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Original Article

Are clinical and functional results of MIPPO and IMN for treatment of extraarticular distal tibia fractures similar?

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Abstract

Aim: Controversy still exists on whether intramedullary nailing (IMN) or minimal invasive percutaneous osteosynthesis (MIPPO) is better for treatment of extra-articular distal tibia fractures. In this study, our aim was to retrospectively compare the clinical and functional results of patients with distal tibia fractures that were treated f by plate or nail.

Material and Methods: This study included 46 patients with a mean age of 40,3 (range, 18-63 years). All had closed extra-articular distal tibia fractures within 4 to 10 cm away from the tibial plafond and two senior trauma surgeons operated them with either MIPPO (n=27) or IMN (n=19) technique. Patients were followed up until full bony union occurred and also hospitalization time, union time, malunion criteria; complication rates and AOFAs were evaluated.

Results: Mean follow up was 12.5 (range, 10-16 months) months and no major vessel injury or deep infection was observed in either group. Full bony union time was similar in two groups (15±12.7 weeks in MIPPO and 16±11.3 weeks in IMN group; p=0.062). Also, there was not statistically significant difference in MIPPO and IMN groups for nonunion rates [3 (11%) vs. 1 (5.3%)] and malunion rates 3 (11.1%) vs. 2 (10.5%)] (p>0.05). However, secondary surgical intervention was performed in two patients (7.4%) of MIPPO group for severe wound dehiscence (p=0.04).

Conclusion: The two surgical techniques are equivocal for nonunion or malunion rates. However, wound problems may be seen after MIPPO technique and surgeon must be cautious for applying plate when patient has apparent wound problem.

Keywords: Distal Tibia; Fracture; Nailing; Plate.

INTRODUCTION

Extra-articular distal tibial fractures constitute one third of all tibia fractures and are high-energy injuries, generally caused by traffic accidents or sports injuries (1). Both the energy they are exposed to and the insufficient blood build-up and soft tissue coverage make these fractures difficult to be treated. Conservative treatment is accepted as suitable for the closed fractures shorter than 15 mm on first presentation or those with an angle < 5^0 in any plane after closed reduction attempt (2). In addition, after the conservative treatment there are conventional disadvantages such as non-union, malunion and stiffness. Surgical treatment methods are generally preferred in order to prevent such complications and provide an earlier return-to-work with a good functional result.

Although intramedullary nailing (IMN) is the gold standard method for the tibial fractures, there is noconsensus on the gold standard method for proximal and distal metaphyseodiaphyseal fractures. IMN, which is a minimally invasive and biological method, provides symmetrical and dynamic fracture fixation (3,4). However, for fractures very close to the joint, the distal type of nail and the locking mechanism cannot provide adequate stability, especially when the distal fragment is very short. Furthermore, it is difficult to obtain anatomic reduction during surgical treatment due to the difference in diameter between the metaphysis and the diaphysis, during the nail passage.

Additional procedures are needed to improve the duration of surgery and the duration of fluoroscopy, such as Poller screws. In recent years, Minimal Invasive Percutaneous Plate Osteosynthesis (MIPPO) has become popular in the treatment of distal tibial fractures with the development of locking plate systems (5,6).

Similar to IMN, plates also have a number of disadvantages, such as infections, deficiencies in soft tissue coverage, and a feeling of discomfort below the skin caused by the plate. The aim of this study was to retrospectively compare the clinical and functional results of MIPPO and IMN in a group of patients with extra-articular distal tibia metaphyseodiaphyseal fractures. The study hypothesis

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was that with IMN it is difficult to achieve reduction in such fractures and to ensure stability which will be preserved until union, and therefore the MIPPO method would provide more successful results.

MATERIAL and METHODS

A retrospective examination was made of 46 of 52 fractures of the distal tibial metaphyseodiaphysis (4-10 cm of the tibial plateau), in patients surgically treated at our hospital between 2010 and 2014. Patients with open fractures (n=3), pathological fractures (n=1), and concomitant tarsal fractures (n =2) were not included in the study. The mean age of the patients was 40.3 years (range, 18-63 years). Two different surgeons performed surgical treatments with at least 5 years' experience in extremity trauma using two different methods in such injuries. The first surgeon (AT) applied IMN to 19 patients (9 males, 10 females) and the second surgeon (HŞ) applied MIPPO to 27 patients (11 males, 16 females) (Figure 1 and 2). The fractures were classified according to the AO-OTA classification. All distal fibula fractures within 7 cm of the ankle were fixed before the tibia fracture using a separate incision in both groups.

For all the MIPPO patients, a distal anatomic medial tibia plate (Smith Nephew, Memphis, TN, USA) was applied following closed reduction in the supine position. For the IMN patients, reamed tibia nails (TRIGM IM Nail System; SN Richards, Memphis, TN, USA) were placed using the transpatellar route following closed reduction.

All patients were administered IV antibiotic prophylaxis of 2 g cefazolin 3x1 gr / day preoperatively and for 3 days postoperatively. MIPPO patients were followed up for 14 days in a short-leg splint after surgery. After the removal of the stitches, early active and passive ankle ROM exercises were started for all patients. MIPPO patients were permittted partial weight-bearing in the 6th week postoperative ly and IMN patients were permitted partial weight-bearing on postoperative day one.

Patients were called up for follow-up examinations once a month for the first six months and once every three months in the following six months. Bone union was determined as the presence of bridging callus in at least three cortices on anteroposterior and lateral radiographs. Angulation >5°, shortness of >1 cm and translation of >5 mm were defined as malunion.

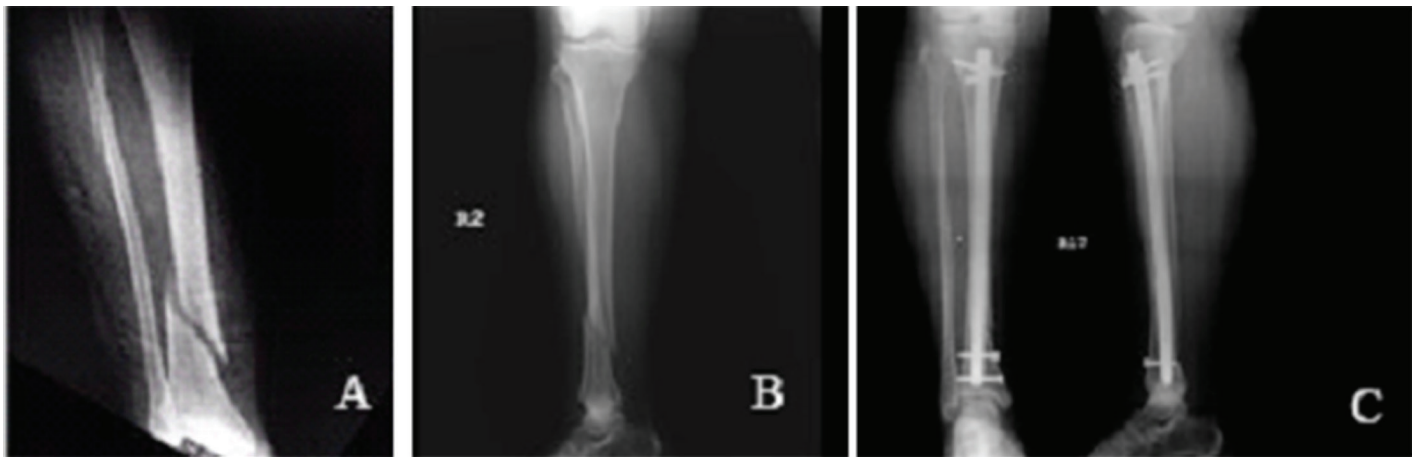

Figure 1 (A-C). The preoperative AP and lateral views of a 41 years old female patient that was admitted to emergency department after a motor-vehicle accident. The fracture was classified as 43 A2 according to AO and postoperative 14th week radiographs show full bony union after IMN.

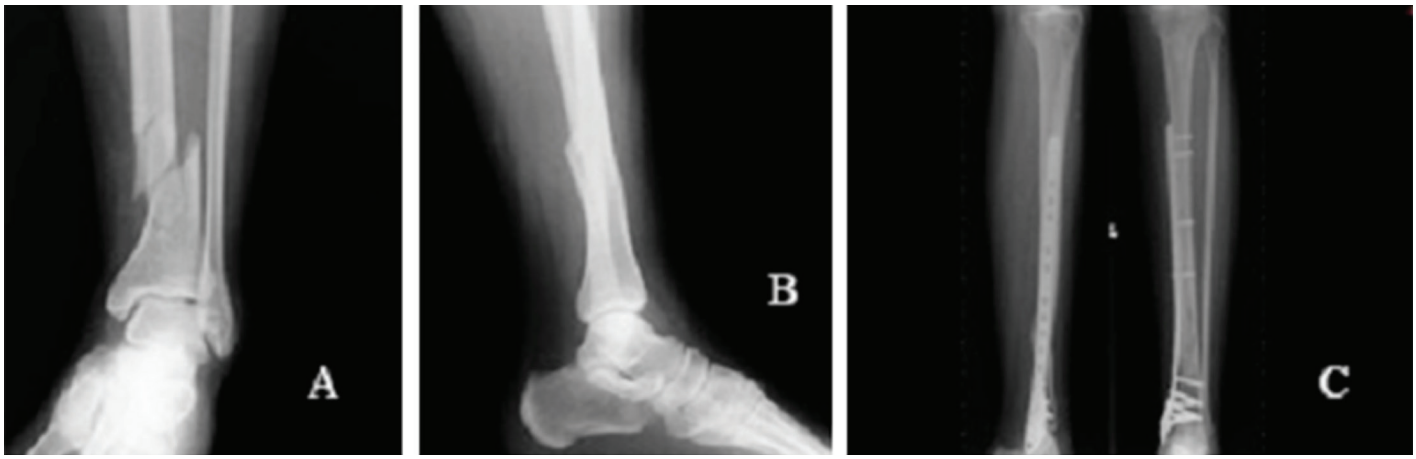

Figure 2 (A-C). The preoperative AP and lateral views of a 38 years old female patient that was admitted to emergency department after a motor-cycle accident. The fracture was classified as 43 A2 according to AO and postoperative 17th week radiographs show full bony union with minimal recurvatum in the sagittal plane after MIPPO.

At the end of 6 months, the presence of bridging callus on ≤ 2 cortices or the presence of pathological movement and pain were investigated to diagnose non-union. Skin/wound site problems requiring secondary intervention in both groups were accepted as major complications. Minor complications such as infection and skin irritation due to the implant in both groups were also noted. Functional results were assessed with the American Orthopaedic Foot and Ankle Score (AOFAS).

Statistical analyses were made using SPSS v. 13. Parametric values were evaluated using the Shapiro-Wilk test and later by the Mann-Whitney U test, and nonparametric values with the Fisher test. Both groups were compared in terms of age, gender, AO classification, bone union time, length of stay in hospital, wound site complications, AOFAS values, and criteria for non-union. A value of $p<0.05$ was considered statistically significant.

RESULTS

The demographic characteristics of the patients before and after surgery are shown in Table 1.

Table 1. Demographics of the patients

	IMN (n/%)	MIPPO (n/%)	Total (n/%)
Age	38 (18-61)	43 (18-63)	46
Gender			
Male	9 (19.6%)	11 (%23.9)	20
Famale	10 (%21.7)	16 (%34.8)	26
AO-OTA			
43A 1	10 (%21.7)	13 (%28.3)	23
43A 2	7 (%15.2)	5 (%10.9)	9
43A 3	2 (%4.3)	9 (19.6%)	11
Fibula fixation	2 (%10.5)	4 (%14.8)	6 (%13)

The average follow-up period was 12.5 months (range, 10-16 months). No deep infection or vascular-nerve injury was seen in any of the cases. Fibula fixation was performed immediately before tibia fixation in 2 patients in the IMN group and in 4 patients in the MIPPO group.

The basic data of the patients in both groups are shown in Table 2.

Table 2. Comparison of the data of two groups

Data	IMN	MIPPO	p
Hospitalization (days)	4.1±2.3	5±3.3	0.256
Mean follow-up (mo)	12.4 (10-14)	12.6 (10-16)	0.243
Union time (weeks)	15±12.7	16±11.3	0.062
Nonunion	1 (%5.3)	3 (%11)	0.054
Malunion	2 (%10.5)	3 (%11.1)	0.378
Major wound complication	0	2	0.04
AOFAS	87±6.6	84±7.8	0.218

No statistically significant difference was determined between the two groups in respect of patient data. The time to full union was 15 ± 12.7 weeks in the IMN group and 16 ± 11.3 weeks in the MIPPO group (p =0.062). The mean AOFAS values at the final follow-up examination of both groups were 87 ± 6.6 in the IMN group and 84 ± 7.8 in the MIPPO group (p=0.218).

Non-union was determined in 3 (11%) of the MIPPO group, two of whom were smokers and one had uncontrolled Type II diabetes. One of these cases was given platelet rich plasma injection three times for three consecutive weeks. A 13° of recurvatum was detected in one patient with non-union and a >10° external rotation deformity in one patient. Both patients underwent implant revision and autogenous grafting to re-establish reduction and stimulate union. The mean union time of these three patients was 24.6 ± 2.9 weeks and the mean AOFAS valuesat the final follow-up were 76 ± 1.3. Superficial infection in 2 patients of this group improved with oral antibiotics for 3 weeks. In 2 patients with a skin defect, which was defined as a major complication, superficial skin graft was performed soon after the VAC application. Non-union was seen in one case with IMN (5.3%), and this case was fully cured after dynamization and fibula osteotomy. In 8 patients with IMN (42.1%), persistent anterior knee pain was determined at the final follow-up examination.

Malunion was seen in 5 (10.8%) patients. In the IMN group, two patients were confirmed malunion with 8° and 12° of valgus deformities. In the MIPPO group, malunion developed as 9°, 11°, and 12° of recurvatum deformities, in three cases respectively. While, fibular fixation was not applied to the 2 patients with valgus deformities, it was performed to one of the patients with recurvatum deformity. No fibula fixation was performed to any of the patients with non-union. At the final follow-up examination, the implants of the 8 patients (29.6%) in the MIPPO group were removed due to skin irritation or at the patient's own request, and in 4 patients (14.8%) in the IMN group, the distal locking screws were removed due to skin irritation.

DISCUSSION

Distal tibia fractures usually occur as a result of a high-energy trauma, and therefore they are severe fractures which are difficult to treat due to soft tissue damage and their proximity to the joint. There are no studies in literature showing which techniques are superior to each other, although there are studies dealing with the results of both methods (4,7-9). In the current study, an evaluation was made of the results of the IMN and MIPPO techniques, which are the two most commonly used methods for the treatment of extra-articular distal tibial fractures. The results showed that both the IMN and MIPPO methods were clinically and functionally successful in this fracture type [87 ± 6.6 and 84 ± 7.8 for the AOFAS in IMN and MIPPO group, respectively; (p=0.218)], and union or malunion rates were low and similar for both techniques. However, in patients who had undergone MIPPO, the skin problems

may be seen that could require secondary surgical intervention on the anterior-posterior surface of the leg.

IMN does not impair blood circulation around the bone and does not require soft tissue dissection. As it is an intramedullary fixation, it biomechanically counteracts torsional forces evenly, and is more resistant to axial loading stresses, allowing earlier weight-bearing compared to plate fixation. Vallier HA et al. reported angular union ratio as 23% (4) and Janssen, Im and Li also found that angular union was higher after IMN (9-11). The authors stated that in the prevention of malunion, obtaining and maintaining reduction was one of the difficulties associated with this technique. In the current study, angular union was found in 2 of the 19 patients with IMN (10.5%). Another disadvantage of IMN is anterior knee pain which can develop after surgery. Transpatellar entry, abduction of the nail type into the joint above, infrapatellar nerve injury and quadriceps muscle weakness have been indicated as causes. Although Li B et al. (8) and Li Y et al. (9) reported this rate as 4.2% and 21.7% respectively, Vaisto (12) and Toivanen (13) stated that this complication could be seen in about half of the patients. Similar to the previously published reports anterior knee pain was observed in 8 patients with IMN (42.1%).

Ozkaya et al. (14) stated that compared to fixation with nails, locking plate systems have a number of disadvantages such as the need for secondary surgical intervention, wound problems, skin irritations and prolonged use of the locking plate systems in the union of the locking plates, since they provide biomechanically more rigid fixation without axial loading. In the current study, although a numerical difference was seen in terms of non-union in the IMN and MIPPO groups [1 (5.3%) and 3 (11%) respectively], there was no statistical significance and time to union was observed to be almost equal (IMN group 15±12.7 weeks, MIPPO group 16±11.3 weeks). Although the prevalence of minor complications was the same in both groups, the rate of major complications in the MIPPO group was statistically significant. Thus, in contrast to previous studies in literature, preoperative wound site problems showed that MIPPO application could be a great disadvantage for possible patients when secondary surgical intervention is considered as an intervention to provide skin coverage (4,8).

In a study of 215 patients, Vallier et al. (4) reported a malunion rate of 12.9% for the plate and 27.3% for the nail treatment groups, but the angular union rate for this type of fracture was generally around 10%. (15-17). Angular malunion rates were also similar between the two groups of this study.

However, malunion was observed in 2 MIPPO patients (10.5%) in recurvatum and in 3 IMN patients (11.1%) in valgus. A controversial aspect of both techniques is whether or not a fibular fracture should be fixed during or before the fixation of the tibia fracture. Although biomechanical studies (18,19) have suggested that fibular fixation may increase rotational stability and prevent malunion in valgus, DeLee et al. and Vallier et al. reported that the tibia may cause delayed union or non-union because it reduces the tension on the fracture line (4,20). Although the current study was not designed to evaluate the effect of fibula fixation on union, there was no fibula fixation in either the valgus union fractures or the non-union fractures.

Limitations of this study are similar to those inherent to all retrospective observational studies. First, this is a single center study with limited number of patients. It is obvious that a multi-center, high quality randomized prospective study with large number of cases would add more information on this topic. Second, two senior trauma surgeons performed two different methods in either group. At first glance, this might bring to mind that there would be a design bias, however, we think that performing two different techniques by two surgeons that are more familiar with those techniques may strength the power of the study. Lastly, the contribution of the soft tissue injury in these patients with distal tibia fractures were not classified, which would necessitate a more comprehensive study than our study.

CONCLUSIONS

Both IMN and MIPPO can be said to be successful surgical treatment modalities with high rates of union, and low rates of malunion, and complications in the treatment of distal extra-articular fractures of the tibia. It should be kept in mind that patients with obvious skin problems before surgery may have skin problems that require secondary surgical intervention after MIPPO application, and the patient should be informed. Although no relationship was determined between fibula fixation and union or malunion, the low power of this study prevents any definitive comment on this subject.

Further prospective, comparative, multicentre studies with a high number of patients will provide both more information as to which technique is superior and about the need for fibula fixation.

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