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Original Research Article

CLINICAL STUDY ON THE ROLE OF DISTAL LOCKING PLATE IN THE MANAGEMENT OF DISTAL TIBIAL FRACTURES

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ABSTRACT

Background: Distal tibia fractures occur mostly in Road Traffic Accidents. Although these fractures are non-fatal, they can result in morbidity for the patients. This can influence the Daily activities of living forgetting about daily activities of earning. These fractures can make patients dependent at a very early age if not managed properly. Good fixation of these fractures can help patients to return to their daily routine. This can also prevent many complications like non-union, malunion, and deformities, which occur due to improper management of fractures. **Aim:** To study the functional outcome of fixation of distal tibia fracture with plate and screws. **Objective:** Functional assessment through radiological and clinical union, and complications.
Materials and Methods: This was a Prospective Study done in 27 cases of extra articular distal tibia fractures treated by distal tibial locking plate in Department of Orthopaedics, S.V.Medical College, Tirupati from October 2022 to May 2024. They were followed up for 9 months post-operatively. **Results:** There were 27 patients included in the study. The average age of patients was 47.03 (± 14.9) years. There are 9 females and 18 males. There were 5 open fractures. We found 5 patients with fibular fractures simultaneously. We had two polytrauma patients. Plating was done in Sixteen patients with MIPPO and the remaining required ORIF during fixation. The average time for the radiological union was 21.4 (± 3.25) weeks. The average OLERUD score was 87.3 (±14.3). We had excellent scores in more than fifty percent of patients.
Conclusion: Distal tibial locking plates and screws when used for distal tibial extra-articular fractures through MIPPO provide good results like faster radiological union, excellent satisfactory rate, and early mobilization post-operatively.
Keywords: Distal tibial fracture, Distal tibial plate, and screws, Open reduction, MIPPO technique.

INTRODUCTION

Human development in Asia is associated with many concerns and complications as there is constant friction between nature and Humans. Unpredicted population growth followed by rapid and unplanned urbanization in this continent is associated with many health concerns. There is a huge increase in vehicular traffic on this continent. A new health problem with Road Traffic Accident (RTA) came to our hospitals at the start of the 19th century. Increased vehicle traffic, road congestion, vehicle speed, and overcrowding of streets are direct consequences resulting in RTA. The intensity and severity of fracture are directly proportional to the energy of trauma during RTA.[1]

Distal tibia fractures include a group of fractures that occur at the distal one-third tibia and fibula. These fractures can be intra and extra-articular. The incidence of distal tibia fracture contributes to about 3-10% of total tibia fractures. They may be 1% of lower limb fractures. 85-90% of these fractures are

associated with fibular fractures.[2] Our interest is only completely extra-articular fractures, A1, A2, A3 according to A0/OTA classification.[3] These fractures can be open and closed. Soft tissue coverage around the distal tibia is sparse. The amount of soft tissue coverage is limited, in fact about distal one-third tibia does not have muscle coverage and is only subcutaneous.[4] Amount of soft tissue injury around this fracture also relates to the prognosis of fracture healing.

Blood supply to the lower third of the tibia is mainly by terminal branches of the nutrient artery, by inadequate periosteal supply from the Anterior tibial artery, and similarly sparse periosteal supply from the posterior tibial artery. This is a compromised area of blood supply in the distal tibia.[5] This results in limited biological healing potential in soft tissue as well as bone. Soft tissues do contribute towards fracture healing, a source of osteoprogenitor cells, growth factors, and vascular supply to bone.[6]

As per AO/OTA fracture fixation requires anatomical reduction, stable internal fixation, preservation of blood supply, and early active pain-free mobilization of bones and joints.[7] These fractures will have a greater impact on Daily Activities of Living, where patients cannot be mobilized to perform them.

Various methods of treatment are available. Conservative methods like immobilization, slab, and cast application for over six weeks. Various surgical modalities like external fixation for open fractures, intramedullary nailing, and plate fixation (either by open or closed fixation). Treatment of these fractures is associated with many complications. It is still a challenge for orthopedic surgeons for its complex type, soft-tissue injuries around these fractures. Postoperatively surgeons can face delayed wound healing and fracture union, and non-union, infections.[8,9]

Minimally invasive techniques and minimal periosteal disturbance in open reduction of distal tibial fractures with plate osteosynthesis can help in the preservation of highly compromised blood supply in this area. This procedure also helps in preserving biological elements contributing to fracture healing. This can further prevent complications happening in this area like wound healing, soft tissue damage during the surgery, infections, delayed fracture union, non-union, and deformities due to malunion and non-union.[10]

We planned to start this study to start fixing the distal tibial fractures with MIPPO, and open reduction with minimal periosteal elevation with plate osteosynthesis. We plan to know the status of union (radiological and clinical), complications with fixation during the study period.

Aim: To study the functional outcome of fixation of distal tibia fracture with plate and screws. Objective: Functional assessment through radiological and clinical union, and complications.

MATERIALS AND METHODS

This was a Prospective Study done in 27 cases of extra articular distal tibia fractures treated by distal tibial locking plate in Department of Orthopaedics, S.V.Medical College, Tirupati from October 2022 to May 2024.

Inclusion Criteria: Patients between age 18-70years with Closed distal tibial fracture and Gustilo and Anderson type I compound extra articular distal tibia fracture.

Exclusion Criteria: Gustilo and Anderson type II and III open Distal tibia fractures, Intraarticular fractures, Patient not willing to give written consent for the study.

Investigations Required: Standard diagnostic procedures include plain radiographs in two planes Antero-posterior view and Lateral view. To ensure that additional injuries and fractures are not missed, special views of the entire lower leg with imaging of the adjacent joints is essential.

Surgical Technique: In the current study, fractures of the distal tibia are treated using two methods: MIPO (Minimally Invasive Plate Osteosynthesis) and ORIF (Open Reduction Internal Fixation). Fractures amenable to reduction by manual traction, K-wire, or Schanz pin manipulation are managed with MIPO.

The procedure begins with the patient in a supine position on a radiolucent table, with a tourniquet applied universally. Anatomical landmarks such as the medial and lateral malleolus are identified and marked. For fractures treated with the MIPO technique, angular deformities in the coronal or sagittal plane are assessed and corrected using K-wires, Schanz pins, or an AO distractor under fluoroscopy. Following correction, a small incision of 2-3 cm is made starting from the tibial plafond and extending proximally along the medial tibia. A subcutaneous tunnel is created through blunt dissection along the medial tibia, and a small incision is made at the proximal end of the plate. The plate is then positioned on the anteromedial aspect of the distal tibia, verified by fluoroscopy in both anteroposterior and lateral views. The distal end of the plate aligns with the tibial plafond, and the proximal end extends at least four screw holes beyond the fracture site. Temporary fixation with K-wires may be used for locking plates, followed by insertion of locking and cortical screws based on the fracture configuration.

Post-operatively, a thorough radiological assessment confirms the stability of the fixation. Wound closure is performed in layers, and the limb is immobilized on a Bohler Braun splint to minimize swelling. Intravenous antibiotics and analgesics are administered, and on the second postoperative day, wound inspection and dressing changes are conducted. Follow-up X-rays in anteroposterior and lateral views are obtained to assess fracture reduction. Rehabilitation begins with static quadriceps exercises and toe movements on the first postoperative day,

progressing to active ankle mobilization by day three. By days five to seven, the patient is encouraged to walk with the aid of a walker without bearing weight. Sutures are typically removed on day 10, and the patient is instructed to continue non-weight-bearing walking with walker support.

Follow-up protocol: Between 8 to 12 weeks post-operation, the patient begins partial weight-bearing using a walker if indications of bone union are observed. Full weight-bearing may commence between 16 to 20 weeks, depending on radiographic evidence of fracture healing. Follow-up continues for a minimum of 9 months, with appointments scheduled at the 3rd, 6th, and 9th months. X-rays of the distal tibia in both anteroposterior and lateral views are taken regularly during these visits to assess fracture healing, ensure proper alignment at the fracture site, and detect any signs of malalignment.

Outcome measurement: In this study the functional outcome is measured using standard questionnaires and consists of OLERUD and MOLANDER Scores. The Olerud and Molander Score is a patient-reported questionnaire ranging from 0 (severely impaired) to 100 (completely unimpaired). It evaluates nine aspects: Pain, Stiffness, Swelling, Stair Climbing, Running, Jumping, Squatting, Use of Supports, and Work/Activities of daily living. Results are categorized as excellent (91-100), good (61-90), fair (31-60), or poor (0-30). Radiographic evaluation involves comparing anteroposterior and lateral views of the affected and normal legs, encompassing both knee and ankle joints.

Statistical Analysis: The collected data is then examined for significant relationships between the variables under study using statistical analysis. Descriptive statistics are presented using frequencies with percentages or means with standard deviations. To compare functional scores across different groups, Independent T-tests and ANOVA are employed. Correlations between scores are assessed using either Pearson correlation or Spearman's correlation, depending on the normality of the data. Scatter plots are utilized to visually depict the data. All statistical analyses are conducted using SPSS version 28.0 for Windows.

RESULTS

There was a total of twenty-seven patients included in the study. The age of patients in the study were from 18 – 69 years. The average age of patients in the study was 47.03 (+ 14.9) years. The average age in male and female patients was 46.23 (+ 17.1), and 48.67 (+ 9.74) years respectively. There are nine female and 18 male patients in the study. Of twenty-seven patients there were seven patients in 41-50 years, six patients in 61-70 years, five in each 31-40 and 51-60 years in distribution.

Table 1: Showing a side of the fracture in the population

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Right	16	59.3	59.3	59.3
	Left	11	40.7	40.7	100.0
	Total	27	100.0	100.0	

Table 2: Shows male and female population distribution in the study

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	18	66.7	66.7	66.7
	Female	9	33.3	33.3	100.0
	Total	27	100.0	100.0	

Table 3: Shows various mechanisms of injury resulting in fracture

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	RTA	19	70.4	70.4	70.4
	Fall	5	18.5	18.5	88.9
	Assault	2	7.4	7.4	96.3
	Heavy Object	1	3.7	3.7	100.0
	Total	27	100.0	100.0	

There were 16 patients on the right side and 11 patients on the left side. There were 22 closed and 5 open fractures. There were 22 cases of fibula fractures associated with tibial fractures. The mean lag time for posting patients for surgery was 5.96 (+ 2.45) days. All the cases are planned for surgery. There were 16 cases planned for MIPPO and eleven cases for ORIF. Though all the cases planned for MIPPO eventually eleven cases required ORIF for anatomical reduction. The average hospital stay was 17.37 (+ 4.34) days. Sixty-six percent of cases were managed by partial weight bearing by 4-8 weeks in the study. Similarly, sixty percent of patients had full weight bearing by 14-18 weeks after returning to daily activities of living. 21 out of 27 patients had radiological union by 18-22 weeks. The mean radiological union rate was 21.3 (+ 3.11) weeks.

The mean Olerud score was 87.2 (+ 13.42) in our study. We had fourteen patients with excellent scores, eleven with good, and two with fair scores in the study. We found no statistical significance in the union between MIPPO and ORIF cases in the study. We had no complications in 23 patients in the study. 2 patients had superficial skin infection treated with

antibiotics and one patient with deep infection required local debridement and re-suturing. There was one patient having diabetes with uncontrolled blood glucose levels with delayed wound healing.

DISCUSSION

Distal tibia extra-articular fractures are difficult to treat and they remain challenging for many reasons. The distal end of the tibia is mostly subcutaneous with decreased soft tissue overage around. Precarious blood supply is seen around distal end of tibia.

Various treatment options are available. Conservative treatment is the management of closed fracture with above slab or cast application followed by immobilization for over 4-6 weeks. Closed fractures with less than shortening of less than 15mm and angulation of less than 50 are acceptable for conservative management. But still, there can be loss of reduction, prolonged bed rest or immobilization, malunion, ankle stiffness, and poor functional outcomes in this management.[12,13,14]

To prevent such complications, it was better to go for surgical fixation. Surgical fixation was planned to prevent malunion, early stabilization of fracture, early mobilization, and rehabilitation of patients. Surgical fixation with Intramedullary and interlocking nailing has a good effect in the case of diaphyseal fractures.[22] Early mobilization and better wound care are positive aspects of nailing, but still had difficulties in maintaining the reduction and stability of fracture fragments.[22] This is due to a discrepancy in intramedullary diameter in the diaphyseal and metaphyseal area of the tibia.[12,15,16,17] Moreover there are chances of implant failure like breakage of the nail, locking screws, implant penetration or propagation into the ankle joint, and loss of alignment of fracture due to the presence of cancellous bone over a metaphyseal area of the tibia.[22]

Open reduction and plating can be helpful in anatomical reduction at the nearest, and prevent malunion at the expense of loss of biological bone healing. MIPPO plate fixation will help in biological fixation. The recent onset of anatomical contoured distal tibial locking plate and screw system with MIPPO can further contribute to early stabilization, mobilization, and better rehabilitation of post-operative patients.

In our study, we had a sample size of 27 patients which is comparable to 32 (Gao H et. al),[18,30] (Im GI et. al),[19] patients in other studies. The sample size in Bo Li et.al, was about 217 patients. This was a meta-analysis study based on sample collection from Pub Med and other databases which was a compilation of eight other studies.[12] Our Institute is a tertiary hospital in the south of Andhra Pradesh and we do have patients presenting with complex fractures. This might be the cause of the small sample size. In our study, we had 26% of (7) patients and 22% of (6) patients in age groups 41-50 years and 61-70years respectively. We had a bimodal distribution of the study population here, representing the active and old age population.

The male and female ratio in our study was 2:1. This can be due to different lifestyles and occupation-related incidents in the male population. We found a similar type of ratio M: F in other studies like 4:1 (Im GI et. al),[19] 18:5 (Li Y et. al),[21] 7:5 (Mauffery C et.al),[22] and 1:1 (Yanf SW et.al,).[23] In India, most of the earning population is male. They have higher chances of meeting with RTA or occupational hazards in working places.

The average age of patients in the study was 47.03 (+ 14.9) years. This is similar in other studies like 39 years (25-59 years) and 33 years (24-43 years).[21,22] Nineteen patients in the study reported RTA as a mechanism of injury for the fracture, followed by a history of falls at home. We found an active population between 21-50 years with a history of RTA and 61-70 years with fall. Osteoporosis in the elderly population might have resulted in fractures with slips and falls at home. The amount of force during RTA is directly to severity, comminution, and open or closed type of fracture in the young population. We found similar findings in Cory et.al, study where 15 of 38 patients presented with RTA.[20] We found 16 patients in our study with right-sided fractures and the remaining eleven fractures on the left side. Most patients are right-hand dominant, leading to higher exposure and vulnerability. We had 22 closed fractures and five open fractures. In our study, we debrided open fractures delayed surgery for a few days, and proceeded for definitive fixation.

We had 22 patients with fibular fractures most of these are upper one-third level which does not require fixation. There were studies that showed they required fibular fixation. This was necessary in maintaining the rotational stability in open fractures, planned for external fixation.[20]

Cory et.al used a different method for the fixation of distal tibial fractures. Of 38 patients in the study, they treated twenty-two (group I) patients with acute primary fixation of the tibia (fibula fixed if indicated) by 6.7 (range 0-28) days. The remaining sixteen (group II) patients included both open and closed injuries. These fractures were treated with external fixation (± fibular fixation). Later definitive fixation was done once the soft tissues healed. The average surgery time was 12 (4-21) days.[20] In our study for closed fractures we had a lag time of 6.54 (± 1.5) days and 3.4 (± 3.6) days for closed and open fractures. We found that the lag time for closed fractures was increased because most patients were admitted to the hospital 5-6 days after fracture. But we calculated lag starting from the day of fracture. Similarly, the lag time for open fractures was less due to early admission into the hospital for treatment.

In our study, we found radiological union at about 21.3 (± 3.1) (range 18-22) weeks. There was variation in union time in various studies like 27.8 (17-59) weeks (Bo Li et.al),[12] 14 weeks (Hong Gao et al)18, 20 weeks (Im GI et. al),[19] 21 weeks (Cory et al)20,

23.1 weeks (Yong Li et al).[23] There was little difference noted in the union rate between open and closed fractures at 15.8 and 13 weeks respectively in the Cory et.al study.[20] The variability of the union in studies may be due to the definition of union. Some studies defined union as the physical continuity of bone with no pain at the fracture site, while others radiological continuity with bridging callus at the fracture site.

Some studies compared the management of distal tibial extra-articular fractures with IM/IL nailing and Plate fixation. A study by Im GI et. Al,[19] showed that there was decreased operative time, faster union rate, increased average angulation (<8.80) at the fracture site, increased dorsiflexion of the ankle, decreased wound healing complications, and good functional outcome (88.5 Olerud/Molender score). Plating on the other hand has average angulation at the fracture site (<0.90), and better restoration of alignment. In our study our Olerud score was 87.2 (+ 13.42). Our score was in line with other studies 88.2 (Im GI et. al),[19] 87.6 (+ 8.4)(Li Y et al)21, 100 (Mauffery C et al).[22]

This score was comparatively lower in patients treated with IM/IL nailing patients. Further improvements in the score were noted in IM/IL nailing because of improvements in present systems. Present nailing systems have multiple locking screws distally and proximally which prevent further propagation of nails into the ankle, possible optimal stabilization of distal fragments.[20] The present locking systems in nailing provide angular, axial, and lateral stability.[21] Delayed union was seen at about 0-11%, and 9-47% in closed and open fractures in nailing patients. Non-union was also reported at 0-8%, and 3-17% in closed and open fractures respectively. Other complications were iatrogenic injury during nailing, fixation failure, and anterior knee pain.[12]

Plating and screws remain as best treatment options for these fractures. ORIF or MIPPO procedures near or total anatomical fixation, fracture fragment stabilization, correction of angulation, prevention of malunion, decrease chances of non-union. Wound healing due to plating was problematic at times. Delayed wound healing, wound dehiscence, and superficial and deep infections were reported in many studies. In our study, we had two patients with superficial infections, later healed with antibiotics for ten days post-operatively. There was one deep infection, managed with local debridement and secondary closure of the wound which healed by third postoperative week. One diabetic patient showed delayed wound healing and eventually healed by 16th postoperative day due to uncontrolled blood glucose levels. We faced no problems of implant exposure to the outside environment. Some studies have reported incidences of partial or complete implant removal due to infection in literature.[18] In another study two patients had no fracture union reported at the end of nine months.[19] One patient had iliac crest bone grafting later fracture union occurred in the next four months. The other patient had a metal exit, debridement, and external fixation followed by refixation of the implant. Later fractures united in the next few months.

Our study has certain limitations small sample size, no comparison with intramedullary and interlocking nailing, and limited period of follow-up. Though we planned for the MIPPO procedure plate osteosynthesis for all patients, at times we required the opening of the fracture site for proper reduction of fragments.

CONCLUSION

We conclude that distal extra-articular tibial fractures are better managed by the MIPPO procedure and locking distal tibia plate and screws. Though it may take longer surgical time, period of wound healing, and bone union, it may prevent malunion, nonunion and allow the patient to undergo early rehabilitation.

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