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Evaluation of Outcome of Surgical Management of Distal Tibial Fracture by MIPO/Open Procedure

Nabil Zunayed Sidny[1*], Md. Sariful Hasan[2], Mohammed Hafijur Rahman Sarker[3], Md. Zahidul Haq Khan[4], Md. Kamrul Islam[5], Aziza Md. Abdur Rahman[6], Shoaib Talukder[7], Rajib Uddin[8]

[1]Assistant Professor, Department of Orthopaedic and Trauma Surgery, Shaheed Monsur Ali Medical College, Dhaka, Bangladesh
[2]Assistant Professor, Department of Orthopaedic Surgery, East West Medical College, Dhaka, Bangladesh
[3]Junior Consultant (C.C.), Orthopaedic Surgery, Upazilla Health Complex, Charfession, Bhola, Bangladesh
[4]Assistant Registrar (Orthopaedic), National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh
[5]Medical Officer, Hand and Microsurgery, Sir Salimullah Medical College Hospital, Dhaka, Bangladesh
[6]Assistant Registrar, Department of Orthopaedic and Trauma Surgery, Uttara Adhunik Medical College Hospital, Dhaka, Bangladesh
[7]Registrar, Department of Orthopaedic and Trauma Surgery, Shaheed Monsur Ali Medical College and Hospital, Dhaka, Bangladesh
[8]Assistant Register, Department of Orthopaedic and Trauma Surgery, Shaheed Monsur Ali Medical College and Hospital, Hospital Dhaka, Bangladesh

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***Corresponding author:** Dr. Nabil Zunayed Sidny
Assistant Professor, Department of Orthopaedic and Trauma Surgery, Shaheed Monsur Ali Medical College, Dhaka, Bangladesh

Abstract **Original Research Article**

***Introduction*:** Distal tibial fractures are common orthopedic injury. These fractures involve distal tibia, sometimes with ankle joint. Distal tibial fracture may range from injuries with little or no displacement to complex fractures with significant associated injuries. Stability of these injuries depends on a combination of boney and associated ligamentous injuries. Surgical management includes MIPO/Open procedure by distal tibial locking plate and screw, this may include distal fibula fracture. The surgical management steps far superior in different aspects of outcome for the patient as the patient needs early mobilization. ***Methods*:** This prospective study was conducted in Dept. of Orthopaedic and Trauma Surgery, Shaheed Monsur Ali Medical College and Hospital, Dhaka, Bangladesh from January 2021 to December-2022. During this study we have operated on total of seven patients with distal tibial fracture sometimes involving distal fibula. All of these patients came to ER with acute injuries following RTA, fall from height etc. All of these patients were assessed pre and post operatively. All of these cases were classified according to AO classification. ***Results*:** Total seven patients included. The mean age of the patients was 32.62± 2.24 years. Maximum study patient were injured from RTA. All of them were treated by minimally invasive and open procedure. Patients were kept on follow up at regular interval. All of the patient's plasters were removed at around after 28th POD. On consequent follow up patients could walk after brief period of physiotherapy and active exercise. There was no significant difference in the distribution of AO/OTA classification, age, gender, AOFAS score, time from injury to operation, follow-up, bone union time, delayed union, malunion and infection ($p>0.05$). The operation time was significantly longer in the open group than in the MIPO group: 69.59±7.21 min. for the ORIF, and 61.14±5.61 for the MIPO group ($p<0.01$). The hospitalization time was significantly longer in the open group than in the MIPO group: 7.64±4.71 days for the MIPO, and 10.18±4.32 days for the ORIF group ($p<0.05$). ***Conclusion*:** In our study internal fixation by MIPO/Open procedure by distal tibial locking plate and screw with small DCP or semi tubular plate & screw or rush nail for fibula resulted in comparative positive outcome in five patients suffering from distal tibial fracture. MIPO technique can be beneficial for the treatment of distal tibia AO/OTA A and B type fractures with reduced hospital stay, cost-effectiveness, and infection rate.

Keywords: Distal tibia, fracture, malunion, MIPO.

INTRODUCTION

Distal tibial fractures are common orthopedic injury. These fractures involve distal tibia, sometimes with ankle joint. Distal tibia fractures are a common result of traffic accidents and fall injuries [1]. The treatment of distal tibial fractures is challenging due to the limited soft tissue, subcutaneous location and poor vascularity [2, 3]. Fracture pattern (proximity of the fracture to the plafond, comminution), soft tissue injury, and bone quality critically influence the selection of the

fixation technique [4]. Distal tibial fracture may range from injuries with little or no displacement to complex fractures with significant associated injuries. Stability of these injuries depends on a combination of boney and associated ligamentous injuries. Surgical management includes MIPO/Open procedure by distal tibial locking plate and screw, this may include distal fibula fracture. The surgical management steps far superior in different aspects of outcome for the patient as the patient needs early mobilization. With operative treatment shortening and other complications associated with prolonged immobilization can be avoided [5]. ORIF have been performed for distal tibial fractures and is associated with complications like infection and delayed or non-union due to dampened blood supply to bony fragments and also additional damage to soft tissue [6]. Soft tissue management plays a vital role in management along with bony reconstruction. There are plenty of devices available for fixation, including intramedullary nail, extramedullary traditional plate and the relatively new precontoured 3.5mm distal locking compression plates. Recently, there has been an increasing trend toward use of a locking compression plate for treatment of distal tibia fractures. Locking compression plate provides better stability and protection against loss of reduction and minimizes contact with bone [7, 8]. A variety of treatments may be used, including external fixation, intramedullary nailing, and plate fixation [9]. Traditional open reduction and internal plate fixation (ORIF) achieves an acceptable reduction and rigid fixation, but re- quires extensive soft tissue dissection and periosteal strip- ping, and these factors increase the rates of complications, including infection, delayed union and non-unions [10]. Minimally invasive plate osteosynthesis techniques have been developed in recent years, [1] with high union rates [8]. This technique aims to reduce surgical trauma and maintain a more biologically favorable environment for fracture healing. However, complications, such as angular deformities, hardware failure, and non-unions have been reported [9-11]. In current orthopaedic practice, minimally invasive percutaneous plating osteosynthesis (MIPPO) and interlocking nailing are the preferred techniques for fractures of the distal third tibia. The intramedullary nail spares the extraosseous blood supply, allows load sharing, and avoids extensive soft tissue dissection. However, proximal and distal shaft fractures can be difficult to control with an intramedullary device, increasing the frequency of malalignment. In this control-matched study, it was aimed to compare traditional open reduction and internal fixation with minimal invasive plating (MIPO). We hypothesized that superior results may be achieved with the MIPO technique.

MATERIALS & METHODS

This prospective study was conducted in Dept. of Orthopaedic and Trauma Surgery, Shaheed Monsur Ali Medical College and Hospital, Dhaka, Bangladesh from January 2021 to December 2022. During this study we have operated on total of seven patients with distal tibial fracture sometimes involving distal fibula. All of these patients came to ER with acute injuries following RTA, fall from height etc. All of these patients were assessed pre and post operatively. All of these cases were classified according to AO classification. Inclusion criteria of the study were distal tibia meta- diaphyseal fractures, closed or Gustillo-Anderson grade 1 open fractures, and skeletally mature patients. The fractures were classified according to the Orthopaedic Trauma Association [12] classification. Ten patients were excluded since they had ipsilateral fractures, five patients were excluded due to pathological fractures, five patients were excluded due to lack of follow-up, eight patients with open fractures according to Gustilo and Anderson type II or type III [13] and four patients with a displaced intraarticular fragment were also excluded.

Among them, thirty-two patients were treated by MIPO and 28 by ORIF. Twenty-two patients treated with traditional open reduction and internal fixation were matched with 7 patients treated with closed reduction and MIPO on the basis of age (±3), gender, and fracture pattern (AO classification). All patients were operated on with locking compression plates. Anteroposterior and lateral radiographs of the involved limb were used to determine fracture pattern. All the operations were performed by the same AO certificated trauma surgeon (HIB). All patients' involved leg was immobilised by above knee Paris-plaster splint before surgery. Ice and mannitol (IV 250 mg daily) were used preoperatively to decrease swelling. The operations were carried out when the skin appeared wrinkled.

Surgical Procedure

All the patients underwent operation on a standard radio- lucent table in supine position. A tourniquet was used in both groups. In both groups, cefazoline 1000 mg was used as prophylaxis 30 minutes prior to surgery and continued (1 gr every eight hours) for 24 hours after surgery. In traditional open surgery, classic anteromedial exposure was used, the reduction was made under vision, and then locking compression plate was fixed with screws. At least 4 screws were preferred at both sides of the fracture. All plates were placed on the medial surface of the tibia. If the fracture line was oblique or spiral, one or two cortical screws were used as lag screws. Fixation of fibula fractures used to be considered unnecessary unless associated with syndesmotic instability, which was tested after tibial fixation (Figs. 1a-d).

In MIPO technique, closed reduction was made under fluoroscopic image. The reduction was achieved by ligamentotaxis with manual traction by a junior assistant and also weber clamp could be used for the assistance of reduction. A 3 cm anteromedial incision was made from 1 cm proximal to the tip of

medial maleol to the distal, the great saphaneous vein was protected and the appropiate plate was advanced upward subcutaneously without disturbing the periost. The plate was selected based on its length with the aid of fluoroscopy. There had to be at least three holes on both sides of the fracture site. Afterwards, a proximal incision about 2 holes long was made to expose the upper part of the plate, and the plate was positioned as needed. Once the clarification of the fracture reduction and plate position was accomplished, the screws were driven in with the assistance of fluoroscopy (Figs. 2a-d).

Postoperative Management

No drain was used in either group. After ORIF, the tourniqyet was deflated and bleeding control was made under careful attention. Both groups received same postoperative care. Active knee and ankle joint motion was allowed as soon as possible. When the postoperative swelling was diminished, all patients were encouraged to mobilise without weight bearing with two crutches. Progressive weight bearing was allowed once there was radiographic evidence of callus formation and also clinical union. Clinical union was defined as pain- free full weight-bearing, and the patients progressed to full weight bearing after bone union. Radiographic union was defined as the presence of callus in three of the four cortices as seen on antero-posterior and lateral radiographs. Radiographs were assessed by a trained reviewer not involved in the patients' care. Malunion was defined as more than five degrees of angular or rotational deformity. Delayed union was defined as lack of union at 24–26 weeks, and nonunion was defined as lack of healing at >9 months. Clinical evidence of infection (deep or superficial) was recorded. Deep infection was de- fined as below the muscular fascia. Superficial infection was confined to the dermal and subcutaneous tissue and persis tent drainage from the wound for at least two days.

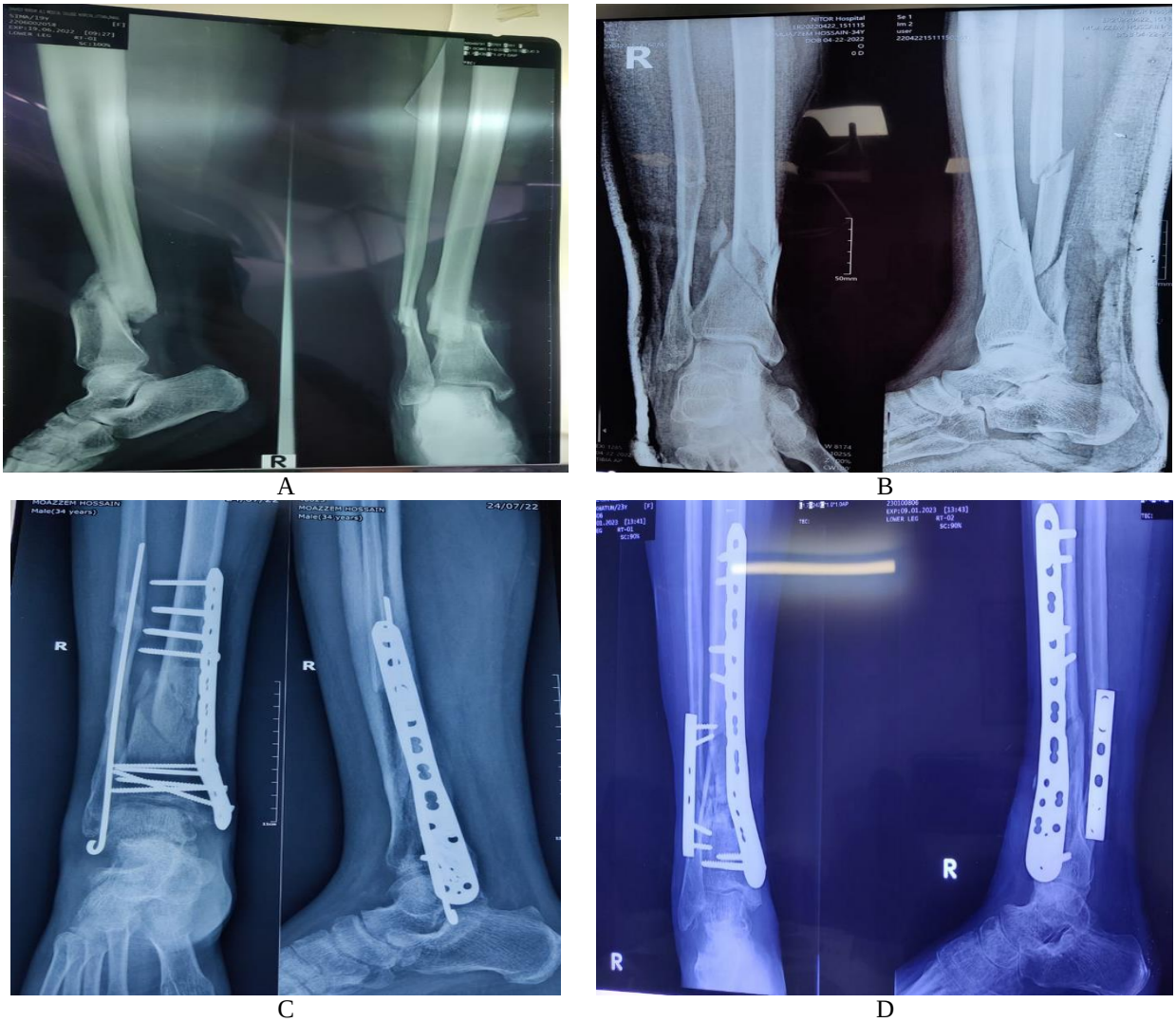

Figure-1: 33 years old female, injuried her right tibia after a traffic accident. She was operated with ORIF at 10 days post-injury. (a) Pre- operative anteroposterior radiograph of the injuried tibia. (b) Preoperative lateral radiograph of the injuried tibia. (c) Postoperative antero posterior radiograph of the tibia at 18 months follow-up. Bony union was achieved. (d) Postoperative lateral radiograph of the tibia at 18 months follow-up.

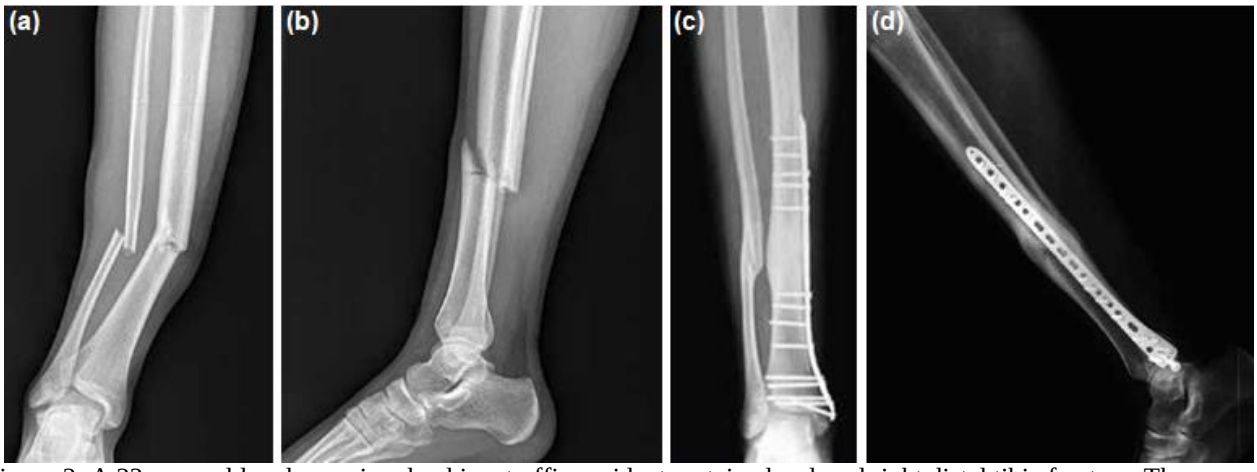

Figure-2: A 22 years old male was involved in a traffic accident sustained a closed right distal tibia fracture. The surgery was performed 9 days post-injury with MIPO technique. (a) Preoperative anteroposterior radiograph of the injuried tibia, (b) preoperative lateral radiograph of the injuried tibia (c) postoperative anteroposterior radiograph of the tibia at two years follow-up. Bony union was achieved. (d) Posopertative lateral radiograph of the tibia at two years follow-up.

The patients were followed up clinically and radiologically at intervals of four weeks until bony union was achieved. After bony union was achieved, the patients were followed up at 3 months interval for the first year, and at 6 months interval for the second year and annually. Evaluation was assed according to wound problems, the American Orthopaedic Foot and Ankle surgery (AOFAS) scoring, [14] radiological union, mal- union, delayed union, hospitalisation time, time from injury to surgery, and operation time. The groups were compared with respect to gender, age, AO fracture type, hospitalization, time from injury to surgery, operating time, bone healing time, incidence of complications, and AOFAS scores.

Statistical Analysis

The SPSS program (Statistical Package for Social Sciences) for Windows 21.0 was used for the evaluation of data obtained in the study. An independent statistician, who was not directly involved in the study, performed the statistical analysis. Descriptive statistical methods (mean, standard deviation, median, percentage, ratio) were used in the evaluation of data and for the analysis of the relation-ship between parameters and Student's t test was used for the interval (age, healing time, follow-up, operation time and AOFAS). Mann-Whitney U test was used for the interval (interval from injury to surgery, hospital stay). Continuity correction yates test was used for the interval (gender, AO/OTA classification). Fischer's exact test was used for the interval (nonunion, delayed union, malunion, infection). The chosen level of significance was $p<0.05$.

RESULTS

Table 1 presents the demographic data and all outcomes for the two groups that were cross-matched. There was no significant difference in the distribution of AO/OTA classification, age, gender, and AOFAS score ($p>0.05$). The operation time was significantly longer in the open group than in the MIPO group: 69.59±7.21 min. for the ORIF, and 61.14±5.61 for the MIPO group ($p<0.01$). There was no significant difference in the distribution of time from injury to operation, follow-up, bone union time, delayed union, malunion and infection ($p>0.05$). The hospitalisation time was significantly longer in the open group than in the MIPO group: 7.64±4.71 days for the MIPO, and 10.18±4.32 days for the ORIF group ($p<0.05$). Three fibula fractures were fixed in both groups due to the syndesmotic instability. Compression plates were used in both groups. All the fractures in both groups healed without the need for secondary procedures. There were two superficial wound infections in the ORIF group, which resolved with daily wound care. At the last follow-up visits, the fractures were healed radiologically, and the patients walked without pain and assistance.

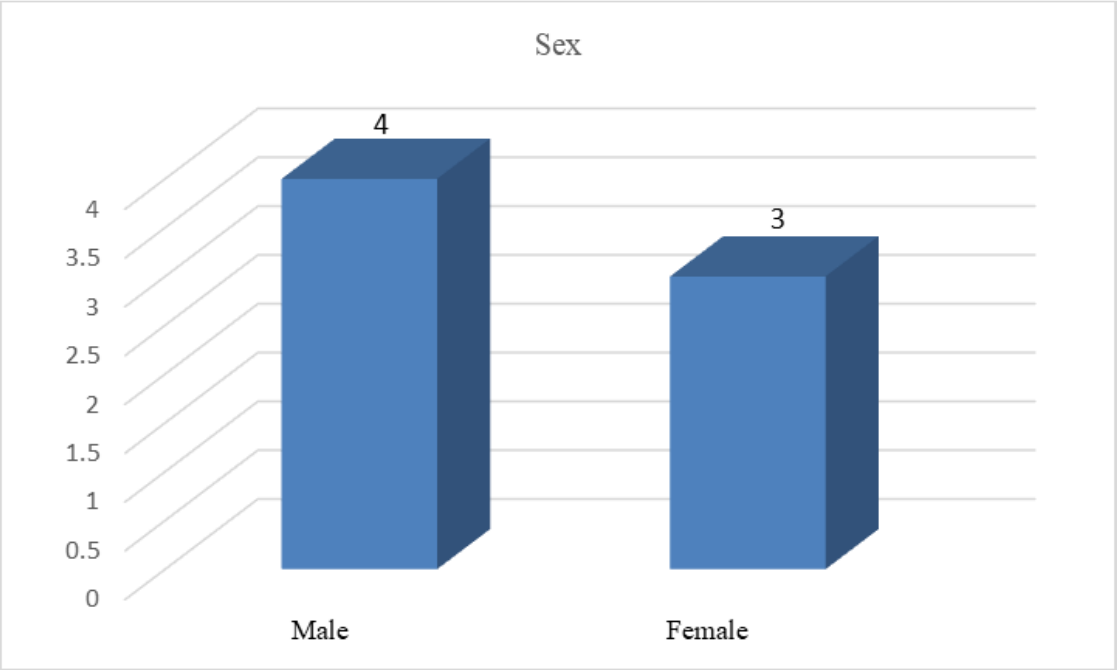

Fig-1: Distribution of male and female patients.

Table 1: Comparison of the main data for both groups of patients (N=7)

	Minimal invasive plating			Opened			p
	n	%	Mean± SD	n	%	Mean± SD	
Age (year) (median)			39.95±13.75			41.68±16.30	10.706
Male	4	57.1		4	57.1		31.000
Female	3	42.9		3	42.9		
AOFAS			78.73±4.72			78.82±7.46	10.962
AO Classification							
Type A	5	71.4		5	71.4		31.000
Type B	2	28.6		2	28.6		
Duration of surgery (min) (median)			69.59±7.21			61.14±5.61	10.001**
Interval from injury to surgery (days) (median)			5.91±4.55 (5)			6.68±4.26 (6)	20.464
Hospital stay (days) (median)			7.64±4.71 (6)			10.18±4.32 (9)	20.023*
Follow-up time (months)			21.77±3.08			21.91±2.94	10.881
Healing time (weeks)			15.82±4.18			17.48±4.86	10.237
Infection	0	0		1	14.3		40.488
Delayed union	1	14.3		1	14.3		41.000
Malunion	1	14.3		0	0		40.488

DISCUSSION

Biological osteosynthesis is a new biological fixation principle that is comparable to the traditional AO principle. The MIPPO technique is a typical method based on biological fixation, which involves minimal soft tissue dissection with preservation of the vascular integrity of the fracture as well as preservation of osteogenic fracture hematoma [8]. The incidence of distal tibial fractures, one of the most common periarticular fractures, is increasing regularly due to road traffic accident. At the same time, surgical treatment options are also being modified continuously. Hence, the treatment of distal tibial fractures has become a challenge for orthopedic surgeons as a difficult fracture to manage [8]. Traditional open surgical technique is based on absolute stability achieved by full contact at the fracture side, and rigid internal fixation; however, open surgery has some limitations, such as infection, and long hospital stay [5]. However, MIPPO 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. Additional radiation exposure during application of the plate to the bone and screw fixation is the disadvantage of this technique. Delayed union, and non-unions are important morbidities in the treatment of distal tibia fractures and common findings. Li et al., [12] have reported no delayed union or nonunion in their retrospective study involving twenty-three patients treated with MIPO. Guo et al., [13] reported no delayed union or nonunion in

their prospective randomised study involving forty-one patients treated with MIPO. Seyhan et al., [8] have reported two (5.6%) nonunion with MIPO in their retrospective study. Zou et al., [14] have reported three (7.1%) delayed union with open surgery. In the current study, two patients in the MIPO group and two patients in the conventional open surgery group had delayed union, there was no statistically significant difference between each group with respect to the delayed union and nonunion parameters ($p<0.05$). The patients with delayed union in the open surgery group suffered from high energy trauma and A3 fractures, therefore, we are of the opinion that stripping the periosteum in open surgery can promote the delay in bone healing. The two patients with delayed union in the MIPO group were heavy smokers. Tobacco has negative effect on bone healing. Lee et al., [15] have recommended that they had only three (3.4%) malunions in eighty-eight distal tibia fractures treated with open plating. Zou et al., [14] have reported no malunion in their study with open surgery. In the current study, malunion was reported in two patients (9.1%) in the MIPO group but none in the conventional open surgery, as it is difficult to achieve anatomic reduction of the fracture site with minimally invasive plating with indirect reduction. There was no significant difference with respect to the time from injury to surgery in both groups ($p<0.05$): 5.91±4.55 days for MIPO, and 6.68±4.26 days for ORIF group. All surgeries were postulated till the wrinkle sign was diminished. Greater number of days in hospital causes higher hospital costs to society. In this retrospective cross-match study, the MIPO group had a significantly shorter hospital stay com- pared with open group ($p<0.05$), which results in reduced healthcare-costs. As incision area was seen odematous and wound edges were seen dehiscence in the early postoperative days, the patients were followed- up closely, which resulted in long hospital stay. In the present study, two (14.3%) superficial infections were noted in the ORIF group, which resolved with local wound care. It is well-known that distal part of the tibia has poor vascularity and soft tissue coverage, so infection is a common complication. Lee et al., [14] have stated seven (8.0%) superficial infections, Jensen et al., [23] have reported nine superficial infections (9%) in one hundred and five patients treated with open plating. Guo et al., [13] have reported 6 wound problems (14.6%) in thirty-eight patients plated with MIPO technique. Open methods may have a higher infection rate than that of MIPO due to the risk of insufficient circulation at wound edges, which exposes to the superficial infection [15]. In the current study, we did not find a statistically significant difference in functional outcome scores (AOFAS) between patients treated with MIPO and patients treated with the ORIF technique. We used the same postoperative management and rehabilitation protocol for both treatment groups. The control-matched design study of the current study has some limitations. It was a retrospective study and not randomized. Secondly, the selection of the surgical technique bias cannot be avoided. In order to maintain a sufficient number of patients, the matching considered only gender, age, AO classification. The last one was that there was a lack of comparison of the x-ray doses of the both group.

CONCLUSION

In our study internal fixation by MIPO/Open procedure by distal tibial locking plate and screw with small DCP or semi tubular plate & screw or rush nail for fibula resulted in comparative positive outcome in five patients suffering from distal tibial fracture. MIPO technique can be beneficial for the treatment of distal tibia AO/OTA A and B type fractures with reduced hospital stay, cost-effectiveness, and infection rate.

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