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EXTERNAL FIXATION VERSUS MINIMALLY INVASIVE PERCUTANEOUS PLATE OSTEOSYNTHESIS (MIPPO) IN THE MANAGEMENT OF DISTAL THIRD TIBIAL FRACTURES

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Abstract:

Background: Distal third tibial fractures are more prone for complications like delayed union or non-union due to poor vascularity. The minimally invasive percutaneous plate osteosynthesis (MIPPO) technique uses indirect reduction methods preserving the vascularity of the soft tissue envelope and maintaining a more biologically favourable environment for fracture healing.

Objective: To compare the surgical outcomes of external fixation versus MIPPO in the management of fractures of distal third of tibia.

Materials and Methods: The prospective observational study was conducted at the Department of Orthopaedics, Sri Venkateshwaraa Medical College Hospital and Research Centre, Ariyur, Puducherry from April 2014 to May 2016 by following up 45 skeletally matured patients with fractures of distal third of tibia from the time of admission till there was documented radiological evidence of bone union and full weight-bearing. Two surgical procedures namely EF and MIPPO were compared and contrasted in terms of outcomes.

Results: The operating time was significantly longer for MIPPO (p=0.005) compared to external fixation (EF) while also demanding more number of fluoroscopic checks (p=0.008) for accurate implant alignment. Wound problems like pin tract infections were more common (p=0.04) in EF compared to MIPPO which had lesser wound problems. There was one case of mal-union reported with EF.

Conclusion: MIPPO as a surgical technique is a time-consuming procedure with more radiation exposure and follow-up time when compared to EF. But complications like wound infection, post-operative pain, implant failure and problems with bone union are minimal in MIPPO compared to EF.

Key words: *MIPPO, External fixation, distal tibial fractures*

Introduction

Distal third tibial fractures account for 7 to 9% of the lower extremity fractures and in 85% of cases are associated with a fracture of fibula.[1-4] Blood supply to the distal third of tibial shaft mainly comes from the nutrient artery and periosteum.[5] This poor vascularity is further compromised during lower third tibial fractures with rupture of the nutrient artery and excessive periosteal stripping during surgery. Hence these fractures are more prone for complications like delayed union or non-union. Among the various treatment modalities like conservative management, external fixation, intramedullary nailing, plate fixation, the minimally invasive percutaneous plate osteosynthesis (MIPPO) technique has gained a promising role in management of distal tibial fractures.[5-7] This technique uses indirect reduction methods and allows stabilisation of distal tibia fractures while preserving the vascularity of the soft tissue envelope and maintaining a more biologically favourable environment for fracture healing. This study aims at comparing the surgical outcomes of external fixation versus MIPPO in the management of fractures of distal third of tibia.

Methodology

This prospective observational study was conducted at the Department of Orthopaedics, Sri Venkateshwaraa Medical College Hospital and Research Centre, Ariyur, Puducherry from April 2014 to May 2016 by following up 45 skeletally matured patients with fractures of distal third of tibia from the time of admission till there was documented radiological evidence of bone union and full weight- bearing. The study subjects were selected based on the following inclusion criteria: (1) displaced, extra-articular, distal metaphyseal tibial fractures with or without fracture of fibula (2) soft tissue injury of Oestern and Tscherne 0–2 grade, (3) Gustilo-Anderson type I open fractures, (4) follow-up time was more than one year. The following patients were excluded: (1) any other associated fractures, (2) pathological fractures, (3) soft tissue injury of Tscherne 3 grade, (4) Gustilo-Anderson type II and III open fractures, (6) associated with nerve or vascular injury requiring repair, (6) metabolic bone disease, previous ipsilateral lower limb surgery, or mental illness. The type of treatment opted was by random allocation at the time of admission. There was no significant difference in the pre-operative variables. [Table 1] All open distal third fractures were operated immediately. The time of injury to the time of surgery varied individually which was inevitable.

Operative definitions

Ground falls were defined as low-energy injuries and traffic accidents and sports injuries as high-energy injuries. Operative time was defined as the time from the skin incision to skin closure. Radiation exposure time was defined as the number of shots taken during the operating time and the time taken which was obtained from the C-arm logger. Fracture union was defined as the absence of pain and the presence of bridging callus in three of the four cortices seen on the anteroposterior and lateral radiographic views of the tibia. Delayed union was defined as lack of any healing on plain radiographs within three months. Non-union was defined as lack of any healing on plain radiographs within six months. Malalignment was defined as >5° ante-/recurvation, >5° varus/valgus deformity or >15° rotation difference[8] The American Orthopaedic Foot and Ankle surgery (AOFAS) scoring system[9] was used to evaluate the function of the ankle.

Operative Procedure

External fixation: The patients were operated under spinal anaesthesia. The pre-op antibiotics were given 30 minutes before surgery. The patient was placed supine on a radiolucent table. A pneumatic tourniquet was applied and inflated after the entire limb was prepared and draped under aseptic precautions. Under guidance of an image intensifier, a 5 mm Denham's pin was passed through the calcaneum from medial to lateral side. With purchase from both the cortices, two schanz pins (4.5 mm diameter) were passed through the anterior aspect of the tibia. The schanz pins were then connected to the Denham pin using connecting rods in an anterior triangular fashion (delta frame). Ligamentotaxis was applied. Satisfactory fracture reduction and maintenance of tibial articular surface was ensured radiographically. Reduction was rechecked using image intensifier and pin tracts were dressed aseptically.

MIPPO: A distal tibia locking plate of appropriate length was aligned on the medial surface of the operated leg in line with the tibial axial line under fluoroscopy. Based on the plate location in vitro, two 3–4 cm longitudinal incisions one at the middle line of the medial malleolus and the other was along the medial aspect of the tibia located at the proximal end of the plate were made on the skin beneath the two ends of the plate. An extraperiosteal, subcutaneous tunnel could then be formed between these two incisions using blunt dissection. The great

saphenous vein was protected, and the plate was inserted percutaneously from the distal to the proximal site. The operated leg was tracted under fluoroscopy to restore its length and coronal alignment. The plate position was adjusted when reduction was achieved. Once functional reduction was accomplished, the locking screws were driven in. No less than six cortical layers should be purchased for each side of the fracture.

Post-operative care was similar following both the procedures. Ankle and knee joint mobilisation exercises were started from second post-op day. Partial weight-bearing was allowed when radiological evidence of progress towards union was seen, usually at six weeks after operation, and full weight bearing was allowed when there was radiological evidence of bone union with no pain at the fracture site. All the external fixators were removed under local anaesthesia in the outpatient department at an average of 3 months.

Statistical analysis

Data entry and statistical analysis was performed using STATA version 11.0. Pearson's chi-square test and Fisher's exact test was applied for nonparametric categorical variables. Independent sample t test was used to compare the means of two numerical variables. The level of significance was set at P<0.05.

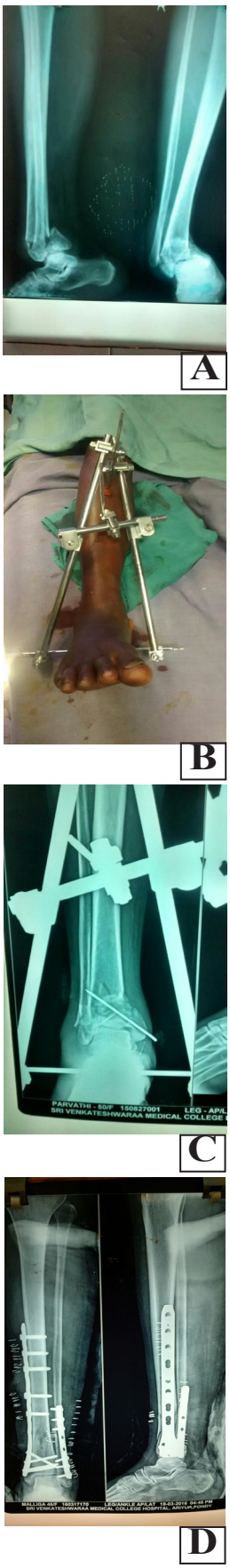

Fig: 1 A. A 45 year old female with open fracture distal tibia with dislocation B. External fixation immediate post-op C. Post-op radiological image of External fixation D. Post-op radiological image of MIPPO

Results

A total of 86 subjects who underwent surgery for distal tibia fracture were followed up and 45 among them who were eligible according to the above mentioned inclusion criteria were included. The mean age of subjects was higher for those who underwent MIPPO but there was no significant difference. In both groups higher proportion of males underwent surgery. There was no significant difference in type of fractures and soft tissue injury (as classified based on Oestern and Tscherne grading) between the compared groups. The time from injury to surgery was significantly longer (5 days) in MIPPO (p=0.006). The operating time was significantly longer for MIPPO (p=0.005) compared to external fixation (EF) while also demanding more number of fluoroscopic checks (p=0.008) for accurate implant alignment [Table 2]. Post-operative follow after MIPPO was significantly (p=0.002) longer (24 to 48 months) compared to external fixation (17 to 32 months). MIPPO was associated earlier bone union but was not significantly different from EF. Wound problems like pin tract infections were more common (p=0.04) in EF compared to MIPPO which had lesser wound problems. There was one case of mal-union reported with EF. The AOFAS score shows no significant differences between MIPPO and EF except for increased pain incidence in EF.

Table 1: Baseline and clinical variables among the two groups

	External Fixation n=20	MIPPO n=25	p value
Mean age (years)	36.9±11.8	41.6±8.2	0.12
Sex (male: female, n)	12:8	15:10	0.11
Tscherne grade (0: 1: 2, n)	4:12:4	8:12:5	0.64
Fracture side (left: right, n)	12:8	17:8	0.58
Cause of injury (High-energy: Low-energy, n)	15:5	19:6	0.94
Open fracture (yes: no, n)	4:16	9:16	0.24
Interval from injury to surgery (days)	3.2±1.1	5.0±2.6	0.006

Table 2: Intra-operative and Post-operative variables in the two groups

	External Fixation n=20	MIPPO n=25	p value
Intra-operative			
Mean operating time (min)	75.9±12.0	89.4±17.7	0.005
Mean Radiation exposure time (min)	3.1±0.9	4.2±1.6	0.008
Post-operative			
Mean Follow-up time (months)	25.8±8.2	36±12.4	0.002
Mean bone union time (weeks)	18.5±9.4	16±7.6	0.32
Patient with wound problems (%)	3 (15%)	0 (0)	0.04
Ankle pain	2 (10%)	4 (16%)	0.55
Mal-union			
>5 degrees	1 (5%)	0 (0)	0.11
>10 degrees	0 (0)	0 (0)	

Table3: Functional outcome scores as measured by AOFAS

AOFAS	External Fixation n=20	MIPPO n=25	p value
Pain	38.1±6.2	31.8±3.2	<0.001
Function	42.5±2.8	43.8±3.6	0.19
Alignment	9.2±0.8	9.4±0.4	0.28
Total	89.8±7.1	86.9±6.2	0.15

Discussion

MIPPO as a surgical technique has harvested good clinical results in terms of reduced iatrogenic soft tissue injury and preserving the osteogenic fracture haematoma by reducing damage to bone vascularity, which is precisely evident from the existing literature.[10-12] The margin of thought in deciding between an EF and MIPPO in distal tibial fractures is very slender and purely on the decision of the operating orthopaedician. Hence a prospective, comparative study of various outcomes of these two surgical studies would be of great use in deciding the surgical option on a case-based approach. In the present study, operating time and radiation exposure was significantly longer for MIPPO when compared to EF which was in line with results drafted by Liao-jun et al[13] who reasoned out that the longer operating time and radiation exposure were due to the indirect reduction techniques which were more complicated in the MIPPO technique. Delayed wound healing and infection rate in MIPPO ranged between 14.3% and 23.5%.[14,15] In contrary to this EF sequenced more wound problems and infections compared to MIPPO in this study. Pin track infection was a common incidence in external fixation technique in many previous studies.[16-18] Mal-union was a rare event in the present study with one case encountered during EF. But available literature states that the use of external fixation alone without intramedullary elastic nailing stabilization might result in insufficient reduction and a relatively high rate of mal-union (range, 5–25%) or non-union (range, 2–17.6 %).[16,19] The mean AOFAS score was not significantly different between the EF and MIPPO group which shows functional outcomes are similar but pain was higher in EF.[Table 3] This was in concurrence with the previous studies which showed a score of 87.5 points on an average for MIPPO.[13,20,21]

Conclusion

MIPPO as a surgical technique is a time-consuming procedure with more radiation exposure and follow-up time when compared to EF. But complications like wound infection, post-operative pain, implant failure and problems with bone union are minimal in MIPPO compared to EF.

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