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Original Research Article

Results of Minimally Invasive Plate Osteosynthesis (MIPO) for Distal Tibia Fractures

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Abstract

Introduction: The presence of a subcutaneous distal tibial fracture is a surgical difficulty and might potentially lead to complications such as delayed union, non-union, wound infection, and wound dehiscence. Minimally Invasive Plate Osteosynthesis (MIPO) is a recommended surgical procedure for the treatment of distal fractures that are displaced or unstable. This approach is favoured because to its technical benefits and favourable clinical results.

Methods: The present study used a prospective design to investigate a cohort of adult patients who had sustained distal tibia fractures and were subsequently treated using locking plates using the minimally invasive plate osteosynthesis (MIPO) approach. Consecutive patients diagnosed with Gustillo type 1 open fracture, with or without articular extension, were included in our study. The evaluation of clinical outcome was conducted with the Olerud and Molander Score (OAMS). A radiographic evaluation was conducted in order to determine the presence of radiological union.

Results: Out of the total sample size of 30 patients, the right side was affected in 53% of the cases. The most prevalent form of fracture seen was the 43.A1 type, accounting for 47% of the cases. The post-operative assessment using the OAMS revealed that 67% of patients had an exceptional result, 27% had a good outcome, 6% had a fair outcome, and none of the patients experienced a poor clinical outcome. The attainment of radiological union occurred within a span of 12 weeks for 20% of the cases, between 12 and 16 weeks for 23% of the cases, between 16 and 20 weeks for 50% of the cases, and within a range of 20 to 24 weeks and 24 to 28 weeks for one patient each. A total of five patients exhibited superficial wound infections, while four patients had ankle stiffness, and two cases showed delayed union.

Conclusion: The results of our investigation indicate that the use of the minimally invasive plate osteosynthesis (MIPO) approach with a locking compression plate does not have a detrimental effect on the blood supply to the periosteum. Furthermore, the success of this technique does not only depend on the compression exerted between the plate and the bone. Therefore, it can be concluded that minimally invasive plate osteosynthesis (MIPO) is a very efficient therapeutic approach for managing fractures of the distal tibia.

Keywords: Distal tibial fractures, locking plate, Minimally invasive plate osteosynthesis

Introduction

The objective of treating proximal and distal tibial fractures is to achieve prompt healing of the fracture in the most optimal anatomical alignment, while also facilitating early and maximal restoration of functional activity [1]. Given the continuous rise in high-velocity road traffic incidents, there has been a corresponding surge in the occurrence of intricate and multifragmentary periarticular fractures affecting the tibia.

The treatment options for fractures of the tibia include closed reduction and cast application, closed reduction and external fixation, closed reduction and internal fixation using the Minimally Invasive Plate Osteosynthesis (MIPO) approach, and open reduction and internal fixation using a plate [2]. Every strategy has its own set of pros and downsides. The non-operative management of closed comminuted fractures, often including the use of a cast, often results in complications such as extended immobilisation, malunion, reduction in bone length, and restricted joint mobility.

The use of open reduction and internal fixation using standard plates often results in several problems, such as non-union, delayed union, infection, and implant failure. The care of underlying soft tissues is considered the primary determinant in the therapy

of these fractures. It was postulated that the primary determinant for successful bone regeneration is the blood supply [3]. When using the method of internal fixation, it is crucial to prioritise the vascular supply of both bone and soft tissue. This may be achieved by minimizing exposure, use indirect reduction techniques, and ensuring the least amount of injury to the periosteum.

Consequently, there has been a shift in the approach of managing these fractures, moving away from complete immobilisation towards a more flexible approach known as relative fixation [4]. This method focuses on achieving biological osteosynthesis while also preserving the vascularity of the bone and surrounding soft tissues. The use of biological plating offers a degree of stability that is comparative in nature, while also maintaining the presence of blood vessels in the vicinity of the fractures. The concepts behind this minimally invasive approach include indirect closure reduction, extraperiosteal dissection, and relative stability. These principles enable a restricted and controlled motion at the fracture site, promoting secondary bone healing via the creation of callus [5]. The purpose of this prospective research was to assess the effectiveness of the minimally invasive plate osteosynthesis (MIPO) approach in treating fractures distal region of the tibia.

Methods

Study Design and Sample population: The present prospective study was conducted of consecutive adult patients with distal tibia fracture treated with locking plates with MIPO technique at the Department of Orthopedics, at Zoram Medical College, Mizoram, India.

Inclusion and Exclusion criteria: During the study duration of 36 months, we included 30 patients in the present study. All consecutive patients with Gustillo type 1 open fracture with or without articular extension were included. We excluded patients with tibial shaft fractures, elderly patient with co-morbid condition, non-weight wearing limb, pathological fractures and Gustillo type II & III open fracture. All patients were explained the purpose of the study and a written consent, separate from the one for surgery, was taken.

Data Collection and Analysis: The categorization of all fractures was conducted based on the AO/OTA classification of long-bone fractures, as established by the Arbeitsgemeinschaft für Osteosynthesefragen/Orthopedic Trauma Association. A pneumatic tourniquet was used to apply pressure to the patient's limb, allowing for the necessary surgical incision and intra-operative assessment of the fracture. The patient was appropriately prepped and draped, ensuring that the leg was adequately exposed for the procedure. After the patient has been prepped and covered with drapes, antibiotics were provided intra-operatively prior to the inflation of the tourniquet. An effort was made to reduce traction and manipulation. The first decrease was then validated with the use of image guiding using C-arm technology (intraoperative imaging). Once sufficient reduction and alignment had been accomplished, the appropriate plate size was chosen with the use of imaging guidance in order to provide sufficient fixation and stabilisation of the fracture.

The MIPO procedure included creating an oblique incision at the tip of the medial malleolus, which was then extended proximally to provide a more convenient passage. The medial malleolus was revealed. The procedure included the cautious preservation of the major saphenous vein, followed by the insertion of percutaneous elevators to create a submuscular, extraperiostal tunnel for the placement of the plate. The examiner proceeded to palpate the anterior and posterior boundaries of the medial tibia, after which an incision was made along the longitudinal axis, therefore exposing the periosteum. The sub-muscular plane was established by a proximal incision, and a tunnel was created extending to the fracture site. The surgeon then applied pressure to the plate using their non-dominant hand. The plate was manually examined in the incision closest to the point of origin and verified to be securely positioned. Subsequently, the plate was affixed onto the tibial surface using a Kirschner wire that was introduced via a fixation bolt. The appropriate location was then verified using anteroposterior and lateral imaging views. Subsequently, the proximity of the plate was assessed in order to verify the central positioning of the tibial shaft. Subsequently, the application of fixation screws ensued, according to the established protocol for both non-locking cortical screws and locking screws. The non-locking screws were first put in accordance with the preoperative plan. Following the achievement of sufficient reduction, the locking screws were then introduced. Each primary fracture fragment was secured with a minimum of four screws. Following the insertion of the plate with screws, the stabilisation bolt was subsequently removed from the middle distal hole and replaced with a screw. The guidelines governing the use of locking compression plates (LCP) were strictly followed throughout the whole fixing process. The wounds were irrigated with normal saline and were closed in layers.

A post-operative X-ray was conducted in order to document the appropriate fixation and alignment of the fractured pieces. The initiation of ankle mobilisation often occurred on the second or third day after the surgical procedure, taking into consideration the patients' tolerance levels and any accompanying injuries. Subsequent appointments were conducted at intervals of 1 week, 4 weeks, 2

months, 4 months, 6 months, 1 year, and thereafter, during which comprehensive assessments were performed.

A clinical assessment was conducted to evaluate the progress. The assessment of clinical outcome was conducted utilising the Olerud and Molander Score (OAMS), a patient-administered questionnaire. The OAMS consists of nine distinct items, namely pain, stiffness, swelling, stair climbing, running, jumping, squatting, supports, and work/activities of daily living. Each item is assigned a score ranging from 0 (indicating complete impairment) to 100 (indicating no impairment). A radiographic evaluation was conducted, whereby the antero-posterior and lateral views of both the afflicted and normal limb were compared. This examination encompassed the knee and ankle joints to determine the presence of radiological union.

During the study period, all cases of distal tibial fracture were subjected to clinical assessment, and only those meeting the study criteria were included in the final analysis. The pre-operative clinical examination and laboratory tests were conducted as a component of surgical preparation. The data of the patients was recorded using a pre-designed semi-structured questionnaire. The researchers recorded the patients' outcomes in terms of OAMS (Orthopaedic Association of Michigan Score) and the duration required for radiological union for all participants. Complications arising during the post-operative follow-up period were observed for all patients. The data were provided, including a descriptive study of demographics, fracture classification, and clinical outcomes.

Results

The current investigation had a sample size of 30 individuals. The age group that appeared most often was those aged 41 to 50 years, accounting for 40% of the sample. This was closely followed by individuals aged 31 to 40 years, comprising 30% of the sample. The study population consisted of 73% men, with 40% of the patients identifying as agriculturists (Table 1). The predominant cause of injury seen in the study population was road traffic accidents, accounting for 73% of cases, whereas the remaining individuals had injuries as a result of falls. Approximately 53% of the patients exhibited injuries on their right side, while the remaining individuals had injuries on their left side.

Table 1: Baseline characteristics of the patients included in the study

Variables	N	%
Age groups		
0 to 18	0	0%
19 to 30	2	7%
31 to 40	9	30%
41 to 50	12	40%
51 to 60	5	17%
61 to 75	2	7%
Gender		
Females	8	27%
Males	22	73%
Occupation		
Agriculture	12	40%
Business	9	30%
Labour	5	17%
Office work	4	13%
Mechanism of injury		
Road Traffic Accident	22	73%
Fall	8	27%
Side of Injury		
Left	14	47%
Right	16	53%

Table 2 provides a description of the categorization of fractures based on the AO/OTA method of classification. The prevalent kind seen was the 43.A1 type, accounting for 47% of the total. The distribution of fracture types observed in the study were as follows: 43.A2 accounted for 20% of cases, 43.A3 accounted for 23% of cases, 43.B1 accounted for 7% of cases, and 43.B2 accounted for 3% of cases. The post-operative OAMS assessment revealed that 67% of the patients had an exceptional result, 27% experienced a good outcome, 6% had a fair outcome, and none of the patients exhibited a

bad clinical outcome. Radiological union was seen within a time frame of 12 weeks in 20% of the patients, between 12 and 16 weeks in 23% of the patients, between 16 and 20 weeks in 50% of the patients, and within a range of 20 to 24 weeks and 24 to 28 weeks in one patient each. Complications were absent in 63% of the patients. A total of five patients had superficial wound infections, while ankle stiffness was seen in four individuals. Additionally, two patients experienced delayed union.

Table 2: Classification of fractures based on The AO Foundation/Orthopaedic Trauma Association (AO-OTA) types

AO-OTA type	N	%
43.A1	14	47%
43.A2	6	20%
43.A3	7	23%
43.B1	2	7%
43.B2	1	3%

Table3: Distribution of patients according to their complications

Outcome assessment	N	%
Clinical outcome(OAMS)		
Excellent	20	67%
Good	8	27%
Fair	2	6%
Poor	0	0%
Radiological union (in weeks)		
Upto12	6	20%
12to16	7	23%
16to20	15	50%
20to24	1	3%
24to28	1	3%
Complications		
None	19	63%
Superficial wound infection	5	17%
Ankle stiffness	4	13%
Delayed union	2	7%

Discussion

The management of distal tibial fractures necessitates the use of individualised decision-making strategies. Conservative treatment is often used for stable fractures, while open reduction and internal fixation necessitates substantial soft tissue dissection and periosteal stripping. The use of the MIPO approach has been shown to effectively decrease the extent of surgical damage while simultaneously promoting a physiologically advantageous environment that facilitates the healing process of fractures [6]. The purpose of this research was to evaluate the functional result of patients who had treatment for distal tibial fractures using locking plates with the minimally invasive percutaneous plate osteosynthesis (MIPO) approach. The data revealed that a majority of the patients, namely 70%, were between the age range of 30 to 50 years [7]. Additionally, it was noted that 73% of the patients identified as male. The economic productivity of this particular age group underscores the need of effectively addressing and treating this fracture. Moreover, it has been previously reported by several investigators that road traffic accidents are a prevalent source of distal tibial fractures.

The assessment of clinical outcome after surgery was conducted using the Objective Assessment of Medical Status (OAMS) in our research. The MIPO approach and its utility in treating distal tibial fractures were elucidated by Patel et al [8]. The researchers used the Teeny and Wiss criteria to evaluate the functional results of the patients. A total of 15 patients, accounting for 75% of the sample, were found to have achieved an exceptional outcome. Additionally, 3 patients, representing 15% of the sample, had a good outcome [9]. Lastly, two instances, amounting to 10% of the sample, resulted in fair outcomes due to the presence of problems. In their study, Gupta et al. conducted an evaluation of the effectiveness of the minimally invasive plate osteosynthesis (MIPO) approach in treating closed

proximal and distal fractures of the tibia [10]. The researchers assessed the functional outcome of the patients using the SJLAM criteria. The findings of their analysis revealed that 60% of the patients had outstanding outcomes, 33% had good outcomes, and 7% had fair outcomes. In their study, Kumar and Sahu conducted a comparison between the use of low multidirectional locked nails and minimally invasive plate osteosynthesis (MIPO) with locking compression plates in the treatment of extra-articular distal tibial fractures [11]. The objective of their investigation was to evaluate the functional results, union rate and time, as well as the potential problems associated with these treatment approaches. The researchers used the Kaikkonen ankle score and the Lysholm knee grading system in their study [12]. The researchers discovered that 16 patients in the nail group and 12 patients in the plate group were able to acquire complete range of motion of the ankle. The nail group had a high level of ankle score, whereas the plate group exhibited a range from fair to exceptional. This finding demonstrates that the restoration of ankle function was successful in all of the patients. Additionally, the group of nails had a faster rate of union in comparison to the group using plates.

In their study, Patel et colleagues documented many problems. Specifically, they observed superficial wound infection in two instances, surgical wound breakdown with exposed implant in one case, which was successfully treated with antibiotics and daily dressing [8]. Additionally, one case exhibited the presence of conspicuous hardware, although it remained asymptomatic. Gupta et al conducted an observation in which they noted the presence of a single superficial wound infection [10]. This infection was successfully treated with the use of daily bandages and a one-week course of oral antibiotics. A single patient presented with non-union, for whom autogenous bone grafting from the iliac crest was performed at 12 weeks. The fracture successfully achieved union at 22 weeks. The non-union of the fracture was ascribed by the authors to factors such as early weight bearing, comminution, and the specific pattern of the fracture. Kumar and Sahu experienced additional problems within the plate group, including delayed union, nonunion, superficial infection, and wound dehiscence and the occurrence of implant failure. A higher incidence of malunion was seen in the group treated with nails [12].

Minimally invasive procedures lack the capability to directly see the fracture, necessitating the use of intraoperative fluoroscopy to verify the reduction. This would result in increased radiation exposure for the surgical crew as well. In contrast, the MIPO technique is known for its ability to maintain additional blood flow to the surrounding bone, while also respecting the osteogenic fracture hematoma. This approach offers a physiologically favourable and stable fixing strategy for fractures of the distal tibia.

The current research exhibits some limitations. The duration of the follow-up period in this research was insufficient to determine if any instances of re-fracture occurred. However, it is worth noting that plate-induced osteoporosis, which may lead to re-fracture following plate removal, is seen less often with the use of locking compression plates. Furthermore, due to the reliance of this approach on individual experiences, it is important to consider that the findings of the current research may not be generalizable to other surgical centres.

Conclusion

Results of our study show that locking compression plate using MIPO technique does not compromise the periosteal blood supply thereby causing less interference with the fracture haematoma and the fracture healing. There is rapid fracture consolidation and union time. In addition, locking compression plate does not rely on the compression between the plate and the bone so re-contouring of the plate is not required. This technique is also preferred by the patients as there was no need of any specialised instrumentation and the method is less time consuming. Thus we can conclude that MIPO is an effective treatment for distal tibia fractures. However, future studies are required from a larger multi-centric sample to arrive at robust conclusions.

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