: (a): Minimal exposure with proximal, distal and stab incisions. (b and c): Operative C-arm images showing fixation of fibula to attain length followed by indirect reduction and use of percutaneous reduction clamps. (c): Final picture after application of LCP. (d): Fracture union at 20 weeks.

Figure-3: MIPO with DT-LCP. (a) Stab incisions. (b): Early post op X ray after surgery. (c): Union at 18 wks.

treated by DT-LCP. There was one case of superficial wound infection in each group which was treated by long course of antibiotics. Implant groups. Significant more than 5 degrees mal-alignment was only seen in one (6.2%) case of DCP group. Functional outcome was graded

from good to excellent in 14 (87.5%), 11(91%) and 22 (95.6%) cases respectively. It was graded as fair in 2 in DCP and one each in LCP and DT-LCP groups (table-III). The three groups were compared with each other by using student t-test for time to union and functional outcome. A *p*-value was greater than 0.05 (table-IV) in all comparisons so there was no statistically significant difference in functional outcome or time for union for the three groups.

Table-I: Functional assessment criteria (Iqbal and Amin)[7].

Criterion	Score				Functional Outcome
	1	2	3	4	
1. Pain	Severe	Moderate	Mild	No pain	
2. Weight bearing	Nil	Walking with bilateral walking aid/toe touching only	Walking with unilateral aid/brace	Walking without aid	
3. Limp	Not able to walk at all	Gross limp	Minor limp	No limp	
4. Joint mobility	Knee joint restric-tion of movement >50° Ankle joint restriction >30	Knee joint restriction of movement <50° Ankle joint restriction <30°	Knee joint restriction of movement <20° Ankle joint restriction <20°	Knee joint restriction of movement <5° Ankle joint restriction <10	

Functional Outcome Grading: Score > 14 = Excellent Score 11-14 = Good Score 8-11 = Fair Score < 8 = Poor.

Comparison study of two surgical options for distal tibia fracture—minimally invasive plate osteosynthesis vs. open reduction and internal fixation.

Table-II: (General statistics).

1.	Age	33 (range: 14-66 years)
2.	Male: Female	37: 14
3.	Mechanism of injury Road Traffic accidents Direct Blow High velocity missile	 41 07 03
4.	Type of Injury Closed (Tscherne) Grade 1 Grade 2	 51 38 13
5.	Fracture type (AO) A2 A3	 08 43
6.	Fixation Tibia only Tibia & Fibula	 44 07
7.	Type of Plate 4.5 Narrow DCP 4.5 Narrow LCP 3.5 DT-LCP	 16 12 23
8.	Average duration of surgery	50 min Range; 40 to 125 min
9.	Hospital stay	3 days Range: 2-12 days

DISCUSSION

Multi-fragmentary distal metaphyseal tibial fractures remain a challenge to manage. Different

methods such as closed management, ORIF with plates and closed IM nailing have been used for treatment. In closed management it is difficult to maintain reduction[4] whereas in open reduction there is soft tissue stripping which retards bone healing[13]. The goal of the operative treatment is to obtain anatomical alignment of the joint surface by providing enough stability to allow early movement this should be accomplished using techniques that minimize osseous and soft issue devascularization in the hopes of decreasing the complications resulting from treatment[14]. In IM nailing the difference in size of medullary canal in distal tibia makes it difficult to maintain reduction[3]. Plating with MIPO technique is relatively new technique which relies on closed functional reduction and plating without large exposures and soft tissue stripping thereby causing less disturbance to blood supply and allowing better chances for fracture healing. We started using MIPO technique by using conventional DCP for fractures of distal tibial metaphysis. The problems we faced were difficult contouring and in fractures with small distal fragment where engaging of 4 cortices was difficult and at times not possible. But it was very cost effective. LCP gives a better fixation than DCP[15] so after the availability of 4.5 mm narrow LCP the distal fixation with 4 cortices using locking screws giving better angular stability, was more satisfactory but the difficulties in contouring persisted. After the introduction of distal tibial pre-contoured LCP, we were able to extend this technique to fractures with smaller distal fragments because of smaller 3.5 mm screws and more options due to wider distal part of the plate. It provided multidirectional locking screws options in relatively small distal fragment, hence providing stable fixation, more angular stability and pull-out strength. It was also found much convenient but about three times more expensive than traditional DCP.

Table-III: Results.

S. No.	Parameters	DCP (n=16)	LCP (n=12)	DT-LCP (n=23)
1.	Union	Mean 19 weeks Range (14-35 wks) Secondary union 2	Mean 19 weeks Range (15-35 wks) Secondary union 2	Mean 18 weeks Range (14-22 wks) Delayed union 0
2.	Infection	Superficial 1	Superficial 1	Superficial 1
3.	Implant failure	Screw breakage 2	Nil	Nil
2.	Radiological Malalignment	Insignificant(<50):8 (50%) Significant(>50): 1 (6.2%)	Insignificant(<50):3 (25%) Significant(>50): 0	Insignificant(<50):4 (17.3%) Significant(>50): 0
3.	Functional outcome	Good-Excellent: 14 (87.5%) Fair: 2 (12.5%) Mean: 12.06	Good-Excellent: 11 (91%) Fair: 1 (8.3%) Mean: 12.66	Good-Excellent: 22 (95.6%) Fair: 1 (4.34%) Mean: 12.44

Table-IV: Comparison of group results.

Comparison	Mean	Standard Deviation	Standard error	*p*-value
Functional outcome score				
DCP/LCP	12.06/12.66	1.98/1.43	0.49/0.41	0.35
DCP/DT-LCP	12.06/12.44	1.98/1.75	0.49/0.41	0.55
LCP/DT-LCP	12.66/12.44	1.43/1.98	0.41/0.41	0.70
Time taken for union				
DCP/LCP	19.8/19.16	5.82/6.69	1.45/1.93	0.79
DCP/DT-LCP	19.8/17.89	5.82/3.85	1.45/0.80	0.21
LCP/DT-LCP	19.16/17.89	6.69/3.85	1.93/0.80	0.54

We compared the groups with each other and did not find any statistically significant

difference as far as time to union and functional score is considered. Bastias *et al*[16] also showed in their study that there is no significant difference in outcome between locking and conventional plates in management of distal tibial fractures[17]. Shabbir *et al*[9] also used DCP and other non locking implants in their study and their time to union is similar to ours. Shrestha *et al*[18] used DT-LCP in their study in Nepal and had comparable results to our study.

CONCLUSION

Distal tibial metaphyseal fractures are challenging to manage. We recommend MIPO as safe method for treating these fractures. DCP, LCP and DT-LCP can be used with comparable results. DT-LCP is easy to use but expensive. DCP is cheaper but requires contouring and a larger distal fragment for stable fixation. Appropriate implant option can be selected considering type and geometry of fracture and patient's financial status.

CONFICT OF INTEREST

This study has no conflict of interest to be declared by any authors.

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