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Original Research Article

An Outcome Assessment of Intramedullary Interlocking Nailing and Minimally Invasive Percutaneous Plate Osteosynthesis: A Comparative Study

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Abstract

Aim: The aim of the present study was to evaluate the functional outcomes of intramedullary interlocking nailing and minimally invasive percutaneous plate osteosynthesis.

Methods: This present study was conducted in the Department of Orthopaedics for the period of 2 years. During this timeframe, 120 patients were recruited for surgical procedures. Patients were randomly allocated into two groups, each containing 60 patients.

Results: Out of these 120 patients, 66 were male and 54 were females. The mean age of the plating group was observed as 43.17 years while the average age of the nailing group was reported as 38.342 years. In the plating group we observed 40 cases of OA type 1, 16 cases were diagnosed as type 2 and only 4 cases were identified under the category of OA type 3. Meanwhile, in the nailing group 41 cases of type 1, 17 were of type 2 and 2 cases of type 3 was managed. The mean duration of surgery was reported as 62.78 ± 8.52 hours in the nailing group while 58.424 ± 8.92 hours in the plating group with no statistical difference. We observed that the IMIL group attained fracture union in an average duration of 26.84. But no statistical difference was observed between both groups. IMIL procedure has less duration of hospital stay when compared with MIPPO. We observed 5° malunion in the MIPPO group whereas the IMIL group reported 10° malunion with a significant difference of 0.001. The average duration of weight-bearing was reported as 7.33 in plating and 7.03 in the nailing group. We observed that 6 cases of the IMIL group reported knee pain with a statistical difference of 0.025 between both groups.

Conclusion: We observed the reliability of both procedures in managing the distal tibia fractures. Both procedures provide a favorable environment for healing fracture sites by preserving the bony vascularity and fracture hematoma. However, our study concluded that the plating technique can better restore the distal tibia alignment but also had chances of postoperative complications which would be manageable.

Keywords: Intramedullary interlocking nailing, minimally invasive percutaneous plate osteosynthesis, distal tibia

Introduction

As tibial fractures are commonly associated with soft tissue injury, if these are not properly treated these can cause substantial disability to the patient. High energy motor vehicle trauma constitutes the commonest cause [1] followed by falls, direct blow, and sports injury. The incidence of distal tibia fractures in most series is 0.6%, and it constitutes to about 10%–13% of all tibial fractures. [2] Distal tibial metaphysis is defined as by constructing a square, with sides of length defined by widest portion of tibial plafond. [3]

Because of its subcutaneous location, poor blood supply and decreased muscular cover anteriorly, complications such as delayed union, nonunion, wound infection, and wound dehiscence are often seen as a great challenge to the surgeon. Minimally invasive plate osteosynthesis (MIPO) and intramedullary interlocking nail (IMLN) are two well-accepted and effective methods, but each has been historically related to complications. Malalignment and knee pain are frequently reported after IMLN, [4,5] whereas wound complications, and implant prominence have been associated with tibial plating in some series. [6]

The treatment of extra-articular distal tibia fractures is a hard challenge because of the peculiar anatomy

of the distal tibia, paucity of soft tissue coverage, relatively poor blood supply and injury of bone and soft tissue often caused by high energy. Conservative treatment has a poor functional result and more late complications. The main purpose of operative treatment is to restore the anatomical alignment of the distal tibia and to provide sufficient stability, which promotes fracture healing and decreases late complications. [7] The traditional surgical treatment for distal tibia fractures using open reduction and international fixation (ORIF) has more serious soft tissue interference and larger blood supply destruction. The distal tibial metaphysis is drawn by constructing a square with its side defined by the widest portion of the tibial plafond. [8] Currently, both minimally invasive plate osteosynthesis (MIPO) and intramedullary nailing (IMN) are established procedures with their pros and cons. Nailing is more frequently associated with knee pain and malalignment [9,10], whereas plating results in more wound problems and implant prominence. [11]

The aim of the present study was to evaluate the functional outcomes of intramedullary interlocking nailing and minimally invasive percutaneous plate osteosynthesis.

Materials and Methods

This present study was conducted in the Department of Orthopaedics, Narayan Medical College and Hospital, Sasaram, Bihar, India for the period of 2 years. During this timeframe, 120 patients were recruited for surgical procedures. Patients were randomly allocated into two groups, each containing 60 patients. The first group of 60 patients was treated with minimally invasive percutaneous plate osteosynthesis (MIPPO) technique while the rest 60 were prepared for intramedullary interlocking nailing (shortened) procedure. Inclusion criteria consisted of patients who had 2 weeks old OA type A1, A2, or A3 fractures and aged above 18 at the time of admission. We only included patients with the presence of at least 3cm distal fragment without articular incongruity. We further assured that the vascular and neurological status of patients were maintained and they meet all the routine medical standards. While we excluded all the cases of compound fractures, intra-articular extension fractures. In case of any vascular injuries associated with fractures, patients were immediately excluded. Pathological traumas and poly traumas were not entertained. Written consent was taken from all the participants after declaring all the research objectives and consequences. We calculated our sample size with a probability of a 30% difference among both groups. The value of alpha error was set as 5% and 80% statistical power was used for sample size. We included anteroposterior and lateral radiographs of fractures with knee and ankle as preoperative examination. The stability of patients was thoroughly examined before radiological assessment. Till the surgery, we applied a posterior slab for immobilization. Regular dressing and limb elevation were used for patients with precarious skin conditions. After the appearance of wrinkle sign within two weeks of trauma we initiated our surgical procedure.

After application of tourniquet patient leg was prepared from toes to mid-thigh for the MIPPO technique. Preventing the saphenous nerve and vein injury we made an incision of 3-4 cm over the distal tibia metaphysis. A blunt retractor was used to make an epiperiosteal tunnel for the insertion of long plates towards the diaphysis through the point of incision. After assuring the fracture reduction and manipulation we positioned the anatomical pre-contoured on the anteromedial aspect of the tibia shaft. This step was depending on the fracture pattern. An acceptable criterion was formed to analyze the reduction; achieving <5°varus-valgus angulation, <10° anteroposterior angulation, and < 10 mm shortening. The plate was fixed with K wire temporarily along with one locking screw we fixed the proximal fragment after insertion of a plate and examined the reduction. A combination of cortical nonlocking and locking screws were used to complete the procedure of distal fragment fixation. The fibula was not fixed unless the fracture was within the syndesmosis region.

Meanwhile, a vertical incision of 5cm was made on the anterior aspect of the knee from the distal tip of the patella to the proximal aspect of the tibial tuberosity. We made the entry portal after cracking the patella tendon. This entry portal was made in the bare area of the tibial extraarticularly around 2 cm proximal to the tibial tuberosity. After provisional reduction, a ball tip wire was inserted to the distal end of the tibia through the entry point. Later on, pointed bone holding forceps was done to fix the shortened length IMIL nail. The interlocking screw was used to enhance the stability and alignment of fractures. After surgery fractures of both groups were supported with a posterior slab for 2 weeks. Immediately after surgery patient's leg was assessed via radiography (anteroposterior and lateral views). After one day of surgery, we recommended calf strengthening exercises. Antibiotics were provided to every patient for three days to minimize the risk of postoperative infections. However, patients were discharged after one week if their wound was dry.

All the patients were asked to visit the hospital at the 6th week, 3rd month, and 6th month of surgery for radiography assessment and for analyzing the knee and joint movements. When callus became visible on radiographs patients were allowed for partial weight- bearing. When callus was visible in 3 to 4 quadrants we considered it as fracture union on both anteroposterior and lateral views with no pain and mobility. Bone grafting was considered in case of

fractures nonunion. Functional assessment was taken place after one year of surgery or once the complete union of fracture has occurred using the American Orthopedic Foot and Ankle Society (AOFAS) score.

For statistical analysis, SPSS Version 23.0 was used. Mean and standard deviations were used for quantitative variables. Independent student t-test was used for comparing the quantitative variables while qualitative variables were analyzed by using Chi-square and Fisher exact test. We set a 0.05 p-value to determine the statistical significance.

Results

Table 1: Demographic information and treatment outcomes of both groups

Variables	IMIL nailing (N=60)	MIPPO (N=60)	P- value
Age	38.32 (19–68) ±12.22	43.17 (18–61)±11.55	0.075
Gender			0.931
Male	32	34	
Female	28	26	
OA type fracture			
Type 1	41	40	
Type 2	17	16	
Type 3	2	4	
Hospital stay (days)	6.44 (4–9) ± 1.18	6.74 (5–10) ± 1.22	0.099
Surgical time	62.78 (44–80) ± 8.52	58.44 (40–80) ± 8.92	0.862
Duration of fracture union	26.84 (18–46) ± 5.15	27.03 (19–48) ± 5.32	
Weight-bearingduration	7.03 (5–10) ± 1.52	7.33 (6–11) ± 1.46	0.084
Fluoroscopy time (min)	14.16 ± 1.23	15.32 ± 1.26	0.840
Final stage AOFAs score	84.86 (61–98) ± 8.82	84.18 (60–98) ± 8.78	0.832
Malunion	10.24 (8–14) ± 2.06	5 (3–7) ± 1.42	0.007

Out of these 120 patients, 66 were male and 54 were females. The mean age of the plating group was observed as 43.17 years while the average age of the nailing group was reported as 38.342 years. In the plating group we observed 40 cases of OA type 1, 16 cases were diagnosed as type 2 and only 4 cases were identified under the category of OA type 3. Meanwhile, in the nailing group 41 cases of type 1, 17 were of type 2 and 2 cases of type 3 was managed. The mean duration of surgery was reported as 62.78 ± 8.52 hours in the nailing group while 58.424 ± 8.92 hours in the plating group with no statistical difference. We observed that the IMIL group attained fracture union in an average duration of 26.84. But no statistical difference was observed between both groups. IMIL procedure has less duration of hospital stay when compared with MIPPO. We observed 5° malunion in the MIPPO group whereas the IMIL group reported 10° malunion with a significant difference of 0.001. The average duration of weight-bearing was reported as 7.33 in plating and 7.03 in the nailing group.

Table 2: Postoperative complications in study participants

Complications	IMIL technique	MIPPO technique	P- value
Superficial infection	3	5	0.07
Delayed union	9	8	0.743
Deep infection	2	2	0.2
Nonunion	4	2	0.05
Knee pain	6	2	0.025

We observed that 6 cases of the IMIL group reported knee pain with a statistical difference of 0.025 between both groups. We also reported a high rate of the delayed union in the nailing group. Patients treated with plating were more prone to superficial infections.

Discussion

Distal tibial fractures are comprised of subcutaneous anatomical fractures that arise in the distal region between 4 to 12 cm from the tibia plafond. [12] The management of these fractures becomes challenging for many orthopedics due to their uniqueness of the location and poor blood supply. Many complications have been seen during management in the form of nonunion and delayed union. Wound dehiscence and infections are also persistent in these fractures. [7] However, different treatments are available for managing the distal tibial metaphyseal fractures including open reduction and internal fixation (ORIF), intramedullary nailing technique, minimally invasive percutaneous plate osteosynthesis (MIPPO) technique, and external fixation. However, no satisfactory results had been obtained in previous years. [13,14] Though open

reduction and internal fixation method with plating provide early mobilization and reduction still it cannot be considered as the first-line treatment due to extensive soft tissue injury. [15]

Out of these 120 patients, 66 were male and 54 were females. The mean age of the plating group was observed as 43.17 years while the average age of the nailing group was reported as 38.342 years. In the plating group we observed 40 cases of OA type 1, 16 cases were diagnosed as type 2 and only 4 cases were identified under the category of OA type 3. Meanwhile, in the nailing group 41 cases of type 1, 17 were of type 2 and 2 cases of type 3 was managed. The mean duration of surgery was reported as 62.78 ± 8.52 hours in the nailing group while 58.424 ± 8.92 hours in the plating group with no statistical difference. We observed similar coherence of our findings with meta-analysis of Hu et al [12] In his meta- analysis, he also observed fewer cases of knee pain and malunion in the MIPPO group however foot function index was better in the IMIL group along with fewer cases of superficial infection. Meanwhile, the meta-analysis of Lin et al [13] suggested IMIL for managing distal tibia due to a lower risk of wound complications. In the past, huge variations have been observed regarding the comparison of IMIL nailing and the MIPPO technique.

We observed that the IMIL group attained fracture union in an average duration of 26.84. But no statistical difference was observed between both groups. IMIL procedure has less duration of hospital stay when compared with MIPPO. We observed 5° malunion in the MIPPO group whereas the IMIL group reported 10° malunion with a significant difference of 0.001. The average duration of weight-bearing was reported as 7.33 in plating and 7.03 in the nailing group. We observed that 6 cases of the IMIL group reported knee pain with a statistical difference of 0.025 between both groups. We also reported a high rate of the delayed union in the nailing group. Patients treated with plating were more prone to superficial infections. Studies conducted by Yang et al [16] and Dolagapu et al [3] showed earlier union in the IMN group, which was significant. Other studies such as Ram et al [17], Im et al [18] and Janssen et al. found no significant difference in the union rate between the plating and IMN groups. We found a shorter union time in the IMN group than in the MIPO group, but the difference was not statistically significant (p-value<0.05). The mean AOFAS scores in the MIPO and IMN groups were comparable in our study (p-value >0.05). Patil et al [19] also reported comparable scores between the two groups. Daolagupu et al. also showed similar functional outcomes between the two groups, but using different functional outcome criteria (Johner and Wruh's criteria).

Conclusion

We observed the reliability of both procedures in managing the distal tibia fractures. Both procedures provide a favorable environment for healing fracture sites by preserving the bony vascularity and fracture hematoma. However, our study concluded that the plating technique can better restore the distal tibia alignment but also had chances of postoperative complications which would be manageable.

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