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Original research article

Multidirectional locking nailing versus plating for distal tibial fractures: a prospective randomized controlled trial

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Abstract

Introduction: Orthopaedic doctors see many cases of distal tibial fractures every year. Our goal is to investigate and contrast the healing, functional, and complication rates of extra articular distal tibia fractures treated with multidirectional interlocking intramedullary nails and anterolateral locking compression plates.

Materials and Methods: Our study utilized a sample size of 20 individuals who presented with distal tibial fractures. The age range of participants in the nail group was 33 to 55 years, whereas in the plating group, the age range was 27 to 60 years. The current investigation was carried out from August 2022 to July 2023 at the Department of Orthopaedics, King George Hospital, Visakhapatnam, Andhra Pradesh, India, utilizing both retrospective and prospective methodologies.

Results: The average time for union in the multidirectional interlocking intramedullary group was found to be 4.5 months, but in the plating group, it was 6.4 months. This difference was statistically significant. Additionally, the mean duration for partial and full weight bearing in the nailing group was 4.2 weeks and 9.6 weeks, respectively, which exhibited a statistically significant reduction compared to 7.12 weeks and 13.42 weeks in the plating group. The interlocking group had reduced instances of implant discomfort, ankle stiffness, and infection in comparison to the plating group.

Conclusion: Our research led us to conclude that closed intramedullary interlocking nailing is the treatment of choice for distal tibia fractures because it allows for early weight bearing, promotes early fracture union, and reduces implant-related complications. For distal tibiofibular fractures, intramedullary nailing or locking plate fixation is advised.

Keywords: Fibular Fixation, Locking Plate, Interlocking Nails, Distal Tibia Fractures

Introduction

The percentage of tibia fractures that occur at the distal end is under 7%. Distal tibial fractures account for fewer than 10% of all breaks in the lower extremities. Men in their 30s to 50s are disproportionately affected. Injuries can range from mild to severe, depending on the force that caused them [1, 2].

The elderly are more likely to suffer from low-energy distal tibia fractures, which are typically caused by rotational stresses. Spiral fractures, sometimes extending intra particularly, are prevalent in these situations. High energy distal tibia fractures are more common in children and young adults due to sports and falls from great heights. Axial loading, compression and torsional forces are involved in the mechanism of damage. The most common causes of distal tibial fractures include high-velocity car accidents, falls from great heights, and twisted ankles. Ankle fractures are notoriously challenging to treat due to the fragility of the surrounding vascular. The tibia is also subcutaneously in plane, which makes fracture care further trickier [3, 5].

Distal tibial fractures are often treated with internal fixation devices such as locking compression plates or intramedullary nails. It is essential to learn about the distal tibia fracture pattern and the type of fixation that can be used [6]. Fibula fractures were linked to 85% of distal tibia breaks. Many sources argue on whether or not the fibula should be fixed. In the case of stiff fixation, such as multidirectional interlocking nailing, the fibula fracture is not required to be fixed, but it may be fixed for better reduction. Diabetes mellitus, peripheral vascular disorders, smoking, and alcoholism are all examples of comorbid ailments that further worsen an already precarious situation [7, 8].

Internal fixation via plate osteosynthesis was established as the standard treatment for distal tibial

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fractures by Ruedi *et al*. in 1980. High energy fracture patterns have been linked to increased rates of sequelae like wound dehiscence, infection, and persistent osteomyelitis following open reduction and internal fixation with plating [9].

Soft tissue injury accounts for about 40% to 50% of the complications seen with internal fixation devices and major surgery. Ankle-spanning external fixation, which involves no or minimum internal fixation, gained favour in the 1990s as a means of preserving the tibia's articular surface. The fibular fractures were repaired by plate osteosynthesis to keep the bones the same length and in proper alignment. Because of the benefits of early weight bearing and stability, hybrid external fixators have replaced monolateral external fixators. Ankle stiffness, pin tract infection, subsequent loss of reduction, and instability are among risks associated with using external fixators as the final step in treating open distal tibial fractures [10, 11].

With the better understanding the care of soft tissue injury and the poor end outcomes in the external fixation approach, makes to rethink that, after the soft tissue healing open reduction and internal fixation can be done. In medically compromised patients, non-surgical care has limited use. Complications such as shortening, malunion, subsequent osteoarthritis of the ankle, and reduced range of motion are more common in patients treated with traction or plaster of paris. Patients who have to stay in bed for extended periods of time are more likely to develop conditions like pneumonia, deep vein thrombosis, and pressure sores. Since the AO group adopted the Tscherne classification of soft tissue injury to grade and evaluate the skin, neurovascular tissue, and musculotendinous structure, open reduction and internal fixation of distal tibial fractures have been called into question [12, 13]. Internal fixing methods for distal tibial fractures have been described. They are anterior plating using t- plates, AO medial plating utilizing medial buttress plate, cloverleaf plate and dynamic compression plates. There are benefits and drawbacks to using a plate in an osteosynthesis in every situation. This treatment limits the lateral surgical approach for the repair of the fibular fracture, and wound dehiscence over the sub cutaneous border after AO medial buttress plating necessitates flap cover by the plastic team. For more effective distal tibia fracture reduction, anatomically contoured versions of locking compression plates are already on the market. The use of a low-profile medial locking compression plate has less complications than traditional AO plating when dealing with wound dehiscence and severe infection [14].

Our research aims to evaluate the effectiveness of multidirectional locked nailing and plating in treating distal tibial fractures. The study's principal aims are to evaluate the efficacy of clinical and radiographic characteristics in predicting fracture union as an outcome. The secondary goals of the study are to evaluate the results of surgical interventions.

Materials and Methods

Our study utilized a sample size of 20 individuals who presented with distal tibial fractures. The age range of participants in the nail group was 33 to 55 years, whereas in the plating group, the age range was 27 to 60 years. The current investigation was carried out from August 2022 to July 2023 at the Department of Orthopaedics King George Hospital, Visakhapatnam, Andhra Pradesh, India, utilizing both retrospective and prospective methodologies.

Inclusion Criteria

- An adult patient who is older than eighteen but less than seventy years.
- Distal tibial fractures that are closed and grade I compound fractures without intra-articular extension.

Exclusion Criteria

- Below the age of eighteen and over seventy years
- Distal tibia compound fractures, grades II and III
- Fractures that extend intraarticular

Clinical Evaluation

Patients who report with injuries to the lower extremities undergo evaluations specifically aimed at identifying distal tibial fractures. Following the stabilization of the patient's general condition, an assessment of the injured ankle is conducted. Thorough history taking is crucial as it provides valuable insights for evaluating the mechanism of damage, hence indirectly assessing the velocity of the injury. The identification of comorbid illnesses should be included in the process of obtaining a patient's medical history, as it is well recognized as a significant determinant of the functional result following surgical intervention. Upon examination, the presence of edema, deformity observed during inspection, as well as discomfort, aberrant movement, and crepitus detected during probing, are indicative of the indications associated with a fracture. Assessing the condition of the skin holds greater significance, particularly with regard to the open wound, bruising, and soft tissue swelling in the ankle region. It is imperative to monitor the presence of skin blisters, limb edema, and localized elevation of skin temperature as potential indicators of development. During the early stages of injury, it is recommended to regularly

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assess the capillary refill of the affected extremity. It is imperative to conduct a comprehensive assessment of the extensor tendon's functions and do a complete examination of the neurovascular system. It is imperative to consider the possibility of a distal tibiofibular syndesmotic injury and concomitant knee joint injury on the same side.

Results

In this study, the data analysis was conducted using SPSS version 16.01. The statistical procedures employed included the paired sample t-test and the McNemar Chi Square test. The results of these analyses indicated statistical significance.

Table 1: Age Distribution

Age Groups	Nailing		Plating	
	Number of Patients	%	Number of Patients	%
25 - 35	2	20.00	2	20.00
36 - 45	3	30.00	3	30.30
46 - 55	5	50.00	5	50.00
≥ 56	00	00	00	00
Total	10	100	10	100

The age range typically observed for individuals undergoing multi-directional interlocking nailing procedures is between 33 and 55 years. The average age range for plating often spans from 27 to 60 years. The predominant age range for patients in both the nail and plate groups was 46-55 years.

Table 2: Sex Distribution

Sex	Nailing		Plating	
	Number of Patients	%	Number of Patients	%
Male	3	30.00	7	70.00
Female	7	70.00	3	30.00
Total	10	100	10	100

Within a sample size of 20 individuals, an equal distribution of 10 men and 10 females was observed. The gender distribution in the practice of nailing, specifically with regards to males and females.

Table 3: Nailing and Plating

Status	Nailing		Plating	
	Number of Patients	%	Number of Patients	%
Closed	08	80.00	02	20.00
Open	02	20.00	08	80.00
Total	10	100	10	100

Out of a cohort of 20 patients, a group of 10 patients was chosen for the application of intramedullary nails, while another group of 10 patients was picked for the implementation of bone plates. In the nailing cohort, a total of 8 patients had closed technique surgery, while in 2 individuals, open reduction and fibular fixation were performed. The surgical procedure involved the utilization of open reduction and internal fixation with a low profile 3.5 mm locking compression plate for tibial fixation, as well as the use of a one third tubular plate for fibular fixation.

Table 4: Mode of Injury

Mode of Injury	Nailing		Plating	
	Number of Patients	%	Number of Patients	%
Fall From Height	3	30.00	2	20.00
Road Traffic Accident	7	70.00	3	30.00
Twisting of Ankle	0	0	5	50.00
Total	10	100	10	100

The primary factor contributing to both nailing and plating procedures is road traffic accidents. The success rate for nailing is approximately 100.00%, whereas the success rate for plating is approximately 100.0%. The incidence of falls from height in the context of nailing is 30.00%, whereas in the context of plating, it is 20.00%.

Table 5: Weight Bearing

Weight Bearing	Nailing		Plating	
	Number of Patients	%	Number of Patients	%
Delayed	2	20.00	10	100.00

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Immediate	8	80.00	0	0
Total	10	100	10	100

The initiation of weight bearing for the nail group occurs 48 hours post-implantation, as these implants are designed to sustain loads. Immediate weight bearing is began for patients in this context.

Discussion

Fractures of the distal tibia occur as a consequence of either low energy torsional forces or high energy axial-loading processes. High-energy fractures often coincide with significant damage to the surrounding soft tissues, as well as the fragmentation of the metaphyseal and articular fracture pieces of the tibial plafond, and comminuted fractures of the distal fibula. Tibial pilon fractures constitute less than 10% of lower extremity fractures and primarily manifest in adults as a result of falls from elevated surfaces or involvement in road traffic incidents. The most effective treatment for these fractures continues to be a subject of debate and uncertainty within the academic community. The reason for this occurrence can be attributed to the notable soft tissue injury and the vulnerable vascular supply of the distal tibia. The management of distal tibia fractures presents considerable difficulties due to its superficial position, compromised blood supply, and restricted soft tissue coverage [13, 15].

The primary determinant in the management of these injuries is the assessment of the extent of concomitant soft tissue damage. In order to comprehensively examine the subject matter, our study incorporated both open and closed fractures. To evaluate and determine the extent of soft tissue injury, we employed the Tscherne soft tissue injury categorization system. It is recommended to proceed with definitive fixation only once the soft tissue lesion has healed. The presence of the skin wrinkle sign becomes evident subsequent to the resolution of limb edema. In the present investigation, the application of internal fixation was performed at an average interval of 2 to 3 weeks following the appearance of the wrinkle sign [16, 18].

The utilization of minimally invasive plating procedures has been shown to effectively decrease iatrogenic soft tissue injury and bone vascularity damage, while simultaneously preserving the osteogenic fracture hematoma. However, it is recommended that MIPPO procedures be conducted only after the complete healing of soft tissues. In certain instances, the implementation of MIPPO may not be feasible due to a three-week wait. In this study, distal tibial fractures are managed with a combination of multi-directional locking nailing and anterolateral plating. The initiation of fracture fixation was intentionally postponed for a period of approximately two to three weeks in order to mitigate the risk of complications arising from soft tissue injury. The multidirectional locked nailing procedure involves adjusting the length and diameter of the nails based on individual patient characteristics. In the case of plating, a 3.5 mm locking compression plate is commonly utilized for tibia fixation, while a one third tubular plate is typically employed for fibular fracture fixation [19, 21].

Out of the total sample size of 20 patients, 12 patients were treatment with multi-directional nailing, while the remaining 12 patients were treated using anterolateral plating. Out of the total sample size of 12 patients, 9 individuals had a closed method procedure whereas the remaining 3 patients received treatment through an open method approach. The study employed AO type classification 43 A1, 43 A2, and 43 A3 types for the purpose of internal fixation. Our study comprised a total of 20 participants. The age group with the highest incidence rates in our study falls within the range of 35 to 55 years. Plating is a technique that can effectively produce robust fixation and satisfactory reduction. However, it is important to note that this method has a tendency to elevate the risk of infection, delayed union, and nonunion due to its potential disruption of the periosteal blood supply [22, 23]. The study determined that the overall infection rate was 25%, with two cases of wound dehiscence and one case of deep infection resulting in plate exposure out of a total of 12 cases of plating. The average follow-up period for these cases was 10 months. One case of superficial infection was observed in the nailing procedure, whereas two cases of superficial infection and one case of deep infection were observed in the plating procedure. The infection rates exhibit similarities to the study conducted by Sean E Nork *et al*. The research conducted by Tyllianakis M. *et al* and Sean E Nor *et al* revealed that the mean duration for union was approximately 4-5 months. In the conducted investigation, the mean duration for union in the nailing group was found to be 4.5 months, while in the plating group it was seen to be 6.4 months [24, 25].

There were two instances of delayed union observed within the nail group after a duration of four months. Following the process of dynamaisation at the four-month mark, the components were successfully joined without any complications at the six-month mark. This finding aligns with previous research undertaken by Fan CY *et al*. (57) and A Mohammad *et al*. There were no instances of nonunion observed in the nailing group, while in the plating group, two occurrences of nonunion were documented together with implant failure [23, 25].

The ankle score achieved in our study on nailing exhibited a commendable level of performance, while the ankle score seen in plating ranged from good to exceptional. This finding indicates that the restoration of ankle function was successful in all of the patients. The findings demonstrate similarity to the outcomes of ankle functionality observed in the investigation carried out by Shon OJ *et al*. The

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restoration of knee function was observed to be successful in a majority of the patients. The findings presented exhibit similarity to the outcomes seen in the investigation carried out by Paraschous *et al*. regarding knee functionality. Therefore, the overall functional outcome of patients included in our study was favorable [24, 26].

Three instances of malunion were observed in which the ankle and knee scores were comparatively lower in comparison to the remaining patients included in the study. The study conducted by Boos *et al*. (year) examined a sample of 51 cases involving distal tibial fractures treated with interlocking nails. The findings revealed a malunion incidence rate of 16%. In our study, there was a slightly higher incidence of malunion when compared to other studies. Ahmed *et al*. documented a success rate of 76.4% by the implementation of plating in a cohort of 17 patients. In the past, plating was favored over intramedullary nailing due to the limitations associated with the latter procedure. The utilization of intramedullary nails has been increasingly prevalent in contemporary medical practice. This approach is favored due to its ability to safeguard the blood supply, diminish the occurrence of infection, minimize soft tissue damage, and reduce the likelihood of delayed healing [25, 27].

The primary issue observed in the nailing procedure, in comparison to plating, was malalignment. Achieving and sustaining proper reduction without malalignment posed challenges in cases involving nailing. In three out of twelve cases, an axial angulation greater than five degrees was seen, accounting for a quarter of the total axial angulation. The duration of operation time in the nail group was found to be longer than that of the plate in our investigation. Despite the greater duration of surgery, many writers support the use of intramedullary nails due to the increased risk of infection associated with plate fixation [26, 27].

Based on the findings obtained from our study, it was seen that the fracture union rate was comparatively shorter in the nail group. Conversely, the malunion rate was greater in the nail group, which may be attributed to the relatively shorter duration of union when compared to the plate group. Additionally, it was noted that the initiation of functional exercise occurred at an earlier stage in the nail group, likely due to the aforementioned shorter period of union. The group of patients who received plates exhibited a greater infection rate, resulting in complications such as wound dehiscence, tendon exposure, implant exposure, implant failure, and nonunion. Hence, it can be argued that the multidirectional intramedullary nail exhibits superiority over the plate [26, 28].

Conclusion

Distal tibial fractures can be efficiently managed with the utilization of interlocking intramedullary nails featuring multi-directional locking capabilities, resulting in favorable outcomes. The operating technique employed was characterized by its simplicity and brevity. Our investigation encountered a limited number of problems. There were no instances of non-union observed. The incidence of post-operative infections was found to be minimal. No complications related to wound healing were seen. Since nails function as weight-sharing devices, it is possible to commence instantaneous weight bearing. The postoperative outcome, as assessed through ankle and knee ratings and range of motion, demonstrated favorable to exceptional results. In certain circumstances where it is deemed appropriate, the combination of fibular fixation with nailing has demonstrated favorable outcomes. Therefore, the utilization of interlocking intramedullary nailing in conjunction with multidirectional locking represents a highly efficacious treatment strategy for appropriate cases of distal tibial fractures.

Funding

None

Conflict of Interest

None

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