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Functional Outcome of Minimally Invasive Plate Osteosynthesis Technique in Distal Tibial Fracture: A Prospective Study

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Abstract

Distal tibia fracture management is difficult due to wound infections and poor wound healing caused by unstable blood supply. Numerous surgical treatment modalities, including closed intra medullary nailing, open reduction and internal fixation with standard plate osteosynthesis external fixation, have been tried, nevertheless, the majority of these have higher complication rates than positive functional outcomes. With less soft tissue manipulation and less periosteal stripping, the more recent method of fixing distal tibia fractures utilising Minimally Invasive Percutaneous Osteosynthesis (MIPO) promotes quicker healing and decreased infection rates. The aim of the study was to evaluate the result of minimally invasive percutaneous osteosynthesis for treatment of distal tibial fractures. The present study was conducted in the department of Orthopaedics at a tertiary care hospital and followed up for a period of 2 years. In this study, 38 patients with distal tibia fractures with or without associated fibula fractures were treated with MIPO. Patients were subjected to history taking, clinical examination and radiological evaluation. American orthopaedic foot and ankle society score (AOFAS) scoring system was used to evaluate the function of the ankle, at 3, 6 and 12 months of postoperative follow-up examination. Results were analysed using SPSS 20.0 version and the association was tested using Chi square test. Patients ranged in age from 28 to 52 years, with a majority of male patients. In 35 (92.1%) of the patients, the mechanism of injury was Road Traffic Accident(RTA), whereas 3 (7.9%) had a history of falling. The most common fracture pattern in the study was AO type 43C1, which was seen in 9 (23.68%) of the patients. The MIPO method revealed fracture union after an average of 15.5 weeks. At the end of a year, 33 patients (86.84%) were rated as excellent, 4 patients (10.53%) as good 1 patient (2.63%) as fair, according to the AOFAS score. A total of 2 (5.26%) patients had superficial wound infection, whereas 1 (2.63%) had deep wound infection. MIPO is a dependable way of fixing not only extra-articular but also intra-articular distal tibia fractures. Patients who receive MIPO treatment have a significantly lower probability of deep infection, which provides a biological advantage by maintaining the blood supply and lowering the likelihood of a delayed or non-union. Early mobilisation is aided by the MIPO approach, which also lowers the possibility of ankle stiffness.

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Key Words

American orthopaedic foot and ankle score, external fixation, intra medullary nail, tibial fractures

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INTRODUCTION

Distal tibia or Pilon fractures are becoming more common as the number of road traffic accidents increases, accounting for 1% of all lower extremity fractures, 10% of tibial fractures, bilateral in 0-8% compartment syndrome in 0-5%[1]. The mechanism of fracture is axial loading caused by the talus hitting the lower end of the tibia forcefully. The articular surface injury, joint impaction, metaphyseal communition accompanying soft tissue injuries are all determined by the axial force on the distal tibia. Although the underlying cause of injury is varied, vertical compression is the dominating force. The position of the foot at the time of impact determines the location of the articular part of the fracture[2].

Distal tibial fractures are frequently linked with severe soft tissue injury as a result of high energy trauma, which can lead to a number of problems such as fixation failure, deep infection or skin flap necrosis. Treatment of fractures at the distal end of the tibia can be difficult for orthopaedic surgeons due to the subcutaneous location, low level of vascularity proximity to the ankle joint[3].

Albin Lambotte was probably the first to undertake open reduction and internal fixation for tibial fractures in 1905[4]. Destot, a French radiologist, coined the word tibial pilon in 1911 to describe the distal tibial metaphysis, which resembles a chemist's pestle (pilon). Bonin (ceiling) coined the term Plafond to describe to the horizontal distal tibia articular surface for these fractures[5].

Surgical intervention, such as closed reduction and intra medullary interlocking (IMIL) nailing, open reduction and internal fixation (ORIF) with plating, closed reduction and per cutaneous plating, or external fixators, is used to treat the majority of these fractures. Each of these methods has advantages and disadvantages of its own. It has been noted that IMIL nailing has a greater rate of malunion because it is challenging to install two distally locking screws. Complications of traditional osteosynthesis with plates include wound infections, skin disintegration delayed or non-unions needing further treatments such bone grafting. Similar complications with external fixators include pin tract infections, pin loosening, malunion non-union leading to osteomyelitis, which is why they have not been preferred as a permanent fixation technique[6].

A technique called Minimally Invasive Per cutaneous Plate Osteosynthesis (MIPO) seeks to protect the osteogenic fracture haematoma and lessen iatrogenic soft tissue damage and bone vascularity loss. It provides a secure fixation without endangering the nearby soft tissues. The biological fixation principle, which underpins its operation, preserves as much of the blood flow to the fracture pieces as possible. A plate is introduced per cutaneously to be secured at a distance proximal as well as distal to the fracture site by minimal exposure. It is placed on the epi-periosteum[7,8].

Aims and Objectives: To evaluate functional outcome in patients with distal tibia fractures treated by Minimally invasive percutaneous plate osteosynthesis technique

MATERIALS AND METHODS

The present study was a prospective study conducted in the department of Orthopaedics, Sree Mookambika Institute of Medical Sciences, Kulasekharam for a period of 2 years from January 2021-December 2022. The study included 38 patients of distal tibia fractures. Patients age above 18 years, intact neurological and vascular status, fracture line locating in or extending to 10 cm long region of metaphysis of distal tibia and patients willing to participate in the study were included. Patients with compound fractures, multiple trauma, pathological fractures, open fractures, diabetes patients with poor glycemic control and patients who were not willing to participate in the study were excluded.

A distal tibial fracture was defined as a fracture affecting the distal part of the tibia, distal to the isthmus a 10 cm long segment of the distal tibial metaphysis. The time of the procedure was chosen based on the condition of the soft tissue and level of edema[3].

A pre-operative anaesthesia assessment was performed after receiving previous informed consent. Fixation planning was done prior to surgery. Subjects were positioned supine on an ordinary operating table while under anaesthesia. Under c arm guidance, a closed reduction with MIPO and a locking compression plate (LCP) was performed using the conventional medial technique. Fixation of the accompanying fibula fractures in every case involved open or closed reduction with a plate, K wires, or screws. Fixation of the tibia was always done following fixation of the fibula. A below-knee slab was put for two weeks in a few patients, depending on the strength of the fixation non-weight-bearing mobility was indicated. The 14th day was spent removing the sutures. Depending on the fracture configuration, callus response accompanying injuries, weight bearing was initiated.

Following postoperative visits at three months, six months one year, an assessment was conducted in the outpatient department (OPD). The patient was assessed clinically for pain score, soft tissue state radiologically for alignment, fracture reduction union during the follow-up appointment. Painlessness during the entire weight-bearing period was the definition of clinical union. The modified radiological union scale for the tibia (mRUST) score in the anteroposterior and lateral radiographs was used to determine radiological

union. mRUST score of 10 or higher was considered to reliably predict fracture healing. A mRUST score of less than 10 at the 12-month follow-up was considered non-union. At 3, 6 12 months following surgery, the function of the ankle was assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) scoring system. The examined factors were divided into three key areas by this scoring system: pain, function alignment. The scores were then scored as exceptional (90-100), good (75-89), fair (50-74) and bad (<50).

Data were entered in Excel sheet. Results were analysed using SPSS 20.0 version. Descriptive statistics were provided for all baseline characteristics and study endpoints. Quantitative variables were documented as the mean±standard deviation. Quantitative variables between the two groups were assessed by independent Student's t-test. A p value less than 0.05 was considered statistically significant.

RESULTS AND DISCUSSIONS

A prospective study of 38 distal tibia fractures treated by locking compression plate with MIPO technique was undertaken. The age group of patients ranged from 28-52 years of age with the maximum patients 16(42.1%) in the age group of 31-40 years. The mean age group pf the patients was 37.5±7.5 years. Among the study population males 30(78.9%) were commonly affected than females 8(21.5%). The mechanism of injury was Road Traffic Accident (RTA) in 35(92.1%) patients while 3(7.9%) had history of fall.

Majority of the fractures in the study group were of closed type with 28(73.68%) of the study group and 10(26.32%) were of type 1 open fracture (Gustilo Anderson). Of the 38 patients, 22(57.89%) had associated fibula fracture. According to AO/ OTA classification of the fracture pattern in the study was AO type 43C1 seen in 9(23.68%) patients (Table 1).

Most of the patients 17(44.75%)showed radiological evidence of healing. MIPO technique showed fracture union at an average duration of 15.5 weeks ranging from 11 to 23 weeks. (Table 2)

Mean AOFAS score improved with each follow up visits. According to AOFAS score at the end of one year, 33(86.84%) patients were graded as excellent, good in 4(10.53%) patients and fair in 1(2.63%) patient. None of the patients had poor outcome. Comparison of mean AOFAS scale scores between different time interval showed statistical significance. (Table 3)

Superficial wound infection was seen in 2(5.26%) patients and deep wound infection was seen in 1(2.63%) patients.

The management of distal tibial fractures is determined by the fracture pattern, soft tissue injury, patient co-morbidity, fixing resources surgical experience. The logical progression in the surgical management of fractures is MIPO. It mostly depends on applying several approaches to indirectly reduce the fracture. Less infection, less wound complications improved fracture healing are theoretical benefits[8].

Mean age of the patients in our study was 37.5±7.5 years, ranging from 28 years to 52 years which was similar in other studies. The study showed male predominance 30(78.9%) patients. Higher prevalence in males are most probably because of the fact that the fracture is a common occurrence in vehicular accidents which are more common amongst the male population. The study by Patel[9] included 20 individuals, with a mean age of 41[4]. years and a range of 20-76 years. There were 16 male patients and 4 female patients among the 20 patients. In their study, Singh[10] found that the most prevalent age group was 41-50 years (40%), followed by 31-40 years (30%) was made up of 73% males. Donimath[11] observed that 16 (88.8%) of the cases in their study population were admitted owing to RTA. This was similar to the present study.

Comparison with of type of fracture and fracture pattern according to AO/OTA classification with other studies was described in table 4 and 5 respectively.

According to Ruedi and Allgower, the first rule of treating distal tibia fractures was to restore fibular length, which is still essential for getting the best results. Restoration of limb length, prevention of varus tilt, maintenance of rotation mechanical alignment

Fig. 1: Distal tibia-Pre Op

Fig. 2: MIPA done-Post Op X-ray

Fig. 3: Post Op X-ray-6 months

Table 1: Distribution of type of fracture among study patients

Type of fracture	N = 38	Percentage
Type A1	4	10.53
Type A2	6	15.79
Type A3	7	18.42
Type B1	4	10.53
Type B2	0	0
Type B3	2	5.26
Type C1	9	23.68
Type C2	5	13.16
Type C3	1	2.63

Table2: Distribution of duration of radiological union of fracture among study patients

Category	N = 38	Percentage
<8 weeks	0	0
9-12 weeks	6	15.78
13-16 weeks	17	44.75
17-20 weeks	12	31.58
21-24 weeks	3	7.89

Table 3: Comparison of mean AOFAS scale scores between different time interval

Duration	Mean	SD	Min	Max	p-value
3 month	71.32	8.52	54	84	<0.001*
6 month	79.68	7.37	61	89	
1 year	86.16	7.12	71	94	

Table 4: Comparison of type of fracture with other studies

Studies	Closed fracture	Open fracture
Parthasarathy A *et al*.[12]	76%	24%
Agarwal K *et al*.[13]	82.5%	17.5%
Present study	28(73.68%)	10(26.32%)

Table 5: Comparison of fracture pattern with other studies

Studies	Common type of tibia fracture
Singh SD *et al*.[10]	A1 type
Parthasarathy A *et al*.[12]	C1 type
Agarwal K *et al*.[13]	A3 type
Collinge C *et al*.[14]	C2 type
Kantharaju H *et al*.[15]	A2 type
Present study	C1 type

Table 6: Comparison of Mean duration of fracture union with other studies

Studies	Mean duration of fracture union
Donimath VS *et al*.[11]	22.6 weeks.
Parthasarathy A *et al*.[12]	16 weeks
Agarwal K *et al*.[13]	12 weeks
Kantharaju H *et al*.[15]	16.32 weeks
Ishtiaq M *et al*.[177]	17 weeks
Present study	15.5 weeks

were the aims of fibula fixation.16 In the current study, 22 patients (57.89%) had related fibula fractures that were 7 cm from the tip of the lateral malleoli, as a result, the fibula was mended before the distal tibia in each of these cases. This was comparable to the study done by Parthasarathy[12] where 68% of the distal tibia fractures were associated with distal fibula fracture.

The average period of radiological fracture union was 15.5 weeks, ranging from 11-23 weeks in the present study. This was in accordance with earlier studies (Table 6). According to Singh[10] radiographic union was obtained in 20% of patients in 12 weeks, in 23% in 12-16 weeks, in 50% of patients in 16-20 weeks, and in one patient each in 20-24 weeks and 24-28 weeks.

The study analysed the outcome using AOFAS which takes into account pain, function and alignment. Mean AOFAS score improved from 71.32 (at 3 month) to 79.68 (at 6 month) and 86.16 (at 1 year). Parthasarathy[12] conducted a study in which the mean AOFAS score after a year was 85.64. Similar findings were observed by Supe AC et al.18 who studied 32 patients. Of these, 30 (93.8%) had excellent outcomes whereas 2 (6.2%) had good results. The average AOFAS score was 94.4, ranging from 77-99. Zaghloul[19] also reported an Excellent grade in 15 (75%) patients, a Good grade in 3 (15%) patients and a Fair grade in 2 (10%) patients. In contrast to the current investigation, Gulabi[20] observed no statistically significant difference between patients treated with the MIPO approach compared to those treated with the ORIF technique in terms of functional outcome ratings (AOFAS).

The two main soft tissue consequences are wound dehiscence and deep infection. The therapy may involve wound cleaning, antibiotics, skin grafting, myocutaneous flap, or even arthrodesis. Superficial wound complication infections were reported in 2(5.26%) cases and 1(2.63%) patient had deep surgical site infection. This was comparable to the studies done by Patel[9] Singh[10] and Supe[18] Wang[21] found a substantially shorter duration of union in the IMN group than in the MIPO group (138.8±11.0 vs.

153.5±17.1 days, P <0.05) as well as a significantly lower incidence of superficial wound infection rate in the IMN group than in the MIPO group (1.9% vs. 8.2%, P<0.05).

CONCLUSION

MIPO is a dependable way of fixing both extra-articular and intra-articular distal tibia fractures. By maintaining the blood flow and reducing the likelihood of delayed or non-union, MIPO method for distal tibia fractures provides a biological advantage. Patients who receive treatment with the MIPO approach had a significantly lower incidence of deep infection as well as satisfactory radiographic union. Early mobilisation is aided by the MIPO approach, which also lowers the possibility of ankle stiffness. Additional research with a longer follow-up and a larger sample size can be done.

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