Minimal Invasive Plate Osteosynthesis in Closed Distal Tibial Fractures

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Abstract

Purpose
Unstable fractures of the distal tibia can present a management dilemma. Traditionally, there have been a variety of methods of management described and high rates of associated complications reported. In this series we evaluate the outcome of minimal invasive plate osteosynthesis (MIPO) technique for such a fracture.

Patients and Methods
Twenty patients (fourteen men and six women) were operated for closed distal tibial fractures (with or without intra-articular extension) by MIPO technique. The mean age was 36.25 years (range, 20-55 years). If an associated fibular fracture was in need for fixation, it was fixed first before tibial fixation. Patients were followed up for 12 months postoperatively. A functional ankle score was assigned using the criteria of Teeny and Wiss.

Results
Two patients were considered dropout from the study. The mean delay from injury to surgery was 8.4 days (range, 5-17 days). The mean operative time was 108 min (range, 80-150 min). Fibular osteosynthesis was performed in seven patients. The mean hospital stay was 11.4 days (range, 7-14 days). The mean follow-up period was 13 months (range, 9-20 months). There was a 38.9% rate of excellent results, a 27.8% rate of good results, a 22.2% rate of fair results, and a 11.1% rate of poor results. Mean time of radiological union was 14 weeks (range, 10-22 weeks). Only one patient sustained nonunion of the tibia. In 15 patients (83.3%) wound healing was uneventful. Four patients sustained 5-10^0 angular deformities.

Conclusion
MIPO technique for closed distal tibial fracture has satisfactory clinical, functional and radiological outcome.

Keywords
MIPO, Plate Osteosynthesis, Distal Tibial Fractures.

Introduction

Unstable fractures of the distal tibia with or without intra-articular fracture extension can present a management dilemma. Traditionally, there have been a variety of management methods described and high rates of associated complications reported. Non-operative treatment can be technically demanding and may be associated with joint stiffness in up to 40% of cases as well as shortening and rotational malunion in over 30% of cases[1]. Traditional operative treatment of such injuries is also associated with a high incidence of complications. Intramedullary nailing remains the gold standard for treatment of most diaphyseal fractures of the tibia. However, although some authors have described good results with intramedullary nailing in the treatment of distal peri-articular tibial fractures, it is generally considered unsuitable for such injuries, due to technical difficulty and design limitations.[1] Traditional open reduction and internal fixation of such injuries results in extensive soft tissue dissection and periosteal injury and may be associated with high rates of infection, delayed union, and non-union[1]. Similarly, external fixation of distal tibial fractures maybe also associated with a high incidence of complications, with pin infection and loosening in up to 50% of cases and malunion rates of up to 45%[2].

Minimally invasive plate osteosynthesis (MIPO) may offer biological advantages. MIPO involves minimal soft tissue dissection with preservation of the vascular integrity of the fracture and as well as preserving osteogenic fracture haematoma[3]. Minimally invasive techniques in distal tibial fractures are technically feasible and may be advantageous in providing adequate stabilization of the fracture.[4] Indications for minimally invasive plate osteosynthesis of distal fractures include displaced fractures involving the tibial plafond and those unstable fractures too distal for safe stabilization with

intramedullary nails.[5] Minimally invasive techniques maintains alignment without compression.[5]

This study evaluates the clinical, functional and radiological outcome of MIPO technique for patients with closed distal tibial fractures.

Patients and Methods

During the period between November 2011 and February 2014, twenty patients (fourteen men and six women), were operated for closed distal tibial fractures at both of Cairo university hospital and Fayoum university hospital. The mean age was 36.25 years (range, 20-55 years). Eleven fractures were on the right side and nine fractures were on the left side. The mechanisms of injury included motor car accident in two patients, motor bike accidents in five patients, fall from height in nine patients, direct trauma in four patients. According to AO fracture classification, sixteen patients were type 43A, and four were type 43B. There were twelve fractures type C0, and eight fractures type C1 according to Tscherne - Gotzen classification [6].

Exclusion criteria included pathological fractures, neurological deficit, vascular insult, skeletally immature patients and open fractures. Proper clinical examination and radiological assessment were carried out for all patients. CT scan was undertaken for comminuted cases. Informed consents were taken for all patients.

Surgical technique

If the patient sustained an accompanying fibular fracture necessitating fixation, open reduction and internal fixation of fibular fracture was carried out first, using a one-third tubular plate through the lateral approach or K-wire fixation. Skin incision is taken at posterolateral aspect, posterior to fibula and lateral malleolus to maximize the skin bridge between lateral and medial incisions.

The anteromedial skin incisions for tibia is located distally at the level of the medial malleolus and proximally about 2-3 cm proximal to the upper end of the fracture line and opposing to the plate's holes (Fig. 1).

Typically, a subcutaneous tunnel over the periosteum was created between the two incisions and along the medial aspect of the tibia by blunt dissection.

The anatomical distal plate was placed and cortical/cancellous screws were then placed at each end of the plate through the two incisions and in the mid position via small percutaneous stab incisions under fluoroscopy or by using other external identical plate to adjust screws.

Patients were followed up at 2-week, monthly till union achieved, 6, and 12-month postoperatively. They were examined clinically and radiologically. Ankle joint mobilization was started 2-3 weeks postoperatively. Partial weight bearing was allowed 6-8 weeks postoperatively. Thereafter, weight-bearing was gradually increased according to pain and union.

Evaluation of tibial plafond fractures was calculated using the criteria of Ovadia and Beals[7] and subsequently modified by Teeny and Wiss[8].

AP and lat radiographs were obtained (Fig. 2,3). Malalignment was defined as more than 5° of angular deformity. Fracture union was defined radiographically as bridging cortical bone on at least 2 cortices combined with the ability to bear full weight on the extremity. Nonunion was defined as lack of any healing on plain radiographs within 6 months.

Figure 1: Proximal and distal skin incisions used in MIPO technique.

Results

Twenty distal tibial fractures have been treated using MIPO technique. Two patients did not complete the follow-up, thereby they were considered dropout from the study.

All patients were operated upon under spinal anaesthesia. The mean delay between the injury and surgery (till improvement of the skin condition) was 8.4 days (range, 5-17 days). The mean operative time was 108 min (range, 80-150 min).

Fibular fracture was present in fourteen (77.8%) patients. Fibular osteosynthesis was performed in seven (38.9%) patients, where three patients were fixed with one-third tubular plate and four patients were fixed with intramedullary K-wires. The remaining seven cases did not receive fibular fixation because of either poor soft tissue condition (one case), or the type of fracture did not necessitate fixation (six cases).

Figure 2, A: Preoperative AP radiograph of distal tibial fracture. B: Preoperative lateral radiograph. C: Preoperative coronal CT. D: Preoperative sagittal CT. E: Postoperative AP radiograph at 3-month follow-up. F: Postoperative lateral radiograph at 3-month follow-up.

Figure 3, A: Preoperative AP radiograph. B: Preoperative lateral radiograph. C: Early postoperative AP radiograph. D: Early postoperative lateral radiograph.

The mean hospital stay was 11.4 days (range, 7-14 days). The mean follow-up period was 12 months (range, 9-20 months).

A functional ankle score was assigned for each patient at the time of the last follow-up visit using the criteria of Teeny and Wiss[8,9]. This 100-point scale is a modification of the ankle grading system that evaluates pain, ROM, level of activity, and the use of assistive devices. The largest single component of this system is pain (50 points). A score of 93 to 100 points indicates an excellent function; a score of 87 to 92 points, good function; a score of 65 to 86 points, fair function; and a score of less than 65 points, poor function.

Using this scoring system, there was a 38.9% rate of excellent results, a 27.8% rate of good results, a 22.2% rate of fair results, and a 11.1% rate of poor results in the current series (Table 1). Variables contributing to the functional results were analyzed according to this system (Table 2).

Mean time of radiological union was 14 weeks (range, 10- 22 weeks). Only one patient sustained nonunion of the tibia, but he refused any further surgical interference.

Twelve patients could return to their preinjury activity level and jobs, five patients had their activity level decreased and had to change their jobs while one patient was unable to work.

Table (1): Results of individual criteria according to Teeny & Wiss[8] score.

Case No.	Pain	Walking	Support	Running	Toe-raising	Hills	Stairs	Limp	Swelling	Plantar ROM	Dorsal ROM	Total Score	Result
1	50	8	6	3	5	3	3	**8**	2	**2**	**4**	**94**	**Excellent**
2	45	6	6	0	3	2	2	**6**	1	**2**	**3**	**76**	**Fair**
3	50	8	8	3	5	3	3	**6**	2	**2**	**4**	**94**	**Excellent**
4	50	1	0	0	0	0	2	**0**	1	**2**	**4**	**60**	**Poor**
5	50	8	4	3	3	3	2	**8**	1	**2**	**4**	**88**	**Good**
6	50	8	8	3	5	3	2	**6**	1	**3**	**3**	**92**	**Good**
7	50	8	8	0	0	3	2	**2**	1	**0**	**0**	**74**	**Fair**
8	40	8	6	3	5	2	2	**4**	2	**2**	**3**	**77**	**Fair**
9	45	8	8	5	5	3	3	**8**	3	**2**	**4**	**94**	**Excellent**
10	**Lost during follow up**												
11	50	8	8	3	5	3	3	**6**	2	**2**	**4**	**94**	**Excellent**
12	50	8	8	3	5	3	2	**8**	1	**3**	**4**	**95**	**Excellent**
13	50	8	8	5	5	3	3	**8**	2	**3**	**3**	**98**	**Excellent**
14	45	8	8	3	5	3	3	**6**	2	**3**	**3**	**89**	**Good**
15	45	8	8	5	5	3	3	**8**	3	**3**	**4**	**95**	**Excellent**
16	45	2	0	0	1	0	2	**0**	1	**2**	**3**	**56**	**Poor**
17	50	8	8	3	3	2	2	**4**	3	**3**	**3**	**89**	**Good**
18	45	8	8	3	5	3	3	**8**	3	**3**	**3**	**9**	**Good**
19	45	8	8	3	3	3	3	**6**	1	**2**	**3**	**85**	**Fair**
20	Lost during follow up												

Table (2): Overall results according to bone and functional parameters.

Variable		Number of patients	
Bone results			
1.	Union	**17/18**	**94.4 %**
2.	Angular deformities > 5˚	**2 /18**	**11.1%**
3.	Angular deformities ≤ 5˚	**2/18**	**11.1%**
4.	Leg-length discrepancy > 1cm	**0 / 18**	**0%**
Functional results:			
1.	Limping	**2/18**	**11.1%**
2.	Range of motion of ankle > 20˚	**12/18**	**66.7%**
3.	Returned to pre injury activities	**12/18**	**66.7%**
4.	Deep infection	**1/18**	**5.5%**
5.	Pain during walking	**3/18**	**16.7%**
6.	Analgesics	**3/18**	**16.7%**

In 15 patients (83.3%) wound healing was uneventful. Three patients developed a late infection around the proximal or distal screws 13, 15, and 24 weeks postoperatively, respectively.None of these three infections resolved with local wound care and oral antibiotics according to culture and sensitivity examination for 6 weeks. Therefore the plate was removed at 6, 7, and 12 months, respectively. One patient had a failed distal tibial plate 11 months postoperatively with complete union, hence the plate was removed.

Four patients (22.2%) sustained angular deformities, as two patients had 5˚ and 10˚ valgus deformity respectively, one had 5˚ varus deformity, and one had 10˚ anterior angulation. The former three patients had fair results, while the last one had poor results.

Discussion

None of the treatment options available perfectly fulfill requirements of fracture characteristics of distal tibia. With the development of technique of MIPO which preserves extraosseous blood supply and respects osteogenic fracture haematoma, biologically and stable fixation method is available for distal tibia fracture. Indirect reduction method and subcutaneous tunneling of the plate and application of screws with small skin incisions in MIPO technique prevents iatrogenic injury to vascular supply of the bone[10]. Our aim of this series was to evaluate MIPO for closed distal tibia fracture, which has been found by other authors to be an effective treatment option[11].

MIPO offers several theoretical advantages compared to conventional open plating technique. A mechanically stable fracture-bridging osteosynthesis can be obtained without significant dissection and surgical trauma to the bone and surrounding soft tissues. However MIPO does not allow direct visualization of the fracture and the surgeon is dependent on intraoperative fluoroscopy to confirm that an adequate reduction has been achieved[11-13].

Initial clinical series using these methods demonstrated favorable results with low rates of infection and nonunion, but several complications such as angular deformities greater than 7˚ and hardware failure have been reported[4,14,15].

In this study, most of the patients were in age group of 20-55 years (mean, 36 years) with road traffic accidents being the commonest mode of trauma. Our clinical results were graded as excellent in 38.9%, good in 27.8%, fair in 22.2% and poor in 11.1% according to Teeny and Wiss score. These results are quite comparable to other studies, especially those of Borens et al[16], whose results were excellent in 47%, adequate in 41% and poor in 12%. In contrast, our results were slightly lower than those of others[17,18].

The range of radiological union in this series was 10-22 weeks, with nonunion in one case, which is comparable to other trials[3-5,16-18].

Krackhardt et al[19] reported no angular deformities in 80% of patients, an axial deformity more than 10º in 2.5% which required correction osteotomy, and a tolerable deviation of 5-9º in 17.5%. This goes in line with our results which showed no angular deformities in 77.8% of patients, 5º varus deformity in 5.5%, 5-10º valgus deformity in 11.1%, and 5º anterior angulation in 5.5%. No deformity more than 5º or shortening ≥ 1 cm was reported in many studies[3,4].

In this series, the range of time for full weight bearing was 8-12 weeks and 13-24 weeks in 50% and 44.5% of patients respectively. However, one patient (5.5%) with nonunion had a partial weight bearing in the final follow up. This is comparable to Shabbir's[17]

study, who reported that the time taken for weight bearing was 9-12 weeks in 61.6% and 13-16 weeks in 38.4%. While Abdulla[18] reported that most patients had advanced to partial weight bearing by 6-8 weeks.

Twelve patients (66.7%) could return to their preinjury activities. We cannot be certain that no problems related to ankle osteoarthritis will arise in the future in patients with intraarticular involvement who reported satisfactory functional and radiographic results.

We reported wound complications and infection in 16.7% of patients, and limping in 11.1%. Others reported complications related to MIPO, mainly infection, implant failure, and/or non union, with supplementary procedures required in some cases[3,4,19].

The strengths of this study is in the use of a validated functional outcome score beside clinical and radiological postoperative assessment. However, the limitations include the small sample of patients, the relatively short follow-up period, and the lack of control group which did not allow the formulation of definitive statements and guidelines.

Conclusion

On the basis of the finding of this study it can be concluded that MIPO technique yields good to excellent clinical outcomes with accepted functional outcome for the management of closed distal tibia fractures. Being minimally invasive, it preserves the biological environment by preserving the soft tissue and vascularity and reduces incidence of wound complications.

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