



International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2020; 6(1): 995-998
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www.orthopaper.com
Received: 01-11-2019
Accepted: 03-12-2019

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The functional and radiological outcome of minimally invasive percutaneous plate osteosynthesis (MIPPO) in treatment of distal meta-physeal fractures of tibia

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DOI: <https://doi.org/10.22271/ortho.2020.v6.i1m.1947>

Abstract

ccccccThus improving the outcome for function and quality of life of patients with fractures. While the healing progress of bone fractures clearly benefitted by the method of plate and screw fixation construct, a new application of plate fixation started Introduction of the locking compression plate was a revolution in the evolution of management of fractures where prolonged bed rest is avoided and return to work is satisfactorily helpful. Local examination of the injured extremity revealed swelling, deformity and loss of function. Palpation revealed abnormal mobility and crepitus at the fracture site. Distal neurovascular status was assessed by the posterior tibial artery and dorsalispedis artery pulsations, capillary filling, local temperature, pallor and paraesthesia. The closed reduction not only helps in achieving reduction in difficult situations, but also in rapid union, because it facilitates preservation of the blood supply to the fragment and helps to achieve near normal anatomical reduction of the fracture.

Keywords: Functional and radiological outcome, minimally invasive percutaneous plate osteosynthesis, distal meta-physeal fractures of tibia

Introduction

Fractures of the tibia are among the most common of serious skeletal injuries. It is the second most common long bone to be fractured. Of all tibial fractures, 7 - 34% occurs in the distal tibial region. Treatment of distal metaphyseal tibia fracture with or without articular extension is challenging because of its unique anatomical subcutaneous location with precarious blood supply and very close proximity to the ankle joint^[1].

The most important factors that affect the final clinical result are the type of fracture, associated soft tissue injury, the method of treatment and the quality of the reduction. Most of these fractures are managed with an operative intervention such as closed reduction and intramedullary interlocking (IMIL) nailing or open reduction and internal fixation (ORIF) with plating or closed reduction and per cutaneous plating or external fixators.

Each of these techniques has their own merits and demerits. These distal tibial metaphyseal fractures are generally not suitable for –intramedullary nailing. They have reported with higher rate of mal-union because it is difficult to achieve two distally locking screws. Failures in controlling distal fragments may lead to deformities and mal union^[2].

External fixation can be used as either a temporary or definitive method of treatment, especially in fractures with severe soft tissue injury, but pin site infection, loosening, mal-union, delayed union and non-union continue to be the main problems with this method of fixation. Hence not preferred as definitive fixation method^[3].

Conventional plate osteosynthesis with open reduction results in extensive soft tissue dissection and periosteal injury and can further devitalize fragments and lead to higher incidence of non-union, infection and implant failure.

Numerous improvements and developments across all medical specialties took place, at the same time advances in the field of fracture fixation also occurred. Thus improving the outcome for function and quality of life of patients with fractures. While the healing progress of bone fractures clearly benefitted by the method of plate and screw fixation construct, a new

application of plate fixation started Introduction of the locking compression plate was a revolution in the evolution of management of fractures where prolonged bed rest is avoided and return to work is satisfactorily helpful. - Minimally invasive percutaneous plate osteosynthesis (MIPPO) - Minimally invasive percutaneous plate osteosynthesis (MIPPO), performed by indirect reduction, has become a successful treatment modality in complex fractures of the lower extremity. The aim of MIPPO is to preserve the osteogenic hematoma of the fracture and the nutritional arteries of the bone while preventing iatrogenic soft tissue damage. Vascular injection studies have compared cases treated by MIPPO with classic open techniques and MIPPO was found to result in higher preservation of periosteal circulation^[4].

Therefore, minimally invasive osteosynthesis, offers the best possible option as it permits adequate fixation with reduced soft tissue dissection and exposure resulting in low surgical trauma and thus preservation of the blood supply in a biological manner with lesser evacuation of osteogenic fracture hematoma. The locking compression plate (LCP) provides enhanced stability in these situations with a minimum number of screws. Locked screws prevent the plate from pressing the bone, preserving periosteal blood supply. This system stimulates callus formation due to flexible elastic fixation. The anatomic shape of the plate prevents mal-alignment of the fracture and provides a better axial and angular weight distribution. MIPPO has been developed as a method of fracture fixation with which the soft tissue envelope around the fracture is preserved and the fracture biology is less affected. The plate is placed through small incisions with as limited dissection and stripping of the soft tissue envelope as possible. This technique has many biological advantages compared to the traditional open reduction and internal fixation. MIPPO involves minimal soft tissue dissection with preservation of the vascular integrity of the fracture as well as preserving the osteogenic fracture haematoma. However, the MIPPO technique faces some significant drawbacks. Because of its closed fashion without direct sight and overview of the fracture and the implant manipulations, it requires training, manual skills and surgical experience to adequately perform the procedure. In order to overcome the lack of visualisation, intra-operative fluoroscopy with an image intensifier is used, but that inflicts the patients, surgeons and nurses to a significantly higher exposure of radiation. If the operation including the fracture reduction is not appropriately managed, complications may result, such as malalignment and mal-rotation problems, as well as infections and delayed or non-union^[5].

The traditional method of open reduction and plate fixation requires wide exposure of the fracture site with stripping of the soft tissues, which may in turn devascularise fracture fragments. This may contribute to necrosis caused by trauma and consequently increase the risks for delayed healing and infection. Open techniques entail a larger incision, more bleeding and a need for periosteum stripping during surgery. Postoperative recovery is also protracted. This technique was developed to avoid extensive exposure of the fracture site and to minimise soft tissue damage, and entails a smaller incision resulting in a smaller scar and recovery of the soft tissue occurs more rapidly^[6].

Methodology

All cases reporting to emergency trauma care and admitting in our hospital were included in this study as per inclusion and

exclusion criteria, aiming at minimum of 30 cases.

Local examination of the injured extremity revealed swelling, deformity and loss of function. Palpation revealed abnormal mobility and crepitus at the fracture site. Distal neurovascular status was assessed by the posterior tibial artery and dorsalispedis artery pulsations, capillary filling, local temperature, pallor and paraesthesia.

Antero-posterior and lateral radiographs of the affected leg along with ankle were taken and the fracture patterns were classified based on the AO/OTA classification of fractures of distal tibia. The limb was then immobilized in an above knee Plaster of Paris slab till definitive fixation with locking compression plate done.

Pre-operative Planning

All the patients were explained and motivated about the cosmetic problems and difficulties in daily routines by the application of an external fixator. Appropriate and valid written consent was taken. The patient was taken for surgery after routine investigation and after obtaining fitness towards surgery. The investigations done were, Hemoglobin percentage, Fasting blood sugar, Blood urea, Serum creatinine, HIV, HBSAg and ECG. A dose of tetanus toxoid and antibiotic was given pre-operatively. Preparation of the part was done before a day of the surgery. Instruments were checked and sterilized before hand.

Operative Procedure

Type of Anesthesia- Lumbar Sub Arachnoid Block (Spinal)
Position-supine with affected leg elevated on a pillow/sand bag.

- Pneumatic/Esmarchs tourniquet applied and time noted

Surgical Technique

- Medial approach is most commonly used for the mippo technique.
- Plate inserted from distal to proximal through epiperiosteal tunnel between periosteum and intact soft tissue.
- Fracture is reduced by indirect maneuvers using ligamentotaxis and directly by percutaneous reduction forceps.
- 3-5 cm of slightly curved skin incision on medial aspect of distal tibia from the tip of medial malleolus.
- Incision carried out straight through subcutaneous fat with out raising flaps.
- Great saphenous vein and nerve are held anteriorly.
- ORIF of fibula was part of first stage of fixation. Which aids reduction of tibia.
- Epiperiosteal tunneling made towards the diaphysis by blunt tip of plate or tunneling instrument.
- Plate is inserted from distal to proximal on anteromedial surface using drill sleeve as plate manipulator.
- Fracture is by passed and plate is first adjusted to periarticular area and 3.5mm cortical screw inserted in one the distal holes just above ankle joint approximating the plate to bone which prevents overlying soft tissue irritation.
- Fracture reduced by various reduction maneuvers.
- Using another drill sleeve as manipulator at proximal end the plate is fixed using 4.3mm cortical locking screw.
- Rest of the screws are inserted under c arm guidance using stab incisions atleast three on either side.
- Tourniquet was removed, hemostasis was secured and incisions closed with 2'0 nylon.

Postoperative treatment

Postoperative treatment with Locking Compression Plates does not differ from conventional internal fixation procedures.

Results

The fracture pattern was classified based on AO/ASIF classification for fractures of distal tibia. Of the 30 cases studied, 12patients (40%) are A1, 9(30%) patients are A2, (30%) 9 patients are A3.

Table 1: Fracture pattern

Type	No. of patients	percentage
A1	12	40%
A2	9	30%
A3	9	30%
Total	30	100%

5 out of 30 patients had distal fibula fracture, 3 patients had lateral malleoli fracture, 1 patient had distal radius fracture, 1 patient had clavicle fracture, 1 patient had humerus shaft fracture. All the 30 cases were operated under lumbar sub

arachnoid block spinal anaesthesia. All the cases studied underwent closed reduction with MIPPO techniques with the help of fluoroscopic control too. Follow up ranged from 6 months to 12 months

Table 2: Duration of fracture union

Duration in weeks	No. Of. patients	percentage
14weeks	8	27
16weeks	9	30
18weeks	6	20
20weeks	4	14
22weeks		
24weeks	1	3
26weeks	1	3
28weeks		
30weeks	1	3

All the fractures united with an average of 17 weeks. There were 3 delayed union with 24 weeks, 26weeks and 30weeks with signs of radiological callus formation.

Table 3: Objective criteria

Rating	Ankle/subtalar motion	Tibiotalar alignment	Tibial shortening	Chronic swelling	Equines deformity
Excellent	>75% normal	Normal	None	None	None
Good	50-75%	Normal	None	Minimal	None
Fair	25-50%	<5 ⁰ angulaton	<1cm	Moderate	None
Poor	<25%	>5 ⁰ angulation	>1cm	Severe	Present

Table 4: Subjective criteria

Rating	Pain	Return to work	Recreational activity	Limited walking	Pain medication	Limp
Excellent	None	Same work	Normal	No	None	None
Good	Mild	Same work	Mild modification	No	None	None
Fair	Moderate	Modified	Significant modificaton	Yes	Non narcotic	Occasional
Poor	Severe	Unable	None	Yes	Narcotic	Yes

Table 5: Outcome based on Objective criteria

Results	No. of patients	percentage
excellent	15	50%
good	9	30%
fair	5	17%
poor	1	3%

Table 6: Outcome based on Subjective criteria

Results	No. of. patients	percentage
excellent	14	47%
good	10	33%
fair	5	17%
poor	1	3%

Discussion

The present study could not be compared with the other studies because our primary aim is to study the distal end tibial meta-diaphyseal fractures with out intra articular extension. We have excluded the type B & C AO/OTA fractures.

How ever study by Liu *et al.* showed 15% C pattern, Paluvadi *et al.* also had fractures types 14% of B pattern, 16% of C pattern. We had a higher percentage of type A fracture due the selection process based on the aim of the study.

Table 7: Comparison of Fracture pattern

Study	A1	A2	A3	B1	B2	B3	C1	C2	C3
Liu <i>et al.</i> [7]	8	8	10	4	3	1	3	3	-
Li <i>et al.</i> [8]	40	18	8	-	-	-	-	-	-
Paluvadi <i>et al.</i> [9]	20	11	4	3	3	1	6	-	2
Gupta <i>et al.</i> [10]	16	10	4	-	-	-	-	-	-
Present study	12	9	9	-	-	-	-	-	-

The average time for fracture union in various studies conducted using various methods was 16- 28 weeks. Our study had an average fracture union of 17 weeks which were comparable with studies conducted using the locking compression plates. Liu *et al.* had an average union of 20 weeks and Gupta *et al.* had an average of 20 weeks.

Table 8: Comparison of Average duration of fracture union

Study	Method	Average duration of fracture union
Liu <i>et al.</i> [7]	MIPPO	20 weeks
Li <i>et al.</i> [8]	MIPPO	22weeks
Gupta <i>et al.</i> [10]	MIPPO	20 weeks
Paluvadi <i>et al.</i> [9]	MIPPO	24 weeks
Muzzafar <i>et al.</i> [11]	MIPPO	17 weeks
Present study	MIPPO	17 weeeks

Liu *et al.* in their study during time period of 2005 to 2009, in review with 40 patients with distal tibia fractures treated with MIPPO technique of locking plates showed union in average time period of 4 months. Clinical results of functional recovery measured with Mazur grating system 36 patients showed excellent results, 3 patients showed good results, there were no infections nor any complication. They concluded that closed manipulative reduction and MIPPO fixation is a good method of treatment for tibia fractures in middle and distal segment

Li *et al.* in their study of 66 patients with distal tibia comminuted fractures treated with MIPPO technique during time period of 2006 to 2012, compared the clinical outcomes of minimally invasive technique in treating distal tibia comminuted fractures at early and delayed stage, according to soft tissue injury grading by tscherne, showed that there is no significant difference in fracture healing and functional outcomes according to Oleaur molander scoring system, for distal tibia comminuted fractures with grade 1 and 2 tscherne soft tissue injury, MIPPO technique at primary stage cannot increase incidence of soft tissue complications also can obtain the same clinical outcome just like delayed MIPPO

Gupta *et al.* in their study of 30 patients with distal tibia fracture treated with MIPPO plating and distal fibula fractures treated with rush nail during the time period of 2012 to 2014, showed that use of rush nail to fibula fractures showed less soft tissue complications when compared with distal tibia plating (dual plating technique), thus showed decrease the rate of complications when fibula treated with rush nail which finally improved the clinical outcome for patient

Paluvadi *et al.* in their study of 50 patients with distal tibia fractures during time period of 2010 to 2013 treated with MIPPO plating were followed for clinical and radiological outcomes and followed for 3 years showed fracture healing of an average time period of 22 weeks, evaluated based on AOFAS scoring system, showed excellent results in 90% of patients, with superficial infection in 5% patients, concluded that MIPPO technique provides good functional outcome and decreases incidence of non-union and decreases need for bone grafting

Muzaffar *et al.* in their study on 25 patients with distal tibia fractures treated with MIPPO plating using plate on plate technique of locking plate fixation for closed fractures, outcome measured with AOFAS score showed fracture united with average time period of 17 weeks, with superficial infection in 2 cases, concluded that MIPPO using locking plate on plate technique was a safe, effective, inexpensive method for treatment of distal tibia fractures with minimal operative time and soft tissue morbidity^[12].

Conclusion

According to this study, 30 patients with fractures of the distal tibia which have undergone closed reduction through MIPPO techniques and application of the locking compression plates states that this technique has resulted in the strong and effective stabilization of these fractures.

It does provide excellent stability and allows early range of motion at ankle.

Its greatest advantage is closed reduction and internal fixation with locking compression plates in near normal anatomical reduction where the fracture hematoma is not disturbed much.

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