Journal of Rawalpindi Medical College (JRMC); 2018;22(2): 129-132

Original Article

Functional Outcomes in Tibial Fractures, Treated by Interlocking Intramedullary Nails Versus Minimally Invasive Percutaneous Plate Osteosynthesis, with Reference to Wound Infections as Complication Rate

Muhammad Imran Butt, Shahzad Anjum, Tayyab Ahmad, Tooba Iqbal
Department of Orthopaedic Surgery,Benazir Bhutto Hospital and Rawalpindi Medical University, Rawalpindi

Abstract

Background: To compare interlocking intramedullary nails vs minimally invasive percutaneous plate osteosynthesis with locking compression plates for the treatment of diaphyseal tibial fractures, in terms of good functional outcome with reference to wound infections as rate of complications.

Methods: In this descriptive study, 140 patients with diaphyseal tibia fractures, were included. The patients included were adults with closed tibial shaft fractures which were less than 2 weeks old, located at 7 cm below the knee joint and 7 cm above the ankle joint. Fractures which were open and of pathological nature were not included in our study. Random allocation into two equal groups was done and 70 patients in group 1 were operated with interlocking nail and remaining 70 in group 2 were operated with Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) with a locking compression plate. Follow up of all patients was done uptil 6 weeks.

Results: Among all the patients included in the study right tibial fracture involvement was found in 57.9% and that of left side was found in 42.1%. Lesser complications in terms of implant irritation, pain and infection (superficial and deep) were seen in MIPPO group (4.3%) as compared to interlocking group (10%).

Conclusion: Due to less infection, less irritability, early union of the fracture and decreased implant related problems, minimally invasive percutaneous plate osteosynthesis, with locking compression plate is preferable in the treatment of tibial shaft fractures over the closed intramedullary interlocking nailing technique.

Key Words :Distal Tibia Fractures, Minimally invasive percutaneous plate osteosynthesis, Locking Plate, Interlocking Nailing.

Introduction

Among all the bones in the body, the one that is considered to be most commonly fractured is the tibial bone.[1] Due to its relatively subcutaneous location, it is exposed to frequent injuries.[2] This factor along with a poor blood supply makes the treatment challenging.[3] Infection, neurovascular injury and compartment syndrome, and after the initial period non union, delayed union and mal-union may add to the problem.[4,5] Treatment varies with severity, as the injury severity varies from mild injury which can be ignored to such a degree that amputation becomes necessary.[6] The surgeon has to carefully make a decision regarding the management of the patient after looking at the severity of injury and the available treatment options.

The tibia is a triangular shaped bone in cross section with the apex pointing anteriorly.[7] There is no muscular or ligamentous tissue on its anteromedial side which makes it quite superficial.. The muscles on the anterior aspect of the leg lie on its anterolateral. The superficial and the deep muscle compartments of the calf cover its posterior surface.[8] The density of this mostly diaphyseal bone known to have large ends on both sides which have the composition of a cancellous nature, is largely dependant on the age, metabolic status and location of the bone. [9] The thickness of the cortex surrounding the metaphyseal spongiosa is inversely proportional to its distance from the diaphysis. [10].

Both, the posterior tibial vessels and the tibial nerve emerge under the medial malleolus after curving around it.[11] A branch of the posterior tibial artery provides the diaphyseal blood supply of the tibia and then anastomoses with the metaphyseal endosteal vessels. Chances of injury to this vessel increase when the fracture is displaced leading to devascularization of the tibial shaft.[12] Cases in which both the medullary and periosteal blood supply are compromised, there is

increased risk of delayed healing and post traumatic osteomyelitis.[13]

These fractures are caused by injuries classified as high energy which can cause compartment syndrome and low energy which are mostly sports related.[14.]

Multiple classification schemes have been formulated for fractures of the tibia including Gustillo classification and Orthopaedic Trauma Association (OTA) classification.Tibial Fractures are usually diagnosed by signs and symptoms of swelling, pain, tenderness, deformity and instability. Sometimes tibial fractures also present with an open wound. Imaging studies like radiography, CT and MRI are also used to determine type of fracture and to consider treatment options.[15]

The past management with plaster cast led to reports of movement restriction, limb shortening, and osteoarthritis.[16] Complications like as infection, delayed and/or nonunion have been documented with open reduction and internal fixation (ORIF). [17] Interlocking intramedullary nailing is considered to have positive features like inserting the nail far from the injury site and at the load bearing axis. [18] Minimally invasive percutaneous plate has the advantages of being relatively simple, easy and cheap. Furthermore, it provides stability, minimizes intra-operative iatrogenic soft tissue damage, has less frequent requirement for bone grafting with a relatively smaller percentage of delayed or malunion and infection. Additionally, there is early post-operative mobilization and a decreased incidence of re-fracture after plate removal. Finally it is an ideal technique for dealing with multiple injury patients. [19] Minimally invasive percutaneous plate Osteosynthesis (MIPPO) and Locking Compression Plate (LCP),used in combination, are proved to be a biologically friendly and technically sound alternative method. [20] Bilal and associates reported impressive outcomes in 98% of closed fractures and 88% of open fractures. Complications including non-union and infections were observed in 6% of closed and 32% of open fractures.[21] Many other studies also conclude that plate fixation has relatively superior outcomes.Though reasonable data has been generated on the two modalities individually, there have been scarce attempts on comparison of these two modalities

Patients and Methods

After ethical approval, a randomized controlled clinical trial with a quantitative experimental methodology was conducted in patients presenting with tibial shaft fractures at the Orthopaedic Surgery Department, Benazir Bhutto hospital, Rawalpindi, from March 2017 till August 2017. The calculated study sample size was 70 patients in each group. Inclusion criteria was patients 20 to 50 years age, patients with closed tibial shaft fractures,fracture located 7 cm below knee joint and 7 cm above ankle joint and duration of fracture less than 02 weeks old. Exclusion criteria was fractures with other serious injuries,fractures extending into articular surfaces,old fractures more than 02 weeks old, infected fractures and /or fractures with bad skin conditions dermatitis and pathological conditions of bone, osteoporosis and other bone disorders. Standard treatment which is clinically acceptable was given to both patient groups to make sure that no patient was denied potentially beneficial treatment. The patients who participated in the study voluntarily were informed about the whole process verbally and in written form using patient information sheets and documentation containing informed consent was done. The data obtained from the study was protected. Inclusion and exclusion criteria were verified during patient assessment. Standardized subjective and objective examinations were carried out on all patients. These along with radiographs helped in the diagnosis. After taking consent, trial outcome measures were assessed with the help of standard assessment forms. First, baseline measurements were taken and then the patients were randomly allocated into two groups by using a computer generated permuted block randomization scheme and confidentiality was maintained.

Group One constituted Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) patients and Group Two constituted Closed Intramedullary Interlocking Nail (ILN) patients .The patients were prohibited from using any other adjuvant therapy apart from analgesics like non-steroidal anti-inflammatory drugs during the study period.

In group one(Minimally Invasive Percutaneous Plate Osteosynthesis;*MIPPO)*Percutaneous plate placement was performed after direct or indirect reduction. The plate was positioned beneath the muscular layer and extra periosteally via a small incision, keeping in mind that it does not damage vessels compressed beneath it. The fibula was fixed in cases in which ankle anatomy and stability had to be restored. Intra-operative C-arm fluoroscopy was used to evaluate the correct placement and fixation. Patients were evaluated postoperatively at the outpatient clinic; 10 to 15 days after the operation for wound problems, and 06 weeks after for radiological and clinical improvement. Follow-up continued until clinical and radiological union was observed.In group two(Closed

Intramedullary Interlocking Nail;ILN)the interlocking nailing was carried out with a flexion of 90* at the knee joint and 45* at the hip joint. Adequate reduction, guidewire position, nail position and locking were achieved with the help of image intensifier. After reduction and passing a guide wire through the medullary cavity, reaming of both the proximal and distal segments was done. A nail of adequate length was passed over the guidewire. Finally proximal and distal locking were done. Good results were considered when there was union in normal position, alignment measured on X-ray, without shortening and no or minimal surgical site infection.Surgical site infection was categorized using Southampton surgical site infection scoring system (Table 1)

Table 1: Southampton surgical site infection scoring system

Grade	Appearance	Interpretation
0	Normal healing	"good"
I	Normal healing with mild bruising or erythema	
II	Erythema plus other signs of inflammation (swelling, pain, temperature)	
III	Clear or haemoserous discharge	
IV	Pus discharge	"bad"
V	Deep or severe wound infection with or without tissue break	

Results

Mean age of the study cohort was 34.82 years (SD ± 1.01). A total number of 92(65.7%) males and 48(34.3%) female patients were included in the study. Right tibial fracture involvement was found to be in 81 patients (57.9%) and that of left side in 59 patients (42.1%) (Table 2). Among the 70 patients treated in group with MIPPO intervention, 06 weeks follow up showed 03 patients with infection at surgical infection scale as bad. Majority (95.72%) had a good functional out come (Table 3). Among the 70 patients treated in group with IIN intervention a 06 weeks follow up showed on 07 patients with infection at surgical infection scale as bad. 63 patients (90%) presented with a good functional out come (Table 4). Age, gender, location of injury as right or left tibial fractures or duration of fracture less than 2 weeks, were not found to be effect modifiers. Thus supporting the hypothesis that MIPPO is better that ILN in terms of good functional out come that is lesser wound infection and better wound healing (Table 5).

Table 2: Baseline characteristics of patients in the two study groups

Characteristics	Group 1 MIPPO	Group 2 Interlocking Nail
Age mean range in years	35.6	34.04
Gender male n (%)	50(71.42)	42(60)
Gender female n (%)	20(28.58)	28(40)
Affected side right	45	36
Affected side left	25	34

Table 3 : Functional outcome for group 1 (MIPPO)

Functional outcome	Frequency	Percentage
Good	67	95.72
Bad	03	4.28
Total	70	100

Table 4 : Functional outcome for Group 2 (ILN)

Functional outcome	Frequency	Percentage
Good	63	90.00
Bad	07	10.00
Total	70	100

Table 5: Outcome in MIPPO ILN groups

Group	Outcome		p-value
	Good	Bad	
MIPPO	67	03	0.348
ILN	63	7	

Discussion

Despite the fact that different management options have shown reasonable success rates, only a small number of comparative trials have been undertaken to optimize management in tibial shaft fractures.[22] Until now closed interlocking nail has been considered the treatment of choice with fewer complications but it also has the disadvantages of requirement of a certain level of expertise from the surgeon along with the availability of fluoroscopic guidance. Its high cost is a confounding factor in its utilization in our set up. There is also slight difference in complication rate like infection in both these method. There is constant knee pain in more than eighty percent of patient treated with interlocking nail. [23] That is why DCP is still the treatment of choice in our part of the world.

A larger patient group along with the fact that it was adequately powered to rule out any discrepancies in mal-alignment, were the strengths of this study;

however it was limited to see only the surgical site infection. In Rommens et al study the infection rate was 1.2% and nonunion developed in 1.2%. In his study 88.1% of the patients had a good end result . His conclusion was that plate osteosynthesis was a relatively more reliable treatment option for closed tibial shaft fractures.[24] In present study only ten patients (7.4%) developed deep infections of their tibia fractures. The overall infection rate in our study was found to be 7.14 %, while the infection rate in MIPPO group was 4.3 % (n=3) and in ILN group,it was 10 % (n=7). A higher rate of mal-alignment was observed in patients who underwent intramedullary nailing when compared with MIPPO.

Higher rates of complications such as infection, malunion and non union seem to have a direct relationship with factors such as open fractures, higher degree of soft tissue trauma along with tobacco use.[25] Some studies advocate the use of autogenous bone graft to achieve earlier and better healing and functional recovery. [26]

Conclusion

1. Closed intramedullary locking nail and minimally invasive percutaneous plate ostoesynthesis with locked compression plate, have both proven to be effective and safe management options for diaphyseal tibial fractures.
2. Minimally invasive percutaneous plate ostoesynthesis with locked compression plate should be preferred as it has the advantage of good wound healing and lesser infection rate.

References

1. Antonova E. Tibia shaft fractures: costly burden of nonunions. BMC Musculoskelet Disord. 2013; 14: 42-45.
2. Winfield RD, Mellnick VM, Chamieh J. Adipose tissue location and contribution to postinjury hypercoagulability. J Trauma Acute Care Surg. 2016 ;81(1):79-85.
3. Garg S, Khanna V, Goyal MP. Comparative prospective study between medial and lateral distal tibial locking compression plates for distal third tibial fractures. Chin J Traumatol. 2017 ;20(3):151-54.
4. Gougoulias NE, Khanna A, Maffulin N. Open tibial fractures. Are children small adults? Hippokratia. 2009 ;13(3):147-53.
5. Aslani H, Tabrizi A, Sadighi A. Treatment of open pediatric tibial fractures by external fixation versus flexible nailing. Arch Trauma Res. 2013;2(3):108-12.
6. Song W, Zhou D, Dong J. Predictors of secondary amputation in patients with grade IIIC lower limb injuries. Medicine (Baltimore), 2017 ;96(22):e7068.
7. Roemer FW, Jarraya M, Felson DT. Magnetic resonance imaging of Hoffa's fat pad and relevance for osteoarthritis research. Osteoarthritis Cartilage. 2016 ;24(3):383-97.
8. Binstead JT, Bhimji SS. Anatomy, Lower Limb, Calf. StatPearls. 2018.
9. Burnett WD, Kontulainen SA, McLennan CE. Proximal tibial trabecular bone mineral density is related to pain in patients with osteoarthritis. Arthritis Res Ther. 2017 ;19(1):200-04.
10. AuskBJ, HuberP, SrinivasanS. Metaphyseal and diaphyseal bone loss in tibia following transient muscle paralysis are spatiotemporally di stinct resorption events. Bone. 2013;57(2):413-22.
11. De Maeseneer M, Madani H, Lenchik L. Normal anatomy and compression areas of nerves of the foot and ankle: US and MR Imagingwith Anatomic Correlatio n. Radiographics. 2015 ;35(5):1469-82.
12. Brinker MR[1], Bailey DE Jr. Fracture healing in tibia fractures with an associated vascular injury. J Trauma. 1997 ;42(1):11-17.
13. IkpemeIA, NgimNE, IkpemeAA.Diagnosis and treatment of pyoge nic bone infection. Afr Health Sci. 2010 ;10(1):82-86.
14. GamulinA, LübbekeA, BelingaP.Clinical and radiographic predict ors of acute compartment syndrome in the treatment of tibialplateau fractures. BMC Musculoskelet Disord. 20178;18(1):307-10.
15. Courtney PM, Bernstein J, Ahn J. In brief: closed tibial shaft fractures. Clin Orthop Relat Res. 2011 ;469(12):3518-21.
16. Palmu SA, Auro S, Lohman M, Paukku RT, Peltonen JI, Nietosvaara Y. Tibial fractures in children: A retrospective 27-year follow-up study. Acta Orthopaedica. 2014;85(5):513-17.
17. Greeven APA, Bezstarosti S, Krijnen P, Schipper IB. Open reduction and internal fixation versus percutaneous transverse Kirschner wire fixation for single, closed second to fifth metacarpal shaft fractures. European Journal of Trauma and Emergency Surgery. 2016;42:169-75.
18. Hierholzer C, Glowalla C, Herrler M. Reamed intramedullary exchange nailing: treatment of choice of aseptic femoral shaft nonunion. Journal of Orthopaedic Surgery and Research. 2014;9:88-91.
19. Muzaffar N, Bhat R, Yasin M. Plate on plate technique of Minimally Invasive Percutaneous Plate Osteosynthesis in Distal Tibial Fractures, an Easy and Inexpensive Method of Fracture Fixation. Archives of Trauma Research. 2014;3(3):e18325.
20. Akra GA, Lazarides S, Nanu AM. Early results of minimally invasive percutaneous Plate Osteosynthesis for Fractures of the Distal Tibia Clinical Medicine Insights Arthritis and Musculoskeletal Disorders. 2017;10:11-15.
21. Moher D, Liberati A, Tetzlaff J, Altman DG. PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. J Clin Epidemiol. 2009;62(10):1006-12.
22. Hoffmann MF, Jones CB, Sietsema DL . Clinical outcomes of locked plating of distal femoral fractures. Journal of Orthopaedic Surgery and Research. 2013;8:43-47.
23. Burç H, Atay T, Demirci D. The intramedullary nailing of adult femoral shaft fracture by the way of open reduction is a disadvantage or not? The Indian Journal of Surgery. 2015;77(Suppl 2):583-88.
24. Myers SH, Spiegel D, Flynn JM. External fixation of high-energy tibia fractures. J Pediatr Orthop 2007; 27 : 537-39.
25. Wei SJ , Cai XH , Wang HS. A comparison of primary and delayed wound closure in severe o pen tibial fractures initiallytreated with internal fixation and vacuum-assisted wound coverage. Int J Surg. 2014;12(7):688-94.
26. Schnetzke M, Morbitzer C, Aytac S. Additional bone graft accelerates healing of clavicle non-unions and improves long-term results after 8.9 years: a retrospective study. Journal of Orthopaedic Surgery and Research. 2015;10:02-05.