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COMPARATIVE ANALYTICAL STUDY OUTCOME OF MULTIDIRECTIONAL LOCKED NAILING AND PLATING FOR DISTAL TIBIAL FRACTURES

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ABSTRACT

Introduction: Distal tibial fractures are very commonly encountered by orthopaedic surgeons. Our aim is to study and compare clinical and radiological outcome in extra articular fractures of distal tibia treated by multidirectional interlocking intramedullary nails and anterolateral locking compression plates with reference to rate of healing, functional outcome and complications. **Material And Methods:** In this study 24 patients with distal tibia extrarticular fractures, AO type 43 A1,43 A2, 43A3 were randomly selected and 12 of them were operated with multidirectional interlocking nailing and remaining 12 with anterolateral locking compression plate. The patients were regularly followed up for a period of one year and were evaluated clinically and radiologically with respect to tenderness at fracture site, abnormal mobility, infection, pain on movement of knee, ankle joints and anteroposterior and lateral radiographs of the leg for union of the fracture. **Results:** In multidirectional Interlocking intramedullary group average time for union was 4.5months compared to 6.4 months in plating group which was significant (p value <0.00). Also the average time required for partial and full weight bearing in the nailing group was 4.2 weeks and 9.6 weeks respectively which was significantly less (p value <0.00) as compared to 7.12 weeks and 13.42 weeks in the plating group. Lesser complications in terms of implant irritation, ankle stiffness and infection (superficial and deep) were seen in interlocking group as compared to plating group. **Conclusion:** We concluded that due to early weight bearing, early union of the fracture and decreased implant related problems and closed intramedullary interlocking nailing is preferable in treatment of distal tibia fractures. We recommend fibular fixation whenever intramedullary nailing or locking plate fixation is used in distal tibiofibular fractures.

KEYWORDS: Distal Tibia Fractures, Fibular Fixation, Locking Plate, Interlocking Nailing.

INTRODUCTION

In the present world with the escalation in speed and number of fast moving vehicles there is a very high increase in number and severity of fractures. The goal of fracture management is to obtain union of the fracture in the most compatible anatomical position which allows maximal and full restoration of the extremity.[1] Tibia is one of the most frequently fractured long bone of the body. On the basis of the fracture location in the bone; distal tibia fractures have the second highest incidence of all tibia fractures after the middle fracture of tibia.[2] The management of distal tibia fractures is often more complex than the treatment of diaphyseal fractures because of its unique anatomical characteristics of subcutaneous location with precarious blood supply and proximity to the ankle joint, leading to the potential for postoperative complications and poor outcome. Considering its anatomy, it is commonly difficult to achieve and maintain reduction of distal tibia fractures. Although different treatment methods have been developed for distal tibia fractures, there is currently no consensus on the optimal mode of treatment. Distal tibia fractures can be managed conservatively with closed reduction and casting or operative intervention such as closed reduction and intramedullary nailing or open reduction and internal fixation with plating or closed reduction and percutaneous plating or external fixators.[3] Each of these techniques has their own advantages and disadvantages.

Distal tibia metaphyseal fractures can be treated with open reduction and plate fixation. This method mostly requires extensive soft tissue dissection and devitalisation, which create a situation less favorable for fracture healing and more prone to infection and postoperative ankle stiffness.[4] Hence other modalities such as intramedullary nailing, percutaneous plating have become the standard treatment for distal tibia fractures. The use of intramedullary nails decreases the need for extensive surgical dissection, spares the extraosseous blood supply, and allows the device to function in a load-sharing manner.[5] However, intramedullary management of distal tibia metaphyseal fractures is accompanied by its own complications, including malunion, hardware failure, and the risk of fracture propagation into the ankle joint.[6] Locked plate designs act as fixed-angle devices whose stability is provided by the axial and angular stability at the screw-plate interface instead of relying on the frictional force between the plate and bone, which preserves the periosteal blood supply around the fracture site.[7] Locked plates are hence specified for fracture management in osteoporotic bone and in periarticular fracture patterns, making them a feasible treatment option for distal tibia metaphyseal fractures.[8]

Due to lack of defined criteria in the literature for the surgical treatment to extra articular distal tibia fractures, this study is conducted to compare the treatment results of intramedullary nailing and locking plate technique in terms of rate of healing, functional outcome and complications.

METHODS

The present study was conducted between August 2013 to September 2014 in the Institute of Orthopaedics and Traumatology, Madras Medical College, Rajiv Gandhi Government General Hospital, Chennai by retrospectively and prospectively. Inclusion criteria had adult patient more than 18 years of age and less than 70 years of age. Patients who had Closed fractures and grade I compound fractures of distal tibial fractures (43-A1,43-A2,43-A3 OF AO type) without intra articular extension. Where patients who were less than 18 years and more than 70 years, Grade II, III Compound fractures of distal tibia, Fractures with intra articular extension were excluded.

CLINICAL EVALUATION

Patient presenting with lower extremity injury are evaluated for distal tibial fractures. After stabilising the patient general condition injured ankle examination is carried out. Proper history taking is necessary as it gives clue to assess the mechanism of injury.

On examination the swelling, deformity noted on inspection and tenderness, abnormal mobility, crepitus noted on palpation indicates the signs of fracture. Skin status evaluation is more important and note circumferentially around the ankle for the open wound, bruises and soft tissue swelling. Development of skin blisters, limb oedema, and local rise of skin temperature should be looked for. In the initial period of injury, periodically monitor the capillary refill of the involved extremity. Functions of the extensor tendon and thorough neuro vascular examination should be carried out.

Any emergency management if required was done and the patients were evaluated with respect to the pre-operative investigations. Radiographic evaluation was done as Antero Posterior (AP) view and lateral view of the affected leg. Patients were operated under anaesthesia as per the fitness of patient. All patients were given supine position following anaesthesia, on a radiolucent table top to facilitate the use of image intensifier. Tourniquet was used in all patients. The affected limb was thoroughly scrubbed from mid-thigh to foot with betadine scrub. The limb was painted with betadine solution from mid-thigh to foot. Rest of the body and the other limb were properly draped with sterile drapes. Patients in whom fibula was fixed in addition to nailing or plating of tibia, was done either with a one third semi tubular plate, a reconstruction plate or a rush nail. In cases fixed with plating, incision was taken just posterior to fibula, soft tissues were dissected and the reduction of the fracture fragments was achieved after cleaning the fracture site. The fracture was fixed with a six or seven hole plate with screws. In cases of rush nail fixation it was passed percutaneously over a stab incision at the tip of lateral malleolus after reduction of the fracture manually. The passage and location of the nail was checked under image intensifier.

Surgical technique for Intramedullary nailing

A vertical patellar tendon splitting incision over skin extending from centre of the inferior pole of patella to the tibial tuberosity was made about 3cms long. The patellar tendon was split vertically in its middle and retracted to reach the proximal part of tibial tuberosity. Next step was to determine the point of insertion. Essential for the success of the procedure is the correct choice of the insertion point. As a general rule, the insertion point should be slightly distal to the tibial plateau, just medial to lateral tibial spine on a true AP view and exactly in line with the medullary canal on lateral view.

If the insertion point is too distal, there is danger of fracturing the distal cortex of the main proximal fragment. On the other hand, insertion far too proximally bears the risk of opening the knee joint, patella comes in way of the zig or removal of nail may be difficult. After selecting the point of insertion curved bone awl was used to breach the proximal tibial cortex in, so that from perpendicular position its handle comes to be parallel to the shaft. In the metaphyseal cancellous bone an entry portal was created, making sure it was in line with the centre of the medullary canal. After widening the medullary canal with a curved awl, a guide wire of size 3mms diameter x 950mms length was passed into the medullary canal of the proximal fragment.

Reduction of the fracture fragments under image intensifier by maintaining longitudinal traction in line of the tibia was done. Accurate closed reduction of the fracture was verified under image intensifier before insertion of the guide wire in the distal tibial metaphysis. After reduction, the tip of the guide wire was passed till it enters the subchondral bone of distal tibia. In both AP and lateral views the guide wire should lie in the centre of the tibial plafond. Reaming was initiated with hand reamer of size 8 millimeter, and then with one millimetre increment till the scratching sound of the isthumus was felt. Exact length of the nail was measured from the length of the guide wire remaining inside the medullary canal from the entry point.

Size of the nail was assessed as 1 mm less than the diameter of the last reamer. Then a properly selected and assembled nail was passed into the medullary canal over the guide wire. Distal locking was always done first. It was done under image intensifier control by free hand technique. Cases in which the distal fragment was large enough to accommodate two mediolateral screws, two mediolateral screws were passed, and cases in which distal fragment was too small one mediolateral and one anteroposterior screw were passed. This was followed by proximal locking with the help of the zig using 4.9 mm interlocking bolts of appropriate length both static and dynamic. Screw positions were confirmed under C-arm image intensifier. After this, zig was removed and stability was checked by performing flexion and extension at knee and ankle joint. Then all incisions were closed in layers. Sterile dressing was applied over the wound.

Surgical technique for locking plate fixation

The key concept of this approach was to preserve the soft-tissues and blood supply in the metaphyseal fracture area by not exposing them surgically. A straight or slightly curved skin incision was performed on the medial aspect of the distal tibia. The length of the incision varied from 3-5cms, depending on the type of the planned plate.

The incision stopped distally at the tip of the medial malleolus. The incision was carried straight across the subcutaneous fat, preserving the greater saphenous vein and saphenous nerve. They were held anteriorly with a blunt retractor. The dissection was advanced down onto the periosteum which was completely preserved. In this anatomical space the tunneling towards the diaphysis was achieved with the blunt tip of the plate. For the insertion of the proximal screws in the diaphysis, separate stab incisions usually were taken.

Tibial length and rotation was restored indirectly with manual traction. Angulation was approximated in the same way, but was definitively corrected by plate application. The plate was inserted after proximal tunneling with the plate itself. Depending on the fracture situation, the plate was positioned on the anteromedial aspect of the tibia. Proximally, above the fracture zone, a small incision (2-3cms) was aided for plate positioning. It is important that the plate and proximal screw be centered on the tibia, particularly if locking head screws are planned.

Temporary fixation was performed with K-wires through the screw holes to approximate the final plate position before screw insertion. For spiral and short oblique fracture patterns that were anatomically reduced, we placed a lag screw to enhance the overall construct stability. It is possible to apply this screw in a percutaneous fashion under image intensifier control. Alternatively, depending on the fracture plane, the lag screw can be placed independent of the plate. Once accurate position of the plate had been achieved, a conventional screw was inserted in one of the most distal plate holes to approximate the plate close to the bone.

Alternatively, the plate could be manually pressed to the bone, allowing the insertion of a locking head screw instead of the conventional screw. It was crucial that the plate was positioned very close to the bone, especially at the supramalleolar level, to prevent soft-tissue irritation by the plate. For transverse type fractures, fracture compression was achieved by applying tension with the plate, using eccentric placement of screws in non-locking holes. Further proximal and distal screw insertion was completed. All incisions were closed in layers. Sterile dressing was applied over the wound and below knee posterior plaster slab was applied to all patients.

Post-operatively radiographs were taken. Passive knee and ankle range of motion was started in the 1st post-operative week depending on the type of fracture and stability of fixation. Active movements were started in the second week once the pain had subsided. The weight bearing was planned as per the type of fracture, fixation and general condition of the patient. Initially partial weight bearing was advised between 4 to 8 weeks and then full weight bearing was advised when there was radiological evidence of callus formation and process of union of the fracture.

RESULTS

We used SPSS Version 16.0, For analysing the difference paired sample t test, McNemar Chi Square statistical methods for data analysis and statistical significance was accepted when P value is <0.05.

The mean age group for multi directional interlocking nailing ranges from 33-55 years. The mean age group for plating ranges from 27-60 years. The majority of patients of patients were between the age group of 46-55 years for both nail (43.08) and plate group (47.08). The t valve is about 1.12.The p valve is about 0.28 and it is not significant. Coming to sex distribution among 24 patients there were 12 males and 12 females. The sex distribution between males and females in nailing is 42%:58% and for plating is 58%:42%.(Table 1).

Table 1: Age & Sex distribution.

	Nailing	Plating
Age		
Range (in yrs)	33-55	27-60
Mean	43.08±7.8	47.08±9.68
Sex		
Male: female	05:07	07:05

Among 24 patients 12 patients selected for nailing and 12 patients selected for plating. In the nailing group 9 patients are operated in the closed method and in 3 patients open reduction and fibular fixation was done. In the plating group open reduction and internal fixation with low profile 3.5 mm locking compression plate for tibia and one third tubular plate for fibular fixation was done**.**

Coming to the mode of injury Road traffic accident leads as the major cause for both nailing and plating. For nailing it is about 83.30% and for plating it is about 75%.Fall from height for nailing is16.70% and for plating is 8.30%.Twisting of ankle is the cause for distal tibial fractures in the old age and it is about 16.70 % in the plate group and zero percent for nail group.

The weight bearing is started immediately in nailing with in 48 hrs as it has load bearing implants and it is about 75%. In nail group in 25% the fibula is fixed and delayed weight bearing was recommended after one month. In the plate group both tibia and fibula were fixed with open method and the delayed bearing weight was recommended after one month, the p valve is 0.000 which is statistically significant (Table 2).

Table 2: Influence on Weight bearing.

Weight bearing	Nailing	Plating
Immediate	9	0
Delayed	3	12
P value - 0.001		
Chi square test		
Significant		

Range of movements

The range of movements for the ankle joints for nailing ranges from full to near normal and for the plating group ranges from full to mid-range. Among 12 patients 8 patients had full range of movements 4 patients had near normal. In plating group 6 patients had full range of movements 3 patients had near normal and 3 patients had mid-range of movements. About 50% of plate group had near normal to mid-range of movements. Hence the range of movements of the ankle joint in the nailing group is better than plate group.

The range of movements for the knee joint for both the nailing and plate group is full to near normal. In the nailing group the 8 patients had full range of movements and 4 patients had near normal range of movements. In the plate group 12 patients had full range of movements. (Table 3).

Table 3: Range of Movements.

Range of movements	Nailing	Plating
Ankle		
Full	8	6
Near normal	4	3
Mid range	0	3
Knee		
Full	8	12
Near normal	4	0

Time for union for the nail group and plate group was 4 to 6 months. In the nail group the average time for union was 4months and the plate group the average time for union was 5 months. The t-valve is 2.53 and the p-valve is 0.02 and it is significant. The time for union for nail group is shorter than the plate group. Hence the nail group is better than the plate group**.**

The ankle score for both the nail and plate group range from excellent to fair group. In the nail group the ankle score was good to excellent. In the plate group the the ankle score was fair to good. The t-valve is 8.75 and the p-valve is 0.0 and it is significant.(Table 4).

Table 4: Recovery parameters.

Parameters	Nailing	Plating	P value	Significance
Time for union (in months)	4.50±0.52	6.42±2.50	0.02	Yes
Ankle score	90.00±3.69	71.25±6.44	0.001	Yes
Knee score	70.73±6.75	82.92±5.50	0.001	Yes

The knee score for the nail and the plate group range from 60 to 90 out of 100. The nail group range from 60 to 80 and the plate group range from 70 to 90. The mean for nail group was70.73and the mean for plate group was 82.92. the t-valve is 4.76 and the p-valve is 0.0 and it is significant for plate group**.**The knee score the plate group was better than the nail group.

The complication rate in the plate group is high compared to the nail group.the complication noted in the nail group was delayed union and the superficial infection and it was about 25%. The complication noted in the plate group was the wound dehiscence, superficial infection, implant exposed, implant failure and non-union. The complication rate was more than 50%.The complication rate was less in the nail group while compared to plate group. Hence the nail group was better than plate group.(Table 5).

Table 5: Complication post-surgery.

complications	nailing	plating
delayed union	2	0
implant failure/non union	0	1
plate exposed	0	1
superficial infection	1	2
wound dehiscence	0	3
mal union	3	0

DISCUSSION

Distal tibia fractures result from low energy torsional or high energy axial-loading mechanisms. High energy fractures are commonly associated with severe soft tissue injury, comminution of metaphyseal and articular fracture fragments of tibial plafond and comminuted distal fibula fractures. Tibial pilon fractures account for <10% of lower extremity fractures and occur in adults owing to fall from height or from road traffic accidents. The optimal treatment for these fractures remains controversial. This is due to the associated significant soft tissue injury and precarious vascular supply of distal tibia. Treatment of distal tibia fractures can be challenging because of its subcutaneous location, poor vascularity and limited soft tissue.

The main factor in treating these injuries is to estimate the degree of associated soft tissue injury. Since open and closed fractures were included in our study, we used Tscherne soft tissue injury classification to assess and grade the severity of soft tissue injury. Definitive fixation is advaisable and proceeded only when the soft tissue injury heals. This is indicated by the skin wrinkle sign, once limb edema subsides. In our study, internal fixation was carried out at an average of 2 to 3 weeks once wrinkle sign developed.

Minimally invasive plating techniques (MIPPO) reduce the iatrogenic soft tissue injury and damage to bone vascularity, and also preserve the osteogenic fracture hematoma. But even MIPPO techniques should be performed after soft tissues heal. And with a delay of three weeks, MIPPO is not possible in some cases. This is why in our study too, MIPPO could not be carried out even in some AO type A fractures.

The key principles in the management of these fractures are – 1) Restoration of the length and limb axis by open reduction and internal fixation of fibula fracture; the anatomical reconstruction of the articular surface of tibial plafond; the filling of the defect resulting from impaction and the support of the lateral side of tibia, by lateral plating to prevent the valgus deformity.[9]

In our study the distal tibial fractures are treated with the multi directional locked nailing and anterolateral plating. The fracture fixation was delayed for about two to three weeks to prevent soft tissue injury complication. In the multidirectional locked nailing the length and the diameter varies according to the patient and for plating universally the 3.5 mm locking compression plate used for tibia fixation and one third tubular plate for fibular fracture fixation. Among 24 patients the 12 patients are treated with multi directional nailing and 12 patients are treated with anterolateral plating. Among 12 patients in nailing 9 patients are operated in the closed method and 3 patients are treated with open method.

Strong fixation and good reduction can be achieved by plating, but this technique tends to increase the risk of infection, delayed union, non-union by disrupting the periostealblood supply. It was concluded that the infection rate was 25%including wound dehiscence in 2 cases and deep infection leading to plate exposed in 1 case out of 12 cases of plating with average follow up of 10 months. There were **one superficial** infections (8.3%) noted in the nailing and two superficial infection and another deep infection(25%) in plating.The infection rates are comparable to the study done by Sean E Nork et al[10](7%).

In the study conducted by Tyllianakis M et al[11] and Sean E Nor[12] et al, the average time for union was about 4-5 months. In our study the average time for union for nailing was 4.5 months and for plating was 6.4 months. There was 2 cases of delayed union in the nail group at 4 months. after dynamaisation at 4 months they united at 6 months uneventfully. This is comparable to studies conducted by Fan CY et al[13] and Aso Mohammad et al[14] No incidence of non union noted in the nailing and in the platins there was two cases of non union with implant failure.

The ankle score in our study in nailing was excellent and the ankle score for plating was good to excellent. This shows that the ankle function was restored well in all the patients. The results are comparable with the results of ankle function in the study conducted by Shon OJ et al[15] (Average IOWA ANKLE rating score was excellent). The knee function was restored well in most of the patients These results are comparable to the results of knee function in the study conducted by Paraschous S et al[16] (Knee score- 81 Good)Hence the overall functional outcome of patients treated in our study was good.

There were three cases (25%) of malunion whose ankle and knee scores were lesser compared to the other patients included in the study. In the study conducted by Boos N et al in 51 cases of distal tibial fracture with interlocking nail, there was incidence of 16% malunion. Comparatively, the rate of malunion was little higher in our study.

Ahmed et al reported a success rate of 76.4% by using plating in 17 patients. Because of restrictions of intramedullary nailing technology plating was preferred in the past. More and more often the intramedullary nail being performed now-a-days because this technique protects the blood supply, lower the incidence of infection, reduce the soft tissue destruction and lower the incidence of delayed healing.

Malalignment was the major problem in nailing when compared to the plating, reduction and maintaining the reduction without malalignment were difficult in nailing cases. In 3 out of 12 cases the more than 5 degree axial angulation noted, which represents 25% of axial angulation.

The time duration of the operating time in the nail group is longer than the plate in our study. Inspite of longer operating time many authors recommends the intramedullary nail because the risk of infection was increased in plate fixation.

There are different blood supplies outside and inside the tibia. The anterior and posterior tibial vessels gives the periosteal blood supply nourishing the one third of lateral side of cortical bone. The nutrient vessels and the metaphyseal vessels supplies the remaining two third of the bone cortex and the periosteum. The destruction of the endosteal vessel occurs while reaming but the vessels grows in between the nail and the bone widening the haversian canal. Simultaneously the cortical bone receives the periosteal blood supply. Hence comparatively the blood supply at the fracture site preserved in the nailing technique.

In our study the fracture union time is shorter in the nail group compared to plate group as indicated by significant p value. Malunion rate was 25% in the nail group and 16.6% in the plate group showing significant statistics value. Malunion is defined as axial angulation more than 5 degree, shortening of 1 cm or more, angular rotation of more than 10 degree. The shortening and the rotation deformity was not significant statistically. There were 2 cases of delayed union in the nail group and no incidence of non union noted in the nail group. But one case of non union with implant faiure case noted in the plate group. Two cases of the wound dehiscence and one case of deep infection rate noted leading to implant exposed in the plate group, one case of extensor tendon exposed noted in the the plate group.

According to the results in our study, the fracture union rate is shorter in the nail group, the malunion rate is higher in the nail group, due to shorter time of union compared to the plate group the functional exercise started earlier. The infection rate is higher in the plate group leads to complication like wound dehiscence, tendon exposed, implant exposed and implant failure and non union. Therefore the multidirectional intramedullary nail is superior than the plate.

CONCLUSION

Distal tibial fractures can be effectively treated by interlocking intra medullary nails with multi directional locking options with excellent results. The operative technique was simple and short. Very minimal complications were encountered in our study. No cases of non-union were found. The post operative infection rate was low. Wound healing problems were not encountered. As nails are weight sharing devices, immediate weight bearing could be initiated. The post operative outcome as measured by ankle and knee scores and range of movements were good to excellent. Fibular fixation can be combined with nailing in indicated cases for excellent results. Hence, interlocking intra medullary nailing combined with multi directional locking can be considered a very effective modality of treatment of indicated distal tibial fractures.

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