Original Research Paper

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MINIMALLY INVASIVE PERCUTANEOUS PLATE OSTEOSYNTHESIS (MIPPO) WITH LOCKING COMPRESSION PLATE(LCP), A NEW SUNSHINE IN THE MIDST OF DARKNESS IN MANAGEMENT OF DISTAL ONE THIRD TIBIAL FRACTURES IN ADULTS: A FACT OR A FALLACY??

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ABSTRACT **BACKGROUND AND OBJECTIVE:**Distal diametaphyseal tibial fractures though require operative intervention is still difficult to manage. Conventional osteosynthesis is not suitable because distal tibia is subcutaneous bone with poor vascularity. Closed reduction and minimally invasive percutaneous plate osteosynthesis (MIPPO) with locking compression plate (LCP) has emerged as an alternative treatment option because it respects biology of distal tibia, preserves fracture hematoma and also provides biomechanically stable construct. Our objective was to evaluate clinical results and outcomes of fractures of distal one-third of tibia in adults treated using locking compression plate by minimally invasive percutaneous plate osteosynthesis (MIPPO) technique.**MATERIALS AND METHODS:** 42 adult patients with fractures of distal third tibia (including extra-articular,partial-articular and intra-articular types) admitted to UPUMS, Saifai, Etawah were taken up for this study after obtaining their informed, valid written consent. This was a prospective study over a period of 2 years 10 months.**RESULTS:** 42 patients were followed for an average of 14 months (range 6-22 months) with mean fracture healing time of 20 weeks (16 - 28 weeks). Mean radiological union time in extra articular fractures is 20.1wks, partial articular fracture is 22.4wks and complete articular fracture is 26.8 wks. Post-operatively 3 patients developed superficial skin infection, 2 patients developed deep infection and 3 patients developed ankle stiffness.**CONCLUSION:** The present case series shows that MIPPO with Locking compression plate is an effective treatment method in terms of union time and low complication rates. This technique has resulted in adequate stabilization of distal third tibial fractures and allows early motion.

KEYWORDS : Diametaphyseal Tibial fractures, Minimally invasive percutaneous plate osteosynthesis, Locking compression plate

INTRODUCTION

Tibia is the major weight bearing bone of the leg. It is the one of the commonest bone to be fractured. In an average population there are about 53 tibial fractures per 1 lakh population per year,out of which 70% are distal tibial fractures. Males are more commonly affected than females with male incidence being about 41 per lakh per year and female incidence about 12 per 1 lakh per year.[1]

Open fractures are more common, because of its surface is subcutaneous throughout most of its length.Distal third of tibia is particularly prone for delayed and non union because of its precarious blood supply[2].

Distal tibial metaphyseal fractures of Arbeitsgeminschaft fur osteosynthesefragen (AO) type 43A,43B and 43C are difficult to manage and most of these fractures are associated with fracture displacement, comminution and injury to soft tissue envelope[2].

Before 1970, studies advised conservative treatment for distal tibial extra and intra articular closed fracture treated with slab, cast application for 4 to 6 week, followed by functional bracing or patellar tendon bearing Conservative treatment of distal tibia fracture often results in a number of complications including malunion, non union and ankle stiffness.

Operative treatment is indicated for most tibial fractures caused by high energy trauma. Operative treatment allows early motion, provides soft tissue access, and avoids complication associated with prolonged immobilization. The goals of treatment are to obtain a healed,well-aligned fracture ; pain free weight bearing ; and functional range of motion of ankle joint.

Currently available options for the treatment of these fractures are :-

1. Intramedullary interlocking nail and bolts
2. Dynamic compression plate.
3. Locking compression plate.
4. External fixators.

Intramedullary interlocking nailing is a technique which allows stable reduction, maintenance of reduction and allows early mobilization. Intramedullary interlocking nail is advantageous over other surgical methods as it preserves the soft-tissue sleeve around the fracture site, the periosteum is not disturbed, and being a closed procedure there is no disturbance of fracture hematoma, with less incidence of infection.

For the past decade, plating using fracture reduction has been successful in treating complex fractures of the lower extremity especially distal tibia. The goal of this technique is to apply stable plate fixation while maintaining the fracture biology and minimizing soft tissue problems.[3]

Recently, there has been an increasing trend towards use of a locking plate for treatment of complex fractures of the distal part of the tibia[4]. The fundamental goal of treatment of distal tibial fractures is restoration of normal or near normal alignment and articular congruity with locking compression plate.

Compared with a conventional plate, a locking plate imparts a higher degree of stability and provides better protection against primary and secondary losses of reduction and minimization of bone contact .[3]

Locking plates (LPs) have the biomechanical properties of internal and external fixators, with superior holding power because of fixed angular stability through the head of locking screws, independent of friction fit[4].

The newer techniques include Minimally invasive percutaneous plate osteosynthesis which aims at minimal periosteal dissection and disruption of hematoma, stable anatomical fixation and early mobilization, decreased post operative complications and higher rates of union. Minimally invasive percutaneous plating will restore limb alignment and yield successful clinical outcomes for high-energy fractures of the distal tibia.

In this study the fractures are classified according to AO classification and soft tissue damage according to Tsherne classification.

AIMS AND OBJECTIVES

1. To study Distal Tibial Fractures including Pilon Fractures in adults.
2. To assess time required for fracture union.
3. To evaluate functional outcome of the surgery and compare with those in literature.
4. To study complications.

MATERIAL AND METHODS

The present study was carried out over a period of 2years 10 months at the Department of Orthopaedics, Uttar Pradesh University of Medical Sciences, Saifai, Etawah. During this period 42 patients of distal one third tibia fractures were treated surgically.

INCLUSION CRITERIA:

1. Age more than 18 years, both males and females.
2. Patients with fracture of Tibia with or without fracture of fibula of the leg involving region between mid 1/3rd-distal 1/3rd junction to the ankle joint.
3. All closed extra and intra articular distal Tibial fractures as per AO

Classificaation 43A, 43B, 43C with Tsherene and Ostern grade 0 and grade 1.
4. Closed and Gastilo & Anderson type I,II & IIIA open lower one-third Fractures of the leg.

EXCLUSION CRITERIA:
1. Patients less than 18 years of age .
2. Patients medically unfit for surgery.
3. Patient not willing for surgery.
4. Gastilo & Anderson type IIIB and type IIIC open lower one third fractures .
5. Associated neuro-vascular injuries.
6. Pathological fractures.
7. Fractures with distal amputation.

On admission of the patient general information like name, age, sex, occupation and address were noted. Then a detailed history was elicited regarding mode of injury, Road traffic accident, direct injury to leg and ankle. Enquiry was made to note site of pain and swelling over the affected leg. Past medical illness and family history were also recorded. General examination of the patients & routine investigation were done before surgery on all patients.

All patients were operated as early as possible once the general condition of the patients were stable, swelling subsided as assessed by presence of skin wrinkles .the patients were fit for surgery as assessed by the aneasthesia. Routine preoperative instructions were followed.

OPERATIVE PROCEDURE:
- Type of Anesthesia- Spinal Anaesthesia
- Position- Supine with affected leg elevated on a pillow.
- Esmarchs or Pneumatic tourniquet applied and time noted

SURGICAL TECHNIQUE:
Surgical Approach: Medial Approach was used for all cases operated. Proximal incision was taken over the plate depending on the plate size. Percutaneous plate placement was performed after sufficient closed, indirect reduction or percutaneous direct reduction. The LCP was placed submuscularly and extraperiosteally through the small incision on the medial malleolus.

Reduction and temporary plate placement
- Under the guidance of image intensifier fracture was manually reduced and maintained with reduction forceps.
- The plates were temporarily held in place with standard plate holding forceps.
- 2mm K-Wires were used to secure the plates proximally and distally in the slots provided on the plates.
- A Threaded Plate Holder can also be used as an aid to position the plate.

Use the 3.5 mm Universal Drill Guide for an eccentric (compression) or neutral (buttress) insertion of cortex screws.

When pressing the universal drill guide into the DCU portion of the LCP plate, it will center itself and allow neutral pre drilling.

To drill a hole for dynamic compression, place the universal drill guide eccentrically at the edge of the DCU portion of the LCP plate hole, without applying pressure. Tightening of the cortex screws will result in dynamic compression corresponding to that of the LC-DCP.

Insertion of 3.5 mm Locking Screws
- Secure the LCP hole Sleeve on the desired hole.
- Screw the 2.7 mm Threaded Drill Guide into an LCP plate hole until fully seated.
- Use the 2.7 mm Drill Bit to drill the desired depth.
- Remove the drill guide.
- Use the Depth Gauge to determine screw length.
- Insert the locking screw using a screw driver.

Screw placement verification: Since the direction of a locking screw is determined by plate design, final screw position may be verified with a K-wire prior to insertion. This becomes especially important when the plate has been contoured or applied in metaphyseal regions around joint surfaces.

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

Post-Operative care:
- Patients were kept nil orally for 4 to 6 hours post-operatively.
- Intravenous fluids were given as needed.
- Antibiotics were continued for 10 days.
- Analgesics and tranquilizers were given according to the needs of the patient.
- The operated limb was immobilized.
- Check x-rays were taken to study the alignment of fracture fragments.
- The wound was inspected at 3rd or 7th postoperative day.
- Suture removal was done on 12th postoperative day.
- Delayed suture removal on 15th day was done if required in cases where wound closure was difficult.
- Patients were discharged with appropriate advice.
- Rehabilitation of the affected limb was started at the end of 2 weeks. Gentle exercises to the ankle were allowed. At 4 to 6 weeks gentle active range of motion of the ankle was allowed. At 6 to 8 weeks active range of motion in all planes were allowed.

Follow up:
- Regular follow up for every 4 weeks was done.
- Local examination of the affected tibia and fibula for tenderness, instability deformity and ankle movements were assessed.
- X-rays were taken at each follow up visits to known about progressive fracture union and implant position.
- Rehabilitation of the affected extremity were done according to the stage of fracture union and time duration from day of surgery.
- Patients were followed up till radiological union.

The fracture was designated as united, when there was periosteal bridging callus at the fracture site at least in three cortices in the anteroposterior and lateral views. trabeculations extending across the fracture site was also taken into consideration.

Criteria for Assessment: Assessed by Modified American Orthopaedic Foot and Ankle Society (AOFAS) Ankle – Hindfoot Scale,

RESULTS
The age of the patients ranged from 18 to 65 years with an average age of 39 years. 18-30yrs-12(29%), 31-40yrs-16(38%), 41-50 yrs-6(14.3%), 51-60yrs-6(14.3%), 61-70yrs-2(4.4%)

Out of 42 patients, 32 (76%)males and 10 (24%)females showing male preponderance because of traveling and working in fields and factories. 33 (77%) of patients sustained injury following RTA & 9 (23%) sustained injury following fall.

There were 27 (64%) patients with Right distal tibia fractures, 15 (36%) patients with Left distal tibia fractures.

All patients were operated at an average of 6.7 days from the time of arrival to hospital ranging from 1 to 10 days. In open wounds patients surgery is awaited till infection is under control or wound healed.

Out of the 42 cases, 28 (67%) cases were closed fractures and 14 (33%) cases were open fractures.

The fracture pattern was classified based on AO classification for fractures of distal tibia. Type A include extra articular, Type B partial articular and Type C include all complete articular/ pilon fractures. Of the 42 cases studied, A1- 4(11%), A2-8(19%), A3-9(21%), B1-3(7%) B2-2(4%), C1-3(7%), C2- 10(24%), C3-3(7%)

All the 42 cases were operated under Lumbar Spinal anesthesia. All the cases studied under went closed reduction methods and fixation with LCP with MIPPO techniques with help of fluoroscopic control.

Of the 42 cases treated with locking compression plates 32 (76%) took 41-60 minutes, 8(19%) took 61-80 minutes, 2 (5%) took 81-100 minutes. The average time duration was 57 minutes.

All the fractures united with an average of 20 weeks ranging from 16 to 28 weeks. 16-18wks-18, 18-20wks-10, 20-22wks-5, 22-24wks-5, 24-26wks-2, 26-28wks-2.

Mean radiological union time in extra articular fracture was 20.1wks, partial articular fracture was 22.4wks, complete articular fracture was 26.8wks.

At the end of 12 months, of the 42 patients treated, 8 (19%) patients had excellent outcome, 20 (48%) had good results, 9 (22%) had fair outcome and 5 (11%) patient had a poor result using Modified AOFAS ankle- Hindfoot assessment scale

Complications:
There were no cases of intra-operative complications.

Post-operative complications:
Superficial Skin Infection in 3(7%), Ankle Stiffness in 3(7%), Angulation (10° Varus) in 1(2.3%), Deep Infection in 2(4.7%)

DISCUSSION

Fractures of distal tibia are among the most difficult fractures to treat effectively. The status of the soft tissues, the degree of communition sustained at the time of injury affect the long term clinical results. The goal of operative treatment is to obtain anatomic realignment of the joint surface while providing enough stability to allow early motion. This should be accomplished using techniques that minimize osseous and soft tissue devascularization in the hopes of reducing the complications resulting from treatment.

The present study was undertaken to determine the efficacy of the locking compression plates in treatment of the fractures of the distal tibial metaphysis using minimal invasive technique.

We evaluated our results and compared them with those obtained by various other studies utilizing different modalities of treatment. Our analysis is as follows:

Age distribution:

Study	Min Age	Max Age	Average
Cory Collinge et al[5]	17	62	43
Redfern et al[9]	18	72	38.3
Bahari et al[8]	18	65	35
Heather A Vallier et al[6]	16	77	39.1
Present study	18	65	39

In our study, the male preponderance for such kind of injuries was high (76%) comparable to the study by Cory Collinge et al[5], which was 66% possibly due to the fact of male dominance over the female in travelling, occupational injuries etc., in India. Also, the study by Heather A Vallier et al[6] were comparable in the fact that they had 67% male patients.

Cory Collinge et al[5] observed 100% high energy fractures in their study. Andrew Grose et al[7] could attribute only 58% of such injuries to be of high energy. However, in our present study it was 77%.

Our study had 33% open injuries which was comparable to the studies by Heather A Vallier et al[6] who had 30% open fractures, Hazarika et al[12] who had 40% open fractures.

In our study extra articular fracture(TYPE A) are 21 cases(50%), partial articular(Type B) 5 cases(12%) and intra articular (Type C) are 16 cases(38%) of total 42 patients. Our study closely comparable to Heather A Vallier et al[6] study which had 46% Type A fractures, 14% Type B fractures and 40% Type C fractures.in bahari et al[42] study had 36% TypeA ,12% Type B and 52% Type C fractures.

Study by Cory collinge et al[5] showed 53% A2, 16% A3, 18% C1 and 13% C2 type fracture. Heather A Vallier et al[6] also had 46% Type A fractures, 14% Type B fractures and 40% Type C fractures. In our study of 42 cases, 4 (11%) cases were A1, 8(19%) cases were A2, 9 (21%) cases were A3, 3(7%) were B1, 2 cases were B2(4%), 3 (7%) were C1, 10 (24%) were C2, 3 (7%) was C3 type.

Duration of fracture union:

Study	Method	Average Fracture Union (weeks)
Cory Collinge et al[5]	MIPPO	21
Abidmushtaq et al[10]	MIPPO	22
Im GI et al[13]	ORIF	20
Hazarika et al[12]	MIPPO	19.3
Present study	MIPPO	20.4

Mean radiological union time in extra articular fracture is 20.2 weeks compared to 21.3weeks in Siddharth et al[11] Mean radiological union time in partial articular fracture is 22.2 weeks.

Study(Mean union time In weeks)	TYPE B1	TYPE B2	TYPE B3
Siddharth et al[11]	18.8	20.4	-
Andrew grose et al[7]	20.6	24.1	25.8
Present study	21.2	23.2	-

Mean radiological union time in intra articular fracture is 26.8weeks

Study(Mean union time In weeks)	TYPEC1	TYPEC2	TYPE C3
Andrew grose et al[7]	21.6	23.4	26.5
Siddharth et al[11]	18.8	20.4	-
Present study	21.2	23.2	-

Study	Methods	Acceptable	Not Acceptable
Ruedi and Allgower[14]	Open Reduction and Internal Fixation	74	26
Bourne et al[15]	Open Reduction and Internal Fixation with anatomical plates	44	56
Im GI et al[13]	Open Reduction and Internal Fixation	88	12
Hazarika et al[12]	MIPPO	87	13
Ozkaya U et al[16]	MIPPO	81	19

The excellent, good and fair results have been tabulated as acceptable and the poor results as not acceptable for easier comprehension.

CONCLUSION

According to this study, 42 patients with fractures of the distal tibia had undergone closed reduction with MIPPO technique and internal fixation with locking compression plates. This technique has resulted in the effective stabilization of these fractures. It does provide adequate stability and allows early motion. It not only helps in achieving reduction but also in rapid union, because it facilitates preservation of the blood supply to the fragment. The greatest advantage in internal fixation with MIPPO using locking compression plates is that anatomical reduction is achieved and fracture haematoma is not disturbed much. It is also effective in extra articular fractures occurring within 5cm of the joint where intramedullary nails do not provide enough stability and external fixators, usually applied for primary stabilization until soft tissue edema subsides, causes ankle stiffness and delays the return to work.

It is simple, has a rapid and straight forward application and has a reduced surgical time in both extra articular fractures and intra articular fractures due to newer anatomically contoured locking compression plates for the distal end tibia fractures.

Although, a larger sample of patients and longer follow up are required to fully evaluate this method of treatment, we strongly encourage its consideration in the treatment of such complex fractures.

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