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ORIGINAL ARTICLE

Outcome of Minimally Invasive Plate Osteosynthesis in Management of Metaphyseal Fractures of Tibia

Abdallah Attia¹, Ashraf Abd Eldayem¹, Elalfy MN¹, Hesham Ali Mazen^{1*}.

¹Orthopedic Surgery Department, Faculty of Medicine, Zagazig University, Zagazig, Egypt.

*Corresponding author:

Hesham Ali Mazen
Orthopedic Surgery
Department, Faculty of
Medicine, Zagazig
University, Zagazig, Egypt.
Email:
d.hisham.mazen@gmail.com

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ABSTRACT

Background: Tibial metaphyseal fractures represent a treatment challenge, and with increasing incidence of these fractures that mostly involve the productive age group, so, they need optimum treatment. Minimally Invasive Plate Osteosynthesis is the most effective treatment method, as preserving most of the osseous vascularity and fracture haematoma, thus providing more biological repair and decrease complications. Aim of the study to evaluate the results of using MIPO in management of tibial metaphyseal fractures.

Methods: Prospective analysis of 20 patients with proximal and distal tibial metaphyseal fractures treated by MIPO technique. They were 18 males and 2 females, and mean age was **34.0±11.5 years**, main cause was **RTA**. According to AO classification, 60% of fractures **in group 1** were 41A and 40% were 41C, while **in group 2**, 100% of fractures were 43A.

Results: Mean period for full weight bearing was 12.95±3.53wk. Mean time for complete union was 16.6±3.74 weeks. Functionally, the results were 85% of patients had satisfactory outcome and only 15% of patients had unsatisfactory outcome. The complications were 2 cases with superficial & 2 cases with deep wound infections, 2 cases with moderate to severe pain at fracture site, 1 case with screw site pain, and 1 case with swelling and pain overall affected leg.

Conclusions: MIPO technique is the best option for management of tibial metaphyseal fractures, as short time for full union and for full weight bearing and high satisfactory functional result can be obtained.

Keywords: Proximal metaphyseal fracture of tibia; distal metaphyseal fracture of tibia; MIPO technique



INTRODUCTION

Tibial fractures are one of the most common fractures facing in orthopaedic and with increased incidence of high velocity road traffic accidents, it becomes more complex than before with higher rate of multi-fragmentary peri-articular fractures of the tibia [1, 2]. Due to its critical anatomical features, the management of proximal and distal metaphyseal fractures of tibia has faced a lot of challenges [3, 4].

The goal of proximal and distal tibial fracture treatment is to obtain early union of fracture in the most acceptable anatomical position with early and maximum functional return of activity [5, 6].

The most important factor in the treatment of these fractures is the management of overlying soft tissues [7]. Rhinelander [8] believed that blood supply is the most important factor in normal bone healing. Bone has two primary blood supplies, endosteal high pressure, inner 2/3 &

periosteal low pressure, outer 1/3. Therefore, the concept of management of these fractures has been changed from absolute fixation to relative fixation of biological osteosynthesis with preservation of osseous and soft tissue vascularity. The principles of this minimally invasive technique include indirect closed reduction, extraperiosteal dissection and relative stability which allows limited controlled motion at the fracture site with secondary bone healing with callus formation [9]. Aim of the study to evaluate the results of using MIPO in management of tibial metaphyseal fractures.

METHODS

Written informed consent was obtained from all patients, the study was approved by the research ethical committee of Faculty of Medicine, Zagazig University. The study was done according to The Code of Ethics of the World

Medical Association (Declaration of Helsinki) for studies involving humans.

Study design and settings: A prospective analysis of 20 patients that included in this study. All patients were operated in Orthopedic Surgery Department at Zagazig University Hospitals from November 2018 to January 2019 and followed up for at least 6 months, which is the minimum follow up period expected for these patients.

Inclusion criteria include Age group (>18yr), proximal & distal tibial metaphyseal fractures (fractures were classified according to AO classification), and closed tibial metaphyseal fracture and open tibial metaphyseal fractures (Gustilo & Anderson: G&A I-II).

Exclusion criteria include Age group (<18yr), open tibial metaphyseal fractures (Gustilo & Anderson: G&A III), and extended tibial metaphyseal fractures that disrupt joint line of knee & ankle.

Twenty patients that included in this study, divided into two groups; group 1 were 10 patients with proximal tibial fractures and group 2 were 10 patients with distal tibial fractures.

The age incidence ranged from 18 to 69 years, and mean age of patients was 34.0 ± 11.5 years. There were 18 males 2 females. The right side was affected in 12 patients (60%) and the left in 8 patients. Mechanism of injury: 16 fractures were caused by road traffic accidents (RTA), 3 were caused by fall from height, and 1 by direct trauma. Associated medical diseases, only three patients had medical disorders. In group 1, one patient had HCV, and another patient had diabetes, hypertension and liver cirrhosis. while in group 2, only one patient had diabetes and hypertension. All these diseases were controlled before surgery. Twelve patients were smokers, two of these smokers were addicts to cannabis. Fracture was classified according to AO classification of fracture proximal and distal tibia. In group 1, 2 fractures were 41A2, 4 fractures were 41A3, 3 fractures were 41C1, and 1 fracture was 41C2 (60% extra-articular and 40% simple, partial articular fracture). In group 2, 7 fractures were 43A1, 2 fractures were 43A2, and 1 fracture was 43A3 (100% extra-articular). 60% of the fractures were closed and 40% of the fractures were open. Associated injuries: 16 patients (80%) had fibular fractures, and by exclusion of fibular fractures, there were 9 patients (45%) had associated injury. In group 1, one patient had head trauma, two patients had ACL tear, one patient had fracture mandible, one patient had ipsilateral Pott's fracture, and one patient had ipsilateral mid-shaft tibial fracture. In group 2, one patient had ipsilateral mid-shaft femur fracture, one patient

had contra-lateral Pott's fractures, and one patient had open book pelvic fracture.

On admission all patients were subjected to detailed history taking, full clinical examination, temporary stabilization, cold compression and elevation of the fractured side, essential laboratory investigations and plain X-Ray for full-length anteroposterior(AP) and lateral views of affected tibia, AP and lateral views of ipsilateral knee, and AP and lateral views of ipsilateral ankle. Full counseling of participants in this research and informed consent was obtained with full privacy of participants and confidentiality of the data.

Surgical technique of MIPO:

All patients had spinal anaesthesia except one patient in group 2 associated with open book pelvis fracture had general anaesthesia. All patients were placed in a supine position and light manual traction is maintained on the limb, to avoid excessive deformity at the fracture site. A tourniquet was used in all patients except one in group 2 with ipsilateral mid-shaft femur fracture.

For proximal tibia, Minimally invasive anterolateral approach was done in all cases and minimally invasive anteromedial approach was done in one case with double plates fixation. The plate was inserted through epiperiosteal plane that connect the proximal and distal incisions, and its position was confirmed under fluoroscopic control. Then the proximal K-wire was inserted approximately parallel to the plateau. A minimum of 3 screws were inserted in each main fracture fragment. Proximal screws were inserted first, reduction was rechecked, and then distal screws were placed.

For distal tibia, Minimally invasive medial approach was done in all cases. Just anterior to the medial malleolus, the long saphenous vein and the saphenous nerve were retracted anteriorly to protect them. The plate was inserted through epiperiosteal plane that connect the distal and proximal skin incisions. Then the distal K-wire was inserted approximately parallel to the tibial plafond. A minimum of 3 screws were inserted in each main fracture fragment. Distal screws were inserted first, reduction was rechecked, and then proximal screws were placed.

Finally, the proximal, distal and the stab incisions were sutured after releasing the tourniquet.

Radiological assessment of alignment (degree of reduction) and fixation immediate post-operatively. And included alignment and union at regular period of follow-up. Assessment of Clinical outcome regarding ROM, and assessment of functional outcomes at end of follow-up according to Hospital for Special Surgery Knee-Rating Scale (HSS) score [10] in group 1 and

American Orthopaedic Foot and Ankle Society (AOFAS) score [11] in group 2. Excellent and good results are considered satisfactory while fair and poor results are considered unsatisfactory.

Statistical analysis

Data were collected, tabulated, coded, and entered and analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) software for analysis. According to the type of data qualitative represent as number and percentage and quantitative continues group represent by mean \pm SD, the following tests were used to test differences for significance. Difference and association of qualitative variable by Chi square test (X²). Differences between quantitative independent groups by t test or Mann Whitney, P value was set at <0.05 for significant results & <0.001 for high significant result.

RESULTS

Mean operation duration was distributed as 92.5 \pm 18.46 min (65-130 min), mean time of total hospital stay was 4.0 \pm 2.21 (range 1-11) days. Radiological outcome: Most of alignments that achieved at early and late post-operative was good in 70% of cases. The result was better in group 1 (good in 80% of cases) than in group 2 (good in 60% of cases). None of the patients included in this study suffered from secondary loss of alignment during the healing process of the fracture. According to union time, mean time for complete healing of the fracture was 16.6 \pm 3.74 weeks (10-22 weeks), it was shorter in group 1 than in group 2. Clinical outcome: In group 1 ROM regarding knee were distributed as 0.00 \pm 0.0 for extension and 117.0 \pm 10.05 for flexion. In group 2 ROM regarding ankle dorsiflexion and planter flexion were distributed as 19.5 \pm 6.4 and 37.0 \pm 8.56 respectively, and inversion and eversion were distributed as 22.0 \pm 5.8 and 13.0 \pm 4.21 respectively. Mean period for full WB was 12.95 \pm 3.53wk, It was shorter in group 1 than in group 2. Functional outcome: The results were 85% (n=17) of patients had Satisfactory outcome (60% (n=12) Excellent + 25% (n=5) Good) and only 15% (n=3) of patients had unsatisfactory (Fair) outcome, no one had poor grade.

Unsatisfactory outcome significantly associated with addiction, and associated injuries.

Union time and weight bearing time were significantly higher among unsatisfactory, while ROM of ankle were significantly lower. (Table 1) A non significant relation was found between functional outcome and age, gender, BMI, smoking, cause, limb side, associated injury, overall complication that happened, plate size,

total number of screw that used in fixation, operation duration, and total hospital stay.

Complications:

Sixty percent of cases healed without complications, and forty percent of cases (8 cases) healed with complications; more complications were in G2 with 5 cases (25%) and only 3 cases (15%) were in G1. (Table 2) The complications were two cases with superficial wound infection, all from group 2, were treated by oral antibiotic according to culture and sensitivity and daily dressing. One of them had HTN and DM2, was complicated by skin ulceration. Two cases were complicated by deep wound infection, were treated by antibiotic according to culture and sensitivity, first week by intravenous AB, then change to oral AB for three weeks and daily dressing and debridement. Both cases relapsed after stopping AB, then repeated AB again according to repeated culture and sensitivity, one case (group 1) responded, but the other case (group 2) did not respond to AB treatment, and the plate was removed, as complete union was present. Two cases complained from moderate to severe pain at fracture site, even at rest. One of them from group 1, had open (G&A=I), sever comminution (41A3) fracture proximal tibia, and the alignment was accepted with 5 degrees varus angulations and 10 degrees procurvatum. The other from group 2, addict patient, had closed wedge fracture (43A2) on top of old malunion lower mid-shaft both bone ipsilateral leg, and Potts fracture in contra-lateral ankle. Both patients were treated conservatively by analgesia and physiotherapy. One patient complained from screw site pain, because the distal three screws was too long and under skin, that was removed after complete union was present. One patient complained from swelling and pain overall affected leg, that was increased by walking and gravity and did not subside well after leg elevation, treated by long compressed socks and leg elevation.

Case presentation:

Case 1 include 18 years old male patient, had right side closed fracture proximal tibia, extraarticular (41-A2), caused by RTA. Associated injuries: ACL tear. Time for complete union was 11 weeks. Time of full weight bearing was 8 weeks. Despite the ACL tear was not repaired; it minimally affected on (HSS) score; he achieved 92 points = excellent. No Postoperative complication. (Fig. 1)

Case 2 include 18 years old female patient, had right side open fracture (G&A=I) distal tibia, extraarticular (43-A1), caused by RTA. Time for complete union was 14 weeks. Time of full

weight bearing was 12 weeks. Postoperative complication: deep infection were treated by antibiotic(AB) according to culture and sensitivity, first week by intravenous AB, then change to oral AB for three weeks and daily dressing and debridement. The deep infection relapsed after stopping AB, then repeated AB again according to culture and sensitivity, but did

not respond to AB treatment, and the plate was removed after 6 months, and the fracture was healed well. (Fig. 2) The postoperative infection slightly affected the outcome when we used AOFAS score in clinical evaluation in this case; and she achieved 90 points = excellent.

Table 1: Comparison between functional outcomes (satisfactory and unsatisfactory) regarding Union time & weight bearing time.

	Satisfactory	Unsatisfactory	t/ Mann Whitney	P
Full Weight bearing/wk complete Union time /wk	11.94±2.5	18.66±3.1	-4.132	0.001**
	15.64±3.2	22.0±0.0	-3.362	0.003*

Table 2: master sheets of group 1(G1). yr=year, PMH=past medical history, BMI= Body mass index, OTA= Arbeitsgemeinschaft für Osteosynthesefragen -Online Travel Agency, NO=number, m=male, f=female, R=right, L=left, min=minutes, d=days, wk=weeks, ROM= Range of motion, WB=weight bearing, HSS= Hospital for Special Surgery Knee-Rating Scale scoring system, #-fracture, HCV=hepatitis C virus, HTN=hypertention, DM= Diabetes mellitus, LSS= Liver cirrhosis, S=smoker, a=addict, OP=open, cl=ciose, ACL= Anterior cruciate ligament, MSF=mid-shaft femur, O.B.=open book, KW=k=wire, s.=superficial, d.=deep, gd=good, exc=excellent.

G 1 Case NO	pre-operative data							oprative data							total hosp ital stay (d)	post-operative data							
	Age /yr	Gender	PMH	BMI	Smoking /addict	cause	Limb side	classification			associa ted injury	plate size		Total NO of secraw		Operation duration	radiologic al alignment		ROM		Full WB(wk)	HSS	Co mpli cation
								s open(G&A)	closed(O&T)	tibia OTA								Unio n time com plete (wk)	extention	flexion			
1	69	m	HC V	24.1	S	RTA	R	/	I	41 A3	Head Trauma	12	11	95	5	gd	18	0	115	12	gd		
2	26	m	/	24.5	s	RTA	L	/	0	41 C1	ACL tear	10	7	80	2	gd	10	0	120	13	exc		
3	37	m	/	26	s	RTA	L	I	/	41 A3	/	16	10	10	2	acc	17	0	110	14	gd	Pain	
4	43	m	/	23.5	/	RTA	L	/	I	41 C2	/	14	7	130	6	gd	14	0	125	9	gd		
5	55	m	HT N+ D M2 +L SS	31.1	S	FD	R	/	I	41 A3	/	14	9	90	7	acc	16	0	100	12	exc		
6	18	m	/	24.2	s	RTA	R	/	I	41 A2	ACL tear	11	9	70	5	gd	11	0	130	8	exc		
7	33	m	/	23.6	s	RTA	L	I	/	41 A2	#mand ile	12	10	75	4	gd	22	0	105	18	fair	deep infection	
8	50	f	/	22.7	/	RTA	R	I	/	41 C1	#mid-shaft tibia	8	8	25	8	gd	15	0	115	11	exc		
9	41	m	/	23.9	s	direct trauma	R	II	/	41 C1	R/BO TTS #	14	12	85	11	gd	12	0	130	9	exc	scraw site pain	
10	19	m	/	25	/	RTA	L	/	I	41 A3	/	14	9	75	3	gd	11	0	12	7	exc		

Table 3: master sheets of group 2(G2); yr=year, PMH=past medical history, BMI= Body mass index, OTA= Arbeitsgemeinschaft für Osteosynthesefragen -Online Travel Agency, NO=number, m=male, f=female, R=right, L=left, min=minutes, d=days, wk=weeks, ROM= Range of motion, WB=weight bearing, HSS= Hospital for Special Surgery Knee-Rating Scale scoring system, #=fracture, HCV=hepatitis C virus, HTN=hypertention, DM= Diabetes mellitus, LSS= Liver cirrhosis, S=smoker, a=addict, OP=open, cl=ciose, ACL= Anterior cruciate ligament, MSF=mid-shaft femur, O.B.=open book, KW=k=wire, s.=superficial, d.=deep, gd=good, exc=excellent.

G2 preoperative data													total post operative data													
Case NO	Age/yr	Gender	PMH	BMI	Smoking /addict	cause	Limb side	classifications			associated injury	plate size	total NO of screw	fibula Fixation	Operation duration (min)	total hospital stay(d)	radiological		ROM					AOFAS	Compliation	
								open(G&A)	closed(O&T)	tibia OTA							allignment	complete Union time (wk)	DF	PF	inverton	evertion	Full(wk)			
1	28	m	/	27.8	s	RTA	L	/	0	43A1	MSF#	12	11	plate	105	4	acc	17	10	30	15	10	12	12	exc	
2	18	m	/	30.3	s	RTA	L	I	/	43A1	/	14	11	/	80	2	acc	20	20	35	20	15	16	16	exc	s. Infection
3	18	f	/	22.2	/	RTA	R	I	/	43A1	/	14	11	2kw	105	1	gd	14	20	40	25	15	12	12	exc	d. Infection
4	24	m	/	24.7	sa	FD	R	/	0	43A2	L/Potts#	12	9	1kw	90	2	gd	22	15	25	15	5	16	16	fair	pain
5	29	m	/	25.1	/	RTA	R	/	I	43A2	/	14	10	1kw	95	2	gd	18	20	40	20	10	12	12	exc	
6	63	m	HTNDM2	34.2	/	RTA	L	/	I	43A1	O.B.Pelvis#	12	11	1kw	75	7	acc	22	10	25	15	10	22	22	fair	s. Infection+ skin ulcer
7	29	m	/	26.3	/	FD	R	I	/	43A3	/	14	9	2kw	120	3	acc	18	25	35	25	15	14	14	gd	
8	34	m	/	25.5	S	RTA	R	/	I	43A1	/	14	8	plate	65	5	gd	19	20	45	30	15	15	15	exc	
9	24	m	/	31.9	/	RTA	R	I	/	43A1	/	14	12	1kw	95	3	gd	16	30	50	30	20	12	12	exc	swelling+pain
10	22	m	/	24.1	S	RTA	R	/	I	43A1	/	11	10	1kw	85	2	gd	20	25	45	25	15	15	15	gd	

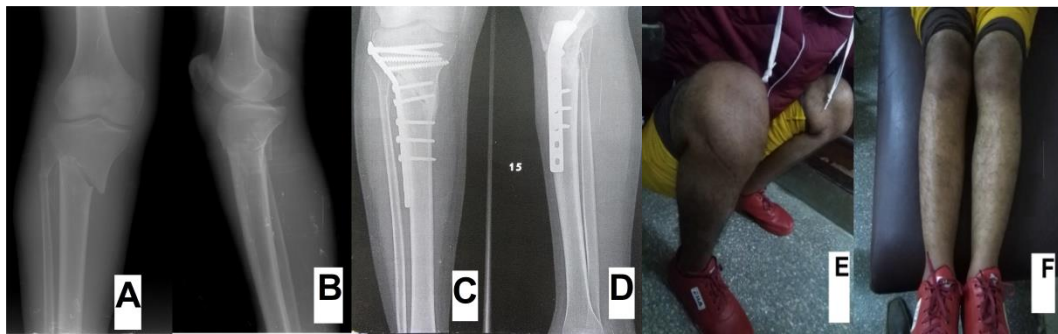


Figure :1 case1: Pre-operative x-ray anteroposterior(A) and lateral(B) views; (4) months follow up x-ray anteroposterior(C) and lateral(D) views showing full union of the fracture; full ROM (130° flexion(E) / 0° extension(F))

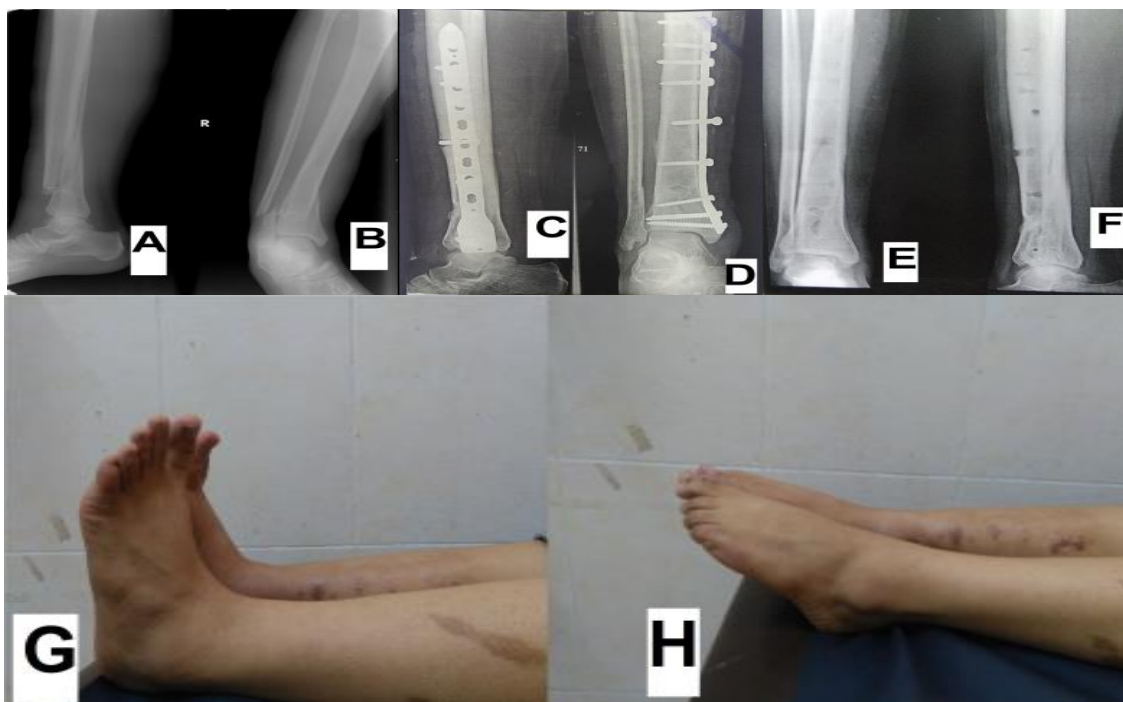


Figure 2: Pre-operative x-ray lateral(A) and anteroposterior(B) views; (5) months follow up x-ray lateral(C) and anteroposterior(D) views showing full union of the fracture; (6) months x-ray anteroposterior(E) and lateral(F) views after infected plate removal, full ROM(D-F 20°(G) & P-F 40°(H))6months.

DISCUSSION

Treatment of proximal and distal tibial fractures has become challenge for orthopaedic surgeons. As the incidence of these fractures are increasing regularly due to RTA, the surgical treatment options also being modified continuously[12]. One of tibial plating limitaion in fracture management that the skin and soft tissue complications are common and the use of the MIPO approach will decrease these complications also the control of the mal-alignment of these fractures. MIPO technique has been frequently used for these type of fractures, involves indirect reduction method of the fracture and minimal soft tissue dissection. These prevent iatrogenic injury to vascular supply of the bone and preserve fracture haematoma, which represent the most

important factor for fracture healing. The development of the LCP system combines two different principles of internal fixation; compression screw osteosynthesis with the principle of absolute stability and biological osteosynthesis with relative stability [13]. Our study presented the outcomes of surgical treatment of 20 tibial metaphysis fractures (10 proximal and 10 distal), using minimally invasive plate osteosynthesis technique. All patients had bony union with duration ranging from 10-22 weeks with mean duration of 16.6 ± 3.74 weeks; 9 fractures (45%) healed within 16 weeks most of them from group 1 and all fractures united without bone graft. No significant correlation was found between union time and age, BMI, OTA classification of tibia and fibula, plate size and

total screws used for tibial fixation, but there was significant correlation was found between union time and fibula fixation, that the union time was longer in group with fibular fixation. No fixation of fibula was needed in G1, while the fibula was fixed in majority of cases (9 cases) in G2 (distal fibular fracture), most of them (7 cases) by intramedullar K-wire and 2 cases by plate fixation. Our results were similar to the results of Gupta, et al. [1]; that the mean time for radiological union was 17 weeks (range: 14-22 weeks), but differ from result of Thapa, et al. [14], that were all fractures got united with the average duration of 22.7 weeks for proximal metadiaphyseal tibia and 19.9 weeks for distal diaphyseal tibia, that need researching about causes.

In the current series, the functional outcome was satisfactory in 17 patients (85%) and unsatisfactory only in 3 patients (15%).(Table 2) The functional results of Ramesh Krishna, et al. [2], were satisfactory in 15 patients (50%) (3=Excellent +12=Good) and unsatisfactory in 15 patients (50%) (15=Fair and no one had poor grade.). In Gill, et al. [15], study on 94 cases (52 proximal and 42 distal) the functional results were 93.8% satisfactory outcome in proximal group and 85% satisfactory outcome in distal group. In Dhakar et al.[16], study on 50 fractures of distal tibia treated by MIPO technique, the functional results were satisfactory in 47 (94%) (n=33 excellent and n=14 good) and unsatisfactory in 3 (6%) (n=3 fair). Functional results of Kim et al. study [17], were all satisfactory outcome. This study was done on 30 patients with an open proximal tibial fracture were treated by MIPO (excellent in 23 (76.7%) patients and good in 7 (24.3%) patients).

Regarding the complications; 60% of cases healed without complication and 40% had complications. Two cases had superficial wound infection and two cases were complicated by deep wound infection. Two cases complained from moderate to severe pain at fracture site, even at rest. One patient complained from screw site pain, because the distal three screws was too long and under skin, and one patient complained from swelling and pain overall the affected leg. Muzaffar, et al. [18], there were 2 cases of superficial and 2 cases of deep infection, and deep infections needed removal of plate for cure. There were 4 cases of ankle stiffness, most of them were intra-articular fractures, 3 cases of palpable implant, 3 cases of malunion, 1 case of loss of reduction and 1 patient required reoperation. Asimuddin and Kulkarni [19], had a total of 6 complications from 21 cases (29%), which included 2 knee stiffness, 1

infection, 1 post operative loss of reduction, 1 knee instability and 1 varus deformity. The main complications of Thapa, et al. study [14], were deep peroneal nerve palsy was seen in 2 cases with proximal tibia fracture treated with longer plate. 3 delayed union cases that united without any surgical intervention. 2 cases of superficial and one of deep infection seen with proximal tibial fracture and 2 superficial infection with 1 case of wound dehiscence and plate prominent seen with distal tibia fracture.

Limitations of this study:

The results of this study must be supported by another studies with larger number of patients, longer follow up period and more specification of a selected fracture type.

CONCLUSIONS

MIPO technique is a good option for management metaphyseal fracture of tibia; The time for full union are short in MIPO technique as it is maintains the appropriate climate for fracture healing by preserving most of the fracture haematoma and osseous vascularity, and providing a rigid fixation. Allows full weight bearing in short time and rapid mobilization of the limb and the patient, as it is relatively a stable fixation. High satisfactory functional result can be obtained with MIPO technique. Biological plating is a safe with low complication rates, as small incision, less soft tissue dissection, and less blood loss.

Conflict of interest: Non

Financial disclosure: Non

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