Original Article

Journal of Trauma & Orthopaedic Surgery 2017; Jan - March; 12(1):7-11

Comparison of surgical management of extra-articular distal tibia fractures treated with closed intramedullary nailing and minimally invasive percutaneous plate osteosynthesis- a prospective study

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Abstract

Background: *We compared the clinical, radiological and functional outcome of extra-articular distal tibia fractures treated with Minimal invasive plate osteosynthesis (MIPO) and intramedullary nailing (IMN)*

Methods: *A prospective study included 51 patients (IMN-25 patients, MIPO-26 patients). Two groups were compared for mean operative time, mean hospital stay, mean healing time, complications, reoperations and mean American Orthopaedic Foot and Ankle surgery (AOFAS) score.*

Results: *Significant difference was observed in mean duration of hospital stay (p-0.0001). There was no significant difference in mean healing time and mean operative time in between the two groups.*

Mean AOFAS score was 88.24 ± 5.19 in IMN and 86.96 ± 6.9 in MIPO group and the difference was not significant (p-0.78). Malalignment was higher in MIPO group (15.3%) as compared to IMN group (12%) but there was no statistically significant difference (p-0.36). One patient in MIPO group in which fibular osteotomy was done developed valgus deformity. Incidence of infection was higher in the MIPO group (11.5%) as compared to IMN group (4%) but the difference was not significant (p=0.15). Non-union, delayed union and resurgeries were almost similar between the two groups.

Conclusion: *Both IMN and MIPO can be safely used to treat distal tibia extra-articular fractures but IMN has the definite advantage of shorter mean hospital stay duration. Fibula fracture, if in distal third should be fixed as it aids in tibia reduction and imparts additional stability to the fixation. The role of fibular osteotomy in simple distal tibia fractures remains controversial and demands further studies.*

Key words: *distal tibia, extra-articular fractures, MIPO, fibula fixation, intramedullary nailing, prospective study*

Introduction

Extra-articular Distal tibia fractures are often difficult to treat since they are close to the ankle joint, usually associated with soft tissue injuries. Minimal invasive Plate osteosynthesis (MIPO) using Locking compression plate (LCP) has replaced the conventional open reduction method since smaller incision and indirect reduction preserves the fracture hematoma and soft tissue vascularity(1). Literature review suggest that both MIPO and Intramedullary nailing (IMN) has been successful in the management of these fractures, but the results are controversial among the two (2-4). MIPO is associated with wound problems, Plate prominence(5), mal-alignment and non-union(6). IMN avoids some of these problems but the technical difficulty in insertion and the risk of mal-union (7), anterior knee pain poses a great challenge in orthopaedics (4). Our hypothesis was that patients treated with IMN has a better outcome than treated with MIPO. The aim of this study is to compare the clinical, radiological and functional outcome of these fractures treated with IMN and MIPO.

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Materials and Methods

A prospective cohort study was conducted at our institute from April 2013 to April 2016 after obtaining approval of the institutional ethical committee. It included 51 patients with extra articular distal tibia fractures. Distal tibia is defined as the area within two Müller squares(8) of the ankle joint, in which the proximal and the distal segments of long bones are defined by a square whose sides have the same length as the widest part of the epiphysis.(9) Accordingly all closed and compound Grade I (Gustilo Anderson classification)(10) extra articular distal tibia fractures as per Orthopaedic Trauma Association (OTA) classification 43A1, 43A2, 43A3 with age more than 18 years with recent fall were included in the study. Compound fractures with grade II and above, with age less than 18 years, intra-articular extension, extremely distal fractures where two distal locking screws are impossible to insert, multiple fractures and all pathological fractures and non-union were excluded from the study. CT scan was used to rule out intraarticular extension. Patients were alternatively divided in two almost equal groups after applying inclusion and exclusion criteria i.e; closed IMN group (25 patients) and MIPO group (26 patients). (Table 1). Antero-posterior and lateral radiographs were obtained for the classification and preoperative planning. Patients in nailing group were operated as and when possible while patients in plating group were

 | pISSN 2278 – 6651

IMN-25	MIPO-26
•Male-21	•Male-20
•Female-04	•Female-6
•A1:A2:A3-12:5:8	•A1:A2:A3-7:6:13
•Grade 1: 7/25	•Grade 1:10/26

Table 1: Detailed demographic characteristics and classification of the two groups

operated after the swelling reduced. Staged management has to be done with the initial application of external fixator to reduce the swelling in the plating group. Fibular osteotomy was done in one patient in MIPO group in which fibula was intact to prevent delayed union.(10)

All surgeries were performed by the same senior surgeon. One hour preoperatively all patients received intravenous third generation cephalosporin and an aminoglycoside. Fibula fracture, if in distal third was fixed first with either 3.5 mm one-third plate or an elastic nail and its fixation is independent of tibial method of fixation.

The operative technique of IMN is same as described elsewhere.(7, 9, 11) Multifunction tibia nail (MTN) with three distal locking screws (Nebula surgicals, Gujarat, India) was used in all the cases. Special measures were taken to prevent anterior knee pain during IMN(12). Medial parapatellar approach with entry point below the knee joint with preservation of Hoffa's fat pad was used and nail was buried into the bone in both coronal and saggital axis. Guide wire was kept exactly in the centre to prevent mal-alignment.(11). Accurate closed reduction of the fracture was verified before insertion of the ball-tip guide.(7) Poller screws(10) were used either as a reduction aid, to keep the nail in the centre, to correct the deformity at the fracture site, to narrow the effective diameter of the widened metaphyseal region and provide extra stability. At least two distal static locking screws were put, if possible one antero-posterior screw was also put.

MIPO was done on a radiolucent plain table and tourniquet was used. Distal tibia 4.5 mm combi hole locking compression plate (LCP) (Sharma orthopaedics, Gujarat, India) was used in all the cases. Medial approach(13) and indirect reduction techniques were used with the preservation of the fracture hematoma and periosteum. If the correct reduction was not achieved at the first attempt the plate was withdrawn and reconfigured for a better fit.(7) Bridging of the fracture site was done using a LCP as a bridge plate, thereby providing the relative stability.(6). Absolute stability(14, 15) if required in simple oblique or spiral fractures, was accomplished with the help of indirect anatomic reduction, holding the reduction with the help of pointed reduction clamp, inserting lag screws using stab incision either through the plate (not through the locking hole) or outside the plate and using LCP as a neutralization plate in a sub muscular plane through a minimally invasive approach (16, 17). The operative technique of MIPO is same as described elsewhere. (1,6,7,18)

Post-operative protocol was same for both the procedures. Antero-posterior and lateral xray views were taken after the surgery, first dressing inspection was done on post-operative day (POD) two, and stitches were removed after two weeks. Non-weight bearing and active ankle and knee mobilization was started on POD two. Patients were discharged three or four days after surgery. First Follow up was done after two weeks, then monthly follow up with clinical and radiological examination done at every visit until bony union was achieved. Radiologically patients were evaluated for signs of union, delayed union and non-union and malunion. Union of the fracture was assessed using the criteria described by Sarmiento et al(19).

1) The ability of the patient to bear weight without pain,

2) Visible bridging callus across the fracture on the radiograph.

Normal time to union was considered to be 24 weeks. No signs of union at nine months was considered to be a non-union. Healing time from six months to nine months was considered to be a delayed union. Mal-union was defined as a varus or valgus deformity > 5°, an anterior/posterior angulation > 10°, a rotational deformity > 10°, and shortening > 10 mm.(20). Partial weight was allowed when the xrays shows some some signs of union, usually after six weeks of operation. Full weight bearing was allowed on the individual basis as tolerated by the patient and depending upon the progress of union.

Patients were clinically evaluated for the signs of infection, skin maceration and pain at the fracture site, anterior knee pain and functional scoring system using American Orthopaedic Foot and Ankle surgery (AOFAS)(21) scoring at minimum 1 year follow up. Superficial infection was confined to dermal and subcutaneous tissue whereas deep infection was defined as those below the deep investing muscular fascia.(1) Informed consent was obtained from all the patients before operation.

Statistical analysis:

Parametric tests of significance were applied after testing normality of data. Incidence of adverse outcomes in the procedures was compared by using standard normal test for difference in proportions. Mean AOFAS scores was compared using unpaired t test.

Results

The study sample consisted of 51 patients in the age group 20 years to 67 years who were followed up for at least 1 year. There were no drop outs. The comparison between the two groups was done in terms of mean operating time, mean hospital stay and mean healing time. (Table 2). Mean hospital stay duration was less in patients with IMN procedure and the difference was statistically significant (p-

	Operating time(min) Mean ± sd	Hospital stay(days) Mean ± sd	Healing time(weeks) Mean ± sd
Intra-medullary Nailing	95.04 ± 7.4	5.12 ± 0.8	19.5 ± 4.8
Plating	97.9 ± 8.8	9.19 ± 2.6	21.4 ± 4.3
P value	0.83	0.0001	0.64

Table 2: Perioperative variable and mean hospital stay were compared in between the two groups. Statistically significant difference was seen in mean duration of hospital stay (p-0.0001).

	Malalign-ment	Infection	Non union	Delayed union	reoperation	Mean Aofas Score
Intra-medullary Nailing	25-Mar	25-Jan	25-Jan	25-Feb	25-Mar	88.24 ± 5.19
	12%	4%	4%	8%	12%	
Plating	26-Apr	26-Mar	26-Jan	26-Feb	26-Apr	86.96 ± 6.9
	15.30%	11.50%	3.80%	7.60%	15.30%	
P value	0.36	0.15	0.51	0.52	0.36	0.78

Table 3: Perioperative variable and mean hospital stay were compared in between the two groups. Statistically significant difference was seen in mean duration of hospital stay (p-0.0001).

0.0001) while the difference in between mean operating time and mean healing time was statistically not significant. (p- 0.83 and p-0.64 respectively)

Functionally mean AOFAS score was 88.24 ± 5.19 in IMN and 86.96 ± 6.9 in MIPO group but the difference was not statistically significant (p -0.78)

Complications (Table 3) included malalignment, infection, non-union, and delayed union. One patient in MIPO group in which fibular osteotomy was done developed valgus deformity Although the malalignment was higher in MIPO group (15.3%) as compared to IMN group (12%) but the difference was not statistically significant (p-0.36). Incidence of Infection was higher in the MIPO group (11.5%) as compared to IMN group (4%). Two out of three cases of infection in MIPO group and one case in IMN group were open grade 1 wound. Statistical analysis showed that there was no significant difference in incidence of infection in between the groups. Non-union and delayed union were almost similar in between the two groups and there was no significant difference. Resurgeries were more common in MIPO group (15.3%) as compared to IMN group (12%). There was no significant difference (p-0.36) in the incidence of resurgeries in between the groups.

A total of 13 cases in IMN group required the use of poller screws. In seven out of 13 cases, poller screws were used in the first surgery to provide stability to the fracture site. In four patients they were used intraoperatively as an aid to reduction. Two cases (one of type 43A1 and A2 each) required addition of poller screws in second surgery at eight weeks interval, to prevent the progression of delayed union. The fracture subsequently healed in next 12 weeks.

Discussion

The fixation of fibula in distal tibia fibula fractures is controversial. Teitz, C.C et al(22) concluded that when the fibula remains intact, a tibiofibular length discrepancy develops and causes altered strain patterns in the tibia and fibula. These may lead to delayed union or non-union of the tibia with the sequelae of joint disturbances.

There are several reports that recommend plating concomitant fibular fractures in distal tibial fractures in order to achieve increased stability and reduce the risk of primary or secondary malalignment(11). Strauss et al(23) concluded that an intact fibula in the presence of a distal tibia fracture improved the fracture fixation stability for both treatment methods. In fracture patterns in which the fibula cannot be effectively stabilized, locked plates offer improved mechanical stability when compared with locked intramedullary nails. They also concluded that if fibula is fractured at same level the mechanical stability of both the groups' decreases, IMN in particular.

Taylor et al(24) concluded that addition of fibular fixation does not affect whether or not alignment is maintained in either the immediate post-operative or short-term follow-up period.

In our series, in MIPO group, 24 patients had fibula fracture, 19 fractures were fixed. Rest of the fibular fractures were in proximal two-third portion of the fibula or it was intact.

In one case where fibular osteotomy was done, patient develop post-operative valgus deformity on follow ups This valgus deformity was thought to be the caused by the collapse at the fracture site due to unsupported distal lateral wall. Although it showed some signs of delayed union but eventually the fracture united. This delayed union might be

caused because of the ineffective compression achieved by screw which acts mostly as a neutralization screw rather than lag screw.(15, 18).

Further it was observed that in cases in which fibula was fixed, none developed deformity.

In IMN group, 16 patients had fibula fracture in the distal one-third and all were fixed. Most studies suggest that fibula fixation improves the result in IMN group but this study suggest that it might improve the results in MIPO group also. In spite of small sample size and multiple confounding factors such as both elastic nail and plate were used for fixation that might affect the outcome differently, the observation of valgus deformity in MIPO group after fibular osteotomy creates a controversy for doing fibular osteotomy in simple fractures and the need for fibular stability in this group.

MIPO has gained popularity with the development of LCP. Closed IMN is another less invasive method which spares the extra osseous blood supply, allows load-sharing and avoids extensive soft-tissue dissection(4, 7). There are not much prospective studies in which the results of MIPO are compared with those of IMN. Guo et al (7) a randomized control trial, compared both methods in 111 patients. They concluded that both closed IMN and LCP with MIPO can be used safely to treat OTA type-43A fractures. Closed nailing has the advantage of shortened operating and radiation time and ease of removal of hardware. A randomized pilot trial done by C.Mauffrey (9) suggests that there may be clinically relevant, functional differences in patients treated with nail versus locking-plate fixation for fractures of the distal tibia and differences in related complications.

The use of poller screws has been studied in detail by Krettek et al.(26). He advocated the use of poller screws on the concave side of deformity to achieve reduction, and screws on both sides of the nail in proximal and distal fragment, to achieve stability. This method of placing the poller screws on both sides of the nail in proximal and distal fragment effectively narrows the diameter of medullary canal, thereby providing the stability.

The current authors have used the above described technique of poller screw insertion and has got successful results in preventing delayed union. The use of poller screw in fresh fracture has not been studied in the present study and is limited by the varied fracture configuration as a confounding factor.

The main limitation of this study is small sample size in each group and short follow up time. Long term effects of the deformity at the fracture site on the nearby ankle joint has to be considered in further follow ups.

Conclusion

Our results indicates that both MIPO and IMN can be safely used to treat extra-articular distal tibia fracture. It mainly depends on the surgeon's confidence and his level of expertise. Closed

Nailing has the advantage of significantly shorter duration of mean hospital stay. Although complication rates are similar in both the groups, all authors preferred IMN for extraarticular type 43A distal tibia fracture provided at least two locking screws can be inserted distally. The fibula fracture, if in distal third should be fixed as it aids in tibia reduction and imparts additional stability to the fixation. The role of fibular osteotomy in simple distal tibia fractures remains controversial and demands further studies. The use of poller screws definitely helps in prevention of delayed union.

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Conflict of Interest: NIL
Source of Support: NIL

How to Cite this Article

Malve SP, Arora N, Kulkarni SG, Gehlot H, Mallikarjun, Garg D. Comparison of surgical management of extra-articular distal tibia fractures treated with closed intramedullary nailing and minimally invasive percutaneous plate osteosynthesis- a prospective study. Journal of Trauma and Orthopaedic Surgery.Jan - March 2017;12(1):7-11.