TITLE

A STUDY OF MINIMAL INVASIVE PERCUTANEAOUS PLATE OSTEOSYNTHESIS (MIPPO) FOR DISTAL TIBIA AND PILON FRACTURES ---DR. SAMIR PILANKAR

INTRODUCTION

Fractures of distal tibia and pilon fractures are one of the most commonly encountered fractures in orthopaedic practice. They are also one of the difficult fractures to treat on account of

1. No muscle tissue attachment on lower ¼ tibia
2. Metaphyseal cancellous comminution,
3. Most of them are compound fractures,
4. poor blood supply to the distal tibia

The conventional technique of Open reduction and internal fixation (ORIF) with plating of distal tibia fracture requires wide exposure, extensive soft tissue stripping with subsequent risk of infection and skin necrosis. MIPPO technique avoids all of the above and hence is associated with better functional results.

MATERIAL AND METHODS

A prospective study of 40 patients with closed intraarticular or extraarticular fracture of distal fourth tibia was done to study the outcome of treatment by MIPPO (minimal invasive percutaneous plate osteosynthesis). Out of 40 patients, 36 were males and 4 were females. The patients were in between the age group of 20 to 50 years with an average age of 35.36 years. Mode of injury in most of the patient's was fall from height 22 patients(55%), vehicular accidents 16 patients (40%), and sport injuries 2 patients (5%) resulting in twisting and compression injury around ankle.

To classify the fractures, A.O. classification was used.

Type–A : 20 patients

Type–B : 10 patients

Type–C : 10 patients

Surgical Technique:

Under regional anesthesia the limb is painted and draped. Ipsilateral iliac crest is kept ready for needful bone grafting. The fracture fragments are reduced with manual traction and esmarch rubber tourniquet. Pneumatic tourniquet applied and inflated to 350mm Hg.

1. Fibula Fixation –

   Establishment of correct tibial length is accomplished by reducing and stabilizing the fibular fracture. Reduction and stabilization of fibula restores the length of lateral column and assist in reduction of anterolateral fragment of distal tibia (Chaput fragment) and posterior malleolar fragment (Wagstaffe's fragment). Restoration of fibula length also helps avoid valgus deformity of tibial plafond. Skin incision is taken posterolateral aspect posterior to fibula and lateral malleolus to maximize the skin bridge between lateral and medial incision. Fibula plating is done with 1/3rd tubular plate or 3.5 DCP after reduction of fibula. Lag screw can be used to get anatomical reduction and interfragmental compression. In cases of comminuted fracture fibula restore the fibula length and bone graft the defect.

2. Fixation of Tibia –

   Various closed techniques are used to achieve articular alignment i.e. by –

   (i) Manual traction with Esmarch application.

   (ii) A.O. femoral distractor -

   Restoration of tibial length and alignment is most readily accomplished, indirectly, with the use of femoral distractor. By applying tension across the fracture it corrects the medial tibial alignment and tibial length can be achieved. This is most effective if fibula is intact or has already been reconstructed which works as buttress against which medial femoral distractor indirectly works.

(iii) Percutaneous 'K' wire to toggle and lever the fragment into alignment.

If closed maneuvers are unsuccessful then open reduction is carried out through a small anteromedial incision under image intensifier control.

(a) Incision :

Location of incision can be either proximally or distally depending upon which fragment (proximal / distal) is displaced and hinging skin medially. For medial displacement of proximal fragment take plate sliding incision proximally. Distal incision is taken if distal fragment is displaced medially. This step aids in easier passage of periosteum elevator over bone spike and helps in getting reduction without much difficulty.

Then under image intensifier control a transverse incision about 1.5 inch long is made bone deep about 2 inches proximal or distal to the proximal or distal extent of the fracture line respectively. A medium sized periosteum elevator is introduced to strip the periosteum downwards till the medial malleolus tip.

(b) Templating and Contouring :

It is most important step as distal end of tibia is concave anteromedially with radius of curvature approximately 20 cm and internally rotated 25° with respect to posterior tibia. This torsion is more extreme proximally than distally. It is more pronounced anteriorly than posteriorly. Hence plate should be contoured according to torsion and concavity. A template passed subperiosteally and contoured.

A 4.5 mm reconstruction plate used as it is easier to contour and strong enough to buttress tibial fragments. Plate contoured and twisted according to template.

(c) Fixation:

Contoured and twisted 4.5 mm reconstruction plate is passed subperiosteally till just above the tip of medial malleolus and its location and reduction are confirmed on image intensifier. Now one of the proximal holes is filled with a 4.5 mm cortical screw through small stab incision. The screw is then used as a hinge to rotate the plate clockwise or anticlockwise as required for accurate placement. Then 4 mm fully threaded screws passed through small stab incision in metaphyseal region to hold fragments of distal end under image intensifier control. This is

followed by insertion of remaining screws in proximal and distal holes through similar small stab incision. A same sized plate is used as a template to aid in making stab incision.

Any articular depression associated is elevated with percutaneously passed K wire and maintained with 4 mm cancellous screw passed either through the plate or percutaneously.

Subcutaneous sutures are taken proximally with 1-0 vicryl.

Skin incision is closed with 2–0 ethilon.

Postoperative Protocol –

Early nonweight bearing mobilization of the patient started from 5th day onwards after inspection of suture line. Early ankle joint range of motion exercises are started with special emphasis on ankle dorsiflexion. Once adequate ankle dorsiflexion is gained then the attention is given to plantar flexion. Aim is to achieve at least 25degree of total ankle motion (from 10 degree of dorsiflexion to 15 degrees of plantar flexion) which is associated with good functional results.

A radiograph is taken at 4 weeks to see signs of union and alignment and then is monthly for assessment. Usually by the end of 3 months the fracture unites sufficiently to allow weight bearing.

If at the end of 3 months fracture is not sufficiently united or showing signs of delayed union then posterolateral bone grafting is resorted for uniting it and weight bearing is delayed till fracture shows signs of union.

OUTCOMES & RESULTS

Following criteria's were used to assess the results. **Grading of the Results:**

Result	Pain	Deformity	X–ray	Stiffness
Excellent	No pain	No deformity	Normal	No stiffness
Good	Pain with intense activity	No deformity	Minimal changes	Minimal stiffness
Poor	Pain while walking	Clinical and Radiological deformity	Arthritis	Restriction of 50% or more ankle and subtalar motion

All the patients were hospitalized for an average of 4 days. The patients were allowed to start mobilization of ankle on 5th day of surgery. Most of the patients started weight bearing at 12 weeks and achieved fracture union..

Result	No. of Patients	Percentage
Excellent	32	75%
Good	6	15%
Poor	4	10%

32 patients achieved excellent results with full range of motion. However, 2 patients developed recurvatum deformity with 10° restriction of dorsiflexion, 1 patient developed valgus angulation and 1 patient developed procurvatum angulation. One patient had wound problems related to poor patient selection as this patient was having a lichen planus lesion on leg. 3 patients had delayed union, 1 of which required posterolateral bone grafting and achieved union.

Excellent results are attributed to a smaller incision and exposure and hence a shorter surgical and tourniquet time resulting in less surgical and hypoxic damage to tissues.

Overall 75% (20patients) of patients achieved excellent results with full range of motion and no pain without any deformity. 15% (6 patients) patients however had some deformity or some restriction of movements, which were acceptable and did not require any intervention. Of the 10% (4 patient) poor results one patient had poor result secondary to wound breakdown and exposed implants which later required implant removal. One patient had wound infection while other 2 had delayed union and pain.

ANALYSIS

The results of surgical management have been shown to be affected by: 1)Type of fracture,2)Quality of articular reduction achieved at surgery,3)Procedure by which fracture is managed.

Sirkin et.al. and Patterson & Cole et.al. in there review of results of treatment of 21 distal tibia fractures with minimally invasive techniques at 22 months follow-up reported good ankle range of motion with 77% excellent results, 14% good results and 9 % poor results. These authors concluded that the two staged approach offered an acceptable results for the treatment of severe pilon fracture while minimizing soft tissue complication and improved articular reduction. In our study, 75% excellent results were achieved with patient having full range of motion at ankle joint and complete union. However, 3 patients had delayed union amongst which one required Posterolateral Bone Grafting (PLBG). 15% patients achieved good results with some restriction of movements. The results were contributed to:

1.**Anatomical Reduction :**

2. Early Mobilization

3. Biological Fixation:

DISCUSSION

Conventional Open Reduction and Internal Fixation (ORIF) is associated with extreme operative dissection through poorly vascularised and traumatised soft tissue envelop of distal part of tibia combined with implantation of subcutaneous plate leads to complications like deep infection, skin flap necrosis, ankle stiffness ultimately leading to ankle arthritis.

Plate and screw fixations have been associated with more frequent wound breakdown and infection than in similar fractures treated with external fixation. Wyrsch et al in 1990 prospectively compared 18 pilon fractures treated with open reduction and internal fixation to 20 fractures treated with external fixation with or without limited internal fixation. In the open reduction group, 6 patients (33%) required free flap for

treatment of wound breakdown, 6 patients (33%) developed deep infection, and 3 patients (17%) eventually required an amputation.

Thus gradually the focus has been shifted from the mechanical aspect of fracture treatment of anatomic reduction and rigid stabilization to biological fixation technique with least disruption of soft tissue envelops which is the base of this study.

Minimal invasive percutaneous plate osteosynthesis avoid extensive dissection and periosteal stripping. A small incision on medial aspect is needed through which plate is slid subperiosteally. Smaller wound heals faster. This causes less wound complications. Biological fixation without disturbing fracture hematoma also aids in achieving early union.

The principles of MIPPO have been elaborately elucidated by Sirkin et al (CORR 2000). They have advocated the use of longer plates (for improved mechanical leverage) and fewer screws (to avoid unnecessary bore and soft tissue damage). In fact filling each and every hole can weaken the bone and it may refracture on implant removal (Gautier et al, Zatrabl Chir 1994). Lag screws are preferably inserted through the plate to avoid excess soft tissue stripping. By this technique plate becomes a load bearing implant till callus appears. These plates require only 2 to 3 bicortical holds in each main fragment to achieve stability. It helps in achieving faster fracture healing.

In our study, long plates and minimal cortical screws on either side are used i.e. atleast 2-3 bicortical holds in each main fragment to achieve stability.

Lag screws are primarily used for fixation of posterior malleolus fragment and getting articular reduction. In our opinion the Recon / AO L.C.P. plate used for MIPPO fixation act mainly on the principle of bridge or span plate. Reconstruction plate is not strong plate enough to allow lag screw fixation through plate as they might cause loss primary reduction if contouring is not proper. In AO-L.C.P. plate, plate mainly acts as an internal fixator, where micromotion is possible between the fragments making lag screw fixation through plate impossible as L.C.P. always has gap between bone and plate, and in case lag screw is used to fix the two fragments the screw will break.

A review of the literature shows that for the best outcome operative treatment of these injuries should be tailored to the fracture pattern (i.e., personality of the fracture); degree of soft tissue injury, patient's demands and expectations, and the surgeon's experience and training. In the past, conservative means of treatment was commonly advocated [5].

Leach et al [1] advocated open reduction and internal fixation (ORIF) of the fibula and nonoperative management of the tibia.

Rouff et al [2] advocated ORIF of the fibula and limited internal fixation of the tibial fragments.

Marsh et al [6] reported results of a prospective multicenter study of 48 patients, treated with an articulated external fixator for displaced pilon fractures. At an average followup of 30 months (n=30), 21 patients were found to have little or no evidence of osteoarthrosis, and 9 patients had joint space narrowing, some with subchondral collapse. 1 patient underwent early ankle arthrodesis.

McFerran et al [4] investigated complications in 52 tibial plafond fractures most of which were treated by ORIF. Overall 54% incidence of local complications and 8 of 11 open fractures were associated with complications.

Teeny and Wiss [7] have encountered 37% infection rate in fractures treated by ORIF and 26% required ankle arthrodesis. They reported poor results in 67% of fractures treated with ORIF.

Watson et al [8] analyzed 39 tibial pilon fractures with variety of external fixation devices. They have found 64% of failures consisted of malunion or nonunion of diaphyseal–metaphyseal junction.

Williams et al [9] retrospectively evaluated the consequences of fibular plating in 54 tibial pilon fractures treated with an articulated medial half–pin external fixator and limited screw fixation of the tibia.

Barbieri et al [11] reported on 37 patients treated with hybrid external fixation for displaced pilon fractures. Fifteen patients also had limited internal fixation, eleven fractures were open. With a followup of 15 months, 12 patients had an excellent result, nine good, seven fair, and six poor. Complications occurred in 12

patients (35%) and included one skin slough, five pin tract infections, three deep infections, three nonunion, and three losses of reductions, which required frame revision.

Sirkin et al [12] using a standard treatment protocol, reported results of 56 high energy pilon fractures. 17% patients have partial thickness skin necrosis, 3% patients developed a chronic draining sinus secondary to osteomyelitis. They also elaborately elucidated principles of MIPPO. They advocated longer plates and fewer screws.

AO group in 2005 had come up with new plate system called Locking Compression Plate (L.C.P.) especially for minimally invasive plating of periarticular fractures with or without osteoporotic bone. The plate has an advantage of two plate systems i.e. conventional D.C.P. along with fixed angle locking compression plating. The plate definitely has an advantage over other plates for periarticular fractures in form of not requiring accurate contouring of the plate for fixation, and prevention of loss of primary and secondary reduction, good fracture healing and less stress shielding as there is no plate bone contact resulting in less subperiosteal damage to cortex.

CONCLUSION & RECOMENDATIONS

The technique of MIPPO is relatively safer and efficacious modality of the treatment for distal fourth tibial fractures with following advantages:

(1) Biological reduction with least disruption of soft tissue and fracture hematoma

(2) Early ankle mobilization leading to complete restoration of joint motion.

(3) Reduced surgical time and tourniquet time along with smaller incision.

(4) Reduced incidence of wound complications..

(5) Early union of fracture.

We recommend the MIPPO technique as a standard mode of treatment for all distal tibia and pilon fractures.

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