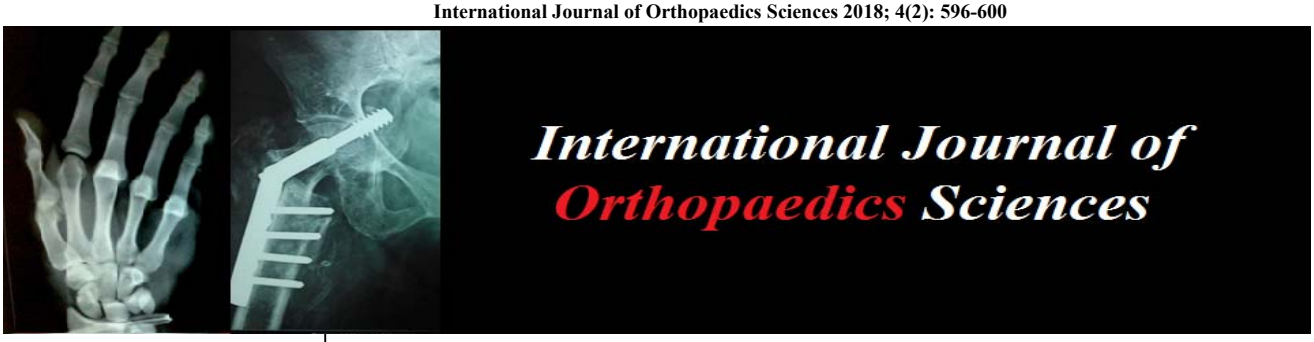

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Minimally invasive percutaneous plate osteosynthesis (MIPPO) in distal tibia fractures-retrospective functional and radiological outcome analysis among rural population

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Abstract
Background: Distal tibia fractures are one of the common fractures and results from indirect coronal or direct axial compression forces. These fractures encompass many and varied fracture configurations that involve medial, lateral, or both sides with many degrees of articular depressions and displacements. Each fracture type has its own characteristic morphology and response to the treatment.
Need for Study: Despite many advances in the care of these fractures, distal tibia fractures continue to be a difficult surgical problem. A survey of literatures indicates that many authors report nearly 50% satisfactory results with either closed or operative methods of treatment. In view of these considerations present study was taken up.
Aim of Study: The aim of our study was to retrospectively analyze the result of distal tibia fractures managed with LCP plating, the effect on ankle joint function, fracture union, operative difficulties encountered and the incidence of complications in the study population.
Materials & Methods: This study is a retrospective study of 30 cases who were admitted and operated in the dept. of orthopedics attached to R. L. Jalappa hospital between January 2011-December 2015.
Inclusion criteria is skeletally mature patients with closed and Gustilo /Anderson open grade I, II, IIIA distal tibia fractures. Exclusion criteria is patients with grade IIIB and IIIC of Gustilo Anderson fractures, patients with other ipsilateral limb fractures, pelvic fractures, Neurovascular injury.
Follow-up is based clinically and using American Orthopaedic Foot and Ankle Score (AOFAS).
Results: Results were analyzed with reference to anatomical reduction achieved, radiological union and ankle functional range of movements. Statistical analysis will be carried out using SPSS version 20(IBM, Chicago, USA).

Keywords: distal tibia fractures, AOFAS, operative fixation, MIPPO, ankle ROM

1. Introduction
Distal tibia fracture is one of the common problems seen in orthopedic practice. As for the tibia, its subcutaneous nature and lack of adequate musculature makes it prone for soft tissue damage of the tibia, various methods of management have been described. The key to handle these troubling fractures is to skillfully preserve and reconstruct the soft tissue, early mobilization and functional use of extremity with the maintenance of satisfactory length and alignment of the fracture. Treatment modality is dictated by the fracture displacement, comminution, intra-articular extension and injury to the soft-tissue envelope [1].
Conventional methods of distal tibial fracture fixation have been associated with high rates of complications, such as wound infection, mal-union, non-union and hardware failure.[2-6] External fixation and intramedullary nailing techniques, beyond doubt minimize soft tissue trauma and have been shown to diminish infection but their use is complicated by mal-union, non-union, unsatisfactory reduction of articular surface, and pin tract infection [2-6, 13-15]. Traditional dynamic plates achieve the first-stage healing of fractures through absolute stable fixation [7]. However, the method was recently challenged by minimally invasive biological osteosynthesis because of the introduction of locking plates [8].
In current orthopedic practice, minimally invasive percutaneous plating osteosynthesis (MIPPO) and interlocking nailing are the preferred techniques for

fractures of the distal third tibia. The intramedullary nail spares the extra osseous blood supply, allows load sharing, and avoids extensive soft tissue dissection. However, proximal and distal shaft fractures can be difficult to control with an intramedullary device, increasing the frequency of malalignment. Concerns regarding difficulties with reduction/loss of reduction, inappropriate fixation in fractures with articular extension, anterior knee pain and hardware failure has slowed the acceptance of intramedullary nailing as a treatment of fractures of the distal tibia. The recent innovation of nails with tip locking is a testimony that earlier nails were insufficient fixation tools for distal tibia; however tip locking is technically difficult and fractures that require it are essentially difficult to fix with nails.

The advantages of locking plates apply most directly to cases of highly comminuted fractures, unstable metadiaphyseal segments and osteoporotic fractures. Compression plating requires absolute stability for bone healing. In contrast locking plates function as "internal fixators" with multiple anchor points. This type of fixed-angle device converts axial loads across the bone to compressive forces across fracture sites, minimizing gap length and strain. However the treatment of distal tibia fractures has remained a subject of vigorous debate for several decades.

2. Materials & Methods

2.1 Source

This study is a retrospective study of 30 cases that were admitted and operated in the dept. of orthopedics attached to R. L. Jalappa hospital from Dec 2011- October 2015. Our institutional ethics committee approved the study & informed consent was obtained from all patients when called for follow-up.

2.2 Inclusion Criteria

Skeletally mature patients with closed and Gustilo/Anderson open grade I, II, IIIA distal tibia fractures.

2.3 Exclusion Criteria

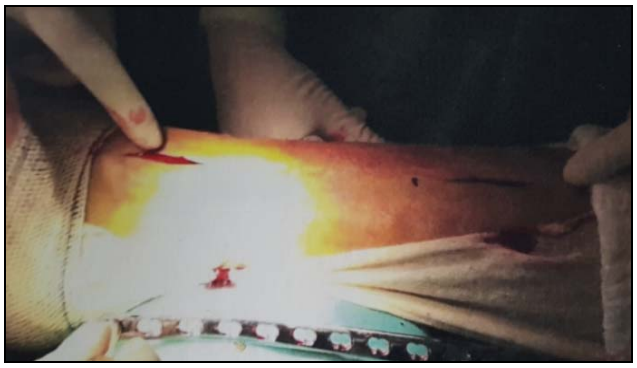
Patients with grade IIIB and IIIC of Gustilo Anderson fractures, patients with other ipsilateral limb fractures, pelvic fractures, neurovascular injury.

2.4 Follow-Up

Based clinically and radiologically, using American Orthopaedic Foot and Ankle Score (AOFAS) scoring system.

2.5 Operative procedure

Patient is prepared and draped, intraoperative antibiotics were given before the inflation of tourniquet. Traction and manipulation reduction was attempted. The provisional reduction was confirmed by image guidance under C-ARM. After adequate reduction and alignment, plate size was selected under image guidance so as to provide adequate fixation and stabilization of fracture. Following a small incision over the medial malleolus, sparing the saphenous vein and nerve, the plate was inserted extra periostealy and position was controlled using fluoroscopy. Fractures were then indirectly reduced by manual traction or occasionally with the help of the AO distractor. Occasionally, reduction was achieved by using a reduction screw through the plate, to bring the distal fragment against the plate before 2 or 3 angular stable screws were inserted. In simple fractures a pointed reduction forceps was inserted percutaneously to achieve direct reduction. Interfragmentary compression was accomplished with either a plate independent lag screw (PILS) or in selected cases through the plate. Fixation of the plate was always done through a small incision. Until mobilization, a below knee slab was applied.



2.6 Post-Operative Regimen

Post-operative x-ray was done to document proper reduction and fixation of fracture fragments. Ankle mobilization was started from 2nd or 3rd post-operative day according to tolerance of patients or associated injuries. Antibiotics were continued till the wound condition necessitates. Progressive weight bearing was allowed according to the callus formation as assessed in follow up x rays. Follow-ups took place at 6 weeks and at 3, 6, 9 and 12 months after surgery with a clinical and radiological examination (lateral and posterior-anterior X-ray).

For this study patients were called to OPD, x-rays and functional outcome was evaluated as per American Orthopaedic Foot and Ankle Score (AOFAS). [20] All long term complications like nonunion, malunion, angular deformity, implant breakage, shortening or infection were recorded. Secondary surgical procedure which was done in the patients will also be analyzed. The final result was based on the functional and radiological outcome and was assessed in terms of: time of bony union, ankle range of movement, malunion, infection, and secondary procedures performed and implant failure.

3. Result

Maximum number of cases (36.7%) seen were in the age group of 41-50 years. And least was in age group of 61-75 years. 70% of cases treated were males and 30% were females. 40% of cases in our study were agriculturists. Majority of cases were due to road traffic accidents (RTA) i.e. 76.7%. Remaining were due to fall i.e. 23.3%. Fractures were more common in the right leg i.e. 60% of cases.

Excellent results were seen in 46.7% of the cases (Table 2).

The percentage of cases which achieved poor result was 10%. The mean time until surgery 2.3 days (range 1-7). Depending on the type of fracture and the surgeon's experience with the MIPO technique, the mean operative time was 82.4 min (range 50-150min). Mean AOFAS score was 85.4 (range 58-98) (Table 2). 13 complications were noted. Most common was wound infection which was seen in 23.3% of the cases and malunion was seen in 3% and ankle stiffness was seen in 6.6%. Screw back out was noted in 1 case (Table 3).

Depending on the soft tissue conditions, mobilization with partial weight bearing started on the mean of 2.75 weeks (range 1-3). LCP plates were used in all 30 patients, of whom four patients received a 3.5 mm LCP-Pilon plate and 26 patients a 4.5 mm LCP plate. Based on radiological definition of fracture healing, a total of 5 patients were classified as healed at 3 months, 11 patients at 4 months, 24 patients at 5 months, 29 patients at 6months and 30 by 7 months post-operatively. None were lost to follow-up. No difference in healing time was observed. All patients reached a full range of motion by about 9 months.

Regardless of whether the patients were pain free and full weight bearing after 9 months or more than 12 months, most of patients reported local disturbance over the medial malleolus, which was caused by the high plate profile. In our series no patient had implant failure. This is also comparable to other similar studies. At the time of this study, implant removal had been carried out in 18 patients. The mean time until removal was 18 months (10-22 months) for 20 patients. One patient had implant removal after 26 months due to poor compliance.

Case no 21

Case no 12: A: pre-op, B: Post-op, C: 3month follow-up, D: 6month follow-up

Table 1: Time of union

Union time (weeks)	No. of cases	%
Up to 12	5	16.7
12-16	6	20
16-20	13	43.3
20-24	5	16.7
24-28	1	3.3
Total	30	100

Table 2: Clinical results

Clinical results	Aofas score	No of cases	Percentage
Excellent	90+	14	46
Good	80-89	9	30
Fair	70-79	4	13.3
Poor	<70	3	10
Total cases		30	100

Table 3: Complications

Complications	Number of cases	Percentage N=30
Superficial wound infection	6	20%
Malunion	3	10%
Ankle stiffness	2	6.6%
Deep infection	1	3.33%
Screw backout	1	3.33%

Table 4: Fracture type

Type	No of cases	%
43.A1	16	53.3
43.A2	6	20
43A3	5	16.7
43.B1	3	10
Total	30	100

4. Discussion

Open reduction in the distal tibia causes an increased risk of disrupting the blood supply, as shown by Borelli [12]. Hence; conventional plating of distal tibial fractures has been associated with high rates of infection and soft-tissue complications requiring multiple surgeries. Minimally invasive percutaneous plate osteosynthesis (MIPPO) is a well-documented technique that offers biological advantages and appears to be a reasonable treatment option for complex unstable distal tibial or pilon fractures. The literature is full of studies from developed nations [9, 11, 17]. But studies from developing nations are lacking.

A mechanically stable fracture-bridging osteosynthesis can be obtained without significant dissection and surgical trauma to the bone and surrounding soft tissues by minimally invasive percutaneous plate osteosynthesis (MIPPO). [9] This technique utilizes indirect reduction and internal fixation with locking compression plates. The plate is tunnelled subcutaneously, but extra periosteally, through limited skin incisions placed at the proximal and distal ends of the plate, bypassing the fracture site and then making a stable construct by judicious use of compression and locking screws. This technique aims to preserve bone biology and minimizes surgical trauma to already traumatized soft tissues. MIPPO with LCP offers biological advantages over conventional plating techniques in terms of low surgical trauma, preservation of the blood supply, lesser evacuation of osteogenic fracture hematoma and stable construct [9-11].

These techniques are newer and technically demanding. Indirect reduction techniques are developed to reduce soft tissue elevation at fracture site and to improve the rate of fracture healing. These techniques in addition reduce the overall incidence of infection, refracture and the need for autologous bone grafting. The perforators as well as nutrient arteries were well preserved by this method if plate is carefully inserted. Preservation of soft-tissue integrity is particularly critical with distal tibial injuries because the antero-medial cortex is subcutaneous, and the remaining soft-tissue envelope is thin. As a result, minimally invasive plating techniques have been developed. LCP using MIPPO causes minimal soft tissue damage. Therefore, it has a biological advantage over ORIF in that it preserves the periosteal blood supply and as a result increases the chance of healing [9, 17].

The bone healing is excellent with this type of fixation because the stresses are distributed over a longer segment of bone and the force per unit area on the plate is lower if the segment without screws is longer. Thus the good results in this method can be explained by a combination of rapid fracture consolidation due to preserved vascularity and a greatest resistance of the plate to fatigue, since the stress is distributed over a longer length of plate. Distal tibial plating by MIPPO technique provides rigid fixation, which obscures the routine use of plaster immobilization in postoperative period. This in turn allows early active ankle exercises. In our study, mean AOFAS score of 85.6 was noted at 16.4 months of mean follow-up. Our study also favors that ankle stiffness is not a problem in management of distal tibial fractures with MIPPO technique [17, 19]

In this study all patients were aged above 18 years. Maximum number of cases (36.7%) seen were in the age group of 41-50 years. And least were in age group of 61-75 years. 70% of cases treated were males and 30% were females. The higher percentage of male cases seen could be due to reason that relatively males as compared to females have a more active lifestyle. 40% of cases in our study were agriculturists probably due to location of the hospital, to which people from nearby villages are brought for treatment. Majority of cases were due to road traffic accidents (RTA) i.e. 76.7%.

Thirteen Complications were seen. Most common complication was wound infection which was seen in 23.3%, malunion in 10%, ankle stiffness in 6.6% and screw back out in 3.3% of cases. Ovadia and Beals reported a 10% incidence of superficial wound infection and a 6% incidence of osteomyelitis in patients with closed fractures treated with ORIF. In the same patient series, the incidence of infection increased to 31% when the fracture was open [16]. McFerran *et al*. reported that major complications occurred in 40% of fractures treated with ORIF [18]. Superficial wound infections were treated by anti-biotics for a period of 7-10 days and infection subsided subsequently. The deep wound infections were treated rigorously with I V antibiotics and wound became healthy after few weeks. Using minimal surgical intervention, in our patient series, the rate of both superficial and deep infection was significantly reduced compared with traditional ORIF, and there was no loss of reduction or implant failure with the use of LCPs. Excellent results were seen in 46.7% of the cases. Good results were seen in 30% of cases. The percentage of cases which achieved poor result was 10%.

5. Conclusion

The MIPPO technique is a reliable fixation approach to fractures of the distal third tibia, preserving most of the osseous vascularity and fracture haematoma and thus providing for a more biological repair. There is rapid fracture consolidation and better union time. Also it leads to fewer incidence of delayed and nonunion and so decrease in need for bone grafting. There is better fixation in osteoporotic bone as locking head screws have more resistance against bending and torsion forces with decreased pull out of screws. There is no need for any specialized instrumentation and the method is less time consuming and cost effective. Thus MIPO technique using LCP plates is a reliable alternative towards diaphyseal and distal tibia shaft fractures that are not suitable for intramedullary nailing.

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