

Comparative Study of Interlocking Intramedullary Nailing and Plating in Distal Third Tibial Fracture

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ABSTRACT

Introduction: At present, there has been a great controversy on the ideal surgical management for distal tibia fracture. The present study was thus planned to evaluate the radiological union, functional outcome, and associated complications in adults with distal third tibial fractures, fixed internally using plating or interlocking intramedullary nailing (IMN). **Materials and Methods:** Forty patients were included in study and divided into two groups (20 each) after explaining the patients about advantages and disadvantages of both operative techniques, Group A (plating) Group B (IMN). Partial weight bearing was advised and full weight bearing was allowed after the appearance of calcified callus. Patients were then followed up at 6 weeks, 3 months, 6 months, and 9 months of surgery. **Results:** In our study, there is no significant statistical difference in criteria such as operative time, hospital stay but IMN group was associated with early weight bearing and union rate, lesser incidence of infection, and failure. **Conclusion:** Both procedures have shown a reliable method of fixation in distal third tibial fracture but intramedullary fixation preferable choice for fixation of extra-articular distal tibial fractures.

Key words: Distal tibia fractures, interlocking nailing, locking plate

INTRODUCTION

Tibia is the major weight bearing bone of the leg. It is the most commonly fractured long bone in the body with an annual incidence of 2/1000 individuals. Tibial fractures can cause a long morbidity and extensive disability unless treatment is appropriate.^[1]

Distal tibial metaphyseal fractures of AO type 43A1, 43A2, and 43A3 are particularly prone for union and non-union because of its precarious blood supply.^[2]

The mechanism of injury and prognosis for distal third metaphyseal tibia fractures different from pilon fractures and their proximity to ankle joint makes surgical treatment complicated.^[3] Most of these fractures are associated with fracture displacement, comminution, and injury to soft-tissue envelope.^[4] Distal tibia fractures can be managed with the help of conservative or operative techniques.

At present, surgeons have a variety of options and implants in their armamentarium for the treatment of these fractures. The newer techniques include external fixator, conventional open reduction and plating, minimally invasive percutaneous plate osteosynthesis (MIPO), and intramedullary nailing (IMN) which are well accepted and effective methods.^[5]

Precise reduction of articular fragments is achieved with open reduction and internal fixation (ORIF) and this method was traditionally used for surgical treatment; however, unfortunately it resulted in

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significant soft-tissue stripping. Many authors reported a high incidence of complications such as delayed union, non-union, and infection.^[6] The MIPO technique has recently been recognized as an alternative technique that enables indirect reduction and stable fixation with minimal biological footprint.^[5] When applied subcutaneously, locking compression plate does not endanger periosteal blood supply, respect fracture hematoma and also provides bio mechanically stable construct. IMN is the gold standard for tibial diaphyseal fractures. It has a small influence on the blood supply of the host tissue, which would contribute to a low rate of non-union and infection.^[7]

Initially, the extreme high malunion rate and poor function prevented orthopedic surgeons from using IMN for distal tibia fractures. With the emerging shortened and multidirectional interlocking nail, for example, expert tibia nail^[8,9] and evolving reduction techniques, for example, blocking screw or poller screw^[10] and other percutaneous reduction technique,^[11] the interest in interlocking nail in distal tibia fractures has been renewed.

At present, there has been a great controversy on the ideal surgical management for distal tibia fracture. A large amount of studies have compared IMN with plating but the results have been controversial and they have failed to show the superiority of one over another. Management of fractured tibia requires the widest experience, greatest wisdom, and best of clinical judgment to choose most appropriate treatment for a particular pattern of injury.^[12] The present study was thus planned to evaluate the radiological union, functional outcome, and associated complications in adults with distal third tibial fractures, fixed internally using plating, or interlocking IMN.

MATERIALS AND METHODS

A total of 40 subjects with extra-articular distal third tibia fractures presenting in casualty of BSTRH Hospital, Talegaon Dabhade, Pune, were chosen for prospective comparative cohort study. Consents were taken from the patients and ethical committee of the hospital for conducting comparative study between the two methods of fracture fixations. Patients were divided into one of the following two groups (20 each) after explaining the patients about advantages and disadvantages of both operative techniques.

- Group A – Plating
- Group B – IMN.

Patients with either gender with age of >18 years, having a closed or type I open fracture of the distal third of the tibial diaphysis treated with either plating

[Figure 1] or nailing [Figure 2]. Exclusion criteria were earlier fracture of tibial shaft on the same side, proximal intra articular or distal intra articular fractures of the tibia, fractures within 5 cm of ankle joint, temporary treatment with an external fixator and patients with pathological fractures.

All surgeries were performed by the same senior surgeon. One hour preoperatively all patients received intravenous third generation cephalosporins combination with intravenous aminoglycoside. Fibula was fixed first with either 3.5 mm one-third semi tubular plate or an elastic nail and its fixation was independent of tibial method of fixation.

Drain (if any) was removed the next day. Appropriate post-operative X-ray – anteroposterior and Lateral view were taken. Physiotherapy was started from the 2nd day of the surgery while sutures were removed on day 12 or depending on the conditions of wound. Prophylactic antibiotics were given to all cases for 7 days.

On first follow-up after 3 weeks of surgery, patient was advised X-ray to evaluate the union and callus formation. Partial weight bearing was advised and full weight bearing was allowed after the appearance of calcified callus. Patients were then followed up at 6 weeks, 3 months, 6 months, and 9 months of surgery for range of motion, pain, power, deformity, limb length measurements, clinical and radiological signs of union (X-ray), gait analysis, patient satisfaction, or any other complaints/findings.

Functional outcome was measured at 9 months by scoring system using American Orthopaedic Foot and Ankle surgery (AOFAS) score.

The quantitative data were represented as their mean \pm SD. Categorical and nominal data were expressed in percentage. Paired *t*-test was used for analyzing quantitative data, or else non-parametric data were analyzed by Wilcoxon sign rank test. The significance threshold of *P*-value was set at <0.05. All analyses were carried out using SPSS software version 21.

RESULTS

Majority of the patients were between the age group of 31 and 40 years of age in both group (62.5%).

Mean age of plating and nailing group was 37.6 and 38.9 years, respectively, (*P* = 0.71) with mean age of study groups as 38.25 years.

Out of total 40 cases, 33 (82.5%) were males while 7 (17.5%) were females. Mean time for fracture union was significantly shorter in nailing group as compared to plating (19.20 vs. 23.8 weeks; *P* < 0.01).

Mean duration of hospital stay was comparable in both nailing and plating group, respectively (4.79 vs. 6.12 days; $P = 0.19$).

Weight bearing was started by 8–10 weeks in 60% and 65% cases of plating and nailing group, respectively. While in 35% and 30% cases, it was started by 10–12 weeks ($P = 0.94$).

Malalignment and non-union were reported in 10% and 5% cases each while superficial infections and delayed union was reported in 10% cases each of plating as compared to 5% cases each in nailing group.

Re-operation rate was 15% in plating while it was 10% in nailing group, respectively. Overall, there was no difference in complication rate ($P > 0.05$).

As per AOFAS score, excellent to good outcome was reported in 90% cases of nailing as compared to 85% cases of plating. Poor outcome was reported in 15% cases in plating as compared to 10% in nailing group. The difference was statistically non-significant ($P = 0.59$).

DISCUSSION

Extra-articular distal tibial fracture is presented to the orthopedician, often pose a challenge to the surgeon as status of soft tissue and degree of comminution itself complicates the plan of management. The goal of operative treatment is to obtain anatomical alignment of the joint surface while providing enough stability to allow early motion. This should be accomplished using techniques that minimize osseous and soft-tissue devascularization in the hope of decreasing the complications resulting from treatment.

For years now, IMN had an advantage over other methods because of its early weight bearing and union rate and lesser incidence of infections.

With the development of minimally invasive surgery, percutaneous plating has challenged interlocking nailing as locked plate designs act as fixed-angle devices whose stability is provided by the axial and angular stability at the screw-plate interface instead of relying on the frictional force between the plate and bone, which is thought to preserve the periosteal blood supply around the fracture site.^[13]

Majority of the patients were between the age group of 31 and 40 years of age in both group (62.5%). Mean age of plating and nailing group was 37.6 and 38.9 years, respectively, ($P = 0.71$) with mean age of study groups as 38.25 years. Out of total 40 cases, 33 (82.5%) were males while 7 (17.5%) were females.

In a similar study by Daolagupu *et al.*,^[14] the patients were in the range of 19–59 years, with mean age being

37.14 years. Of the 42 patients, 32 were males and ten were females. Predominant male involvement in our study was probably due to more outdoor activities and heavier labor undertaken by males as compared to females in the Indian set up. The demographic results of present study were also comparable to that of Baral and Raj,^[15] Yu *et al.*,^[16] Sun *et al.*,^[17] Costa *et al.*,^[18] and Solanki *et al.*^[19]

In the present study, road traffic accident was the most common mode of injury (87.5%) followed by fall from height (12.5%).

Kumar *et al.*^[20] studied 52 patients with distal tibia fracture treated by surgery. The mode of injury was road traffic injury in 32 (61.5%) cases, followed by self-fall in 17 cases (32.6%). Solanki *et al.*^[19] studied 50 patients with distal tibia fractures. Most common mode of trauma in both groups was road traffic accident (60%) followed by domestic accidents (40%).

Similar pattern was also observed by Daolagupu *et al.*,^[14] Sun *et al.*,^[17] Costa *et al.*,^[18] and Solanki *et al.*^[19] who also showed that RTA is the most common mode of injury.

In the present study, mean operating time was comparable between both nailing and plating (95.04 vs. 97.90 min; $P = 0.83$).

Kumar *et al.*^[20] in their study observed average duration of surgery in nailing group as 88 min (range, 65–130 min) whereas average duration of surgery in plating group as 92 min (range, 70–130 min). Daolagupu *et al.*^[14] in their study reported the operating time in the IMN group ranged from 45 to 70 min (mean 57.14 ± 8.30 min), while in case of lock plate it ranged from 60 to 80 min (mean 66.67 ± 5.55 min). The difference was statistically not significant in both the studies. Similar observations were also made by Guo *et al.*,^[21] Li *et al.*,^[22] Pawar *et al.*,^[23] and Yao *et al.*^[24]

Mean duration of hospital stay was comparable in both nailing and plating group, respectively (4.79 vs. 6.12 days; $P = 0.19$).

Yu *et al.*^[16] in their meta-analysis concluded that for distal tibial fractures treatment, IMN and Plating are comparable with respect to operation time and hospital stay. Sun *et al.*^[17] in another systemic review also concluded that there was no significant difference between the two treatment modalities with respect to hospital stay, after the treatment. Similar observations were also made by Guo *et al.*,^[21] Pawar *et al.*,^[23] and Yao *et al.*^[24]

Weight bearing was started by 8–10 weeks in 60% and 65% cases of plating and nailing group, respectively. While in 35% and 30% cases, it was started by 10–12 weeks ($P = 0.94$). Mean time for fracture union was significantly shorter in nailing group as compared

to plating (19.20 vs. 23.8 weeks; $P < 0.01$). Our study showed that IMN led to faster average time for union compared to lock plate.

Daolagupu *et al.*^[14] in their study reported average time for full weight bearing as 10.09 ± 1.41 weeks in intramedullary interlocking nailing (IMIL) and 13.38 ± 1.24 weeks in plating group. The average time of union in the IMIL group was 18.26 ± 2.49 weeks (range 15–24 weeks). In the plating group, union occurred in an average of 21.70 ± 2.67 weeks (range 16–24 weeks). The statistical difference between the two groups comes out to be very significant ($P < 0.0001$). Solanki *et al.*^[19]



Figure 1: X-ray of distal tibia fractures operated with plating

reported the average time for union as 19.1 weeks (19–22 weeks) in Nailing group and 23.8 weeks for plating group (22–30 weeks), ($P = 0.001$).

Kumar *et al.*^[20] in their study observed average time for union as 16 weeks for nailing group and for plating group it was 18 weeks ($P = 0.04$). Similar observations were also made by Guo *et al.*,^[21] Li *et al.*,^[22] Pawar *et al.*,^[23] and Yao *et al.*^[24]

Malalignment and non-union were reported in 10% and 5% cases each while superficial infections and delayed union was reported in 10% cases each of plating as compared to 5% cases each in nailing group. Re-operation rate was 15% in plating while it was 10% in nailing group, respectively.

In the study by Daolagupu *et al.*^[14] observed that complication rate was comparable among the two groups in regards with delayed union, malalignment, knee, and ankle stiffness. However, a higher rate of infection (n-4 vs. n-2) was found in plating patients. Mauffrey *et al.*^[25] in their study observed similar complication rate, but a higher re-operation rate with plating. In a Cohort study done by Barcak *et al.*,^[26] 86 patients treated with either plating or IMN were compared clinically and radio graphically. Complications including malalignment, non- union, and infection rates were also similar between the two groups. Mao *et al.*,^[27] a systematic review suggests that both IMN



Figure 2: X-ray of distal tibia fractures operated with interlocking intramedullary nailing

and Plating had similar complication rate; however, IMN shows lower rate of superficial infections. Solanki *et al.*^[19] observed higher infection rate (28% vs. 12%) in patients of plating group with 12% of patients undergoing secondary surgical procedure as compared to 4% in nailing group. Baral and Raj^[15] in a similar study as ours, reported that delayed union ($P = 0.549$), non-union ($P = 0.311$), infection ($P = 0.549$), malunion ($P = 0.147$), amputation ($P = 0.311$), secondary intervention ($P = 0.116$), and foot function index ($P = 0.217$) were all similar between the groups. Sun *et al.*^[17] in another systemic review concluded that there was no significant difference of secondary operations, delayed wound healing and knee pain after the treatment of plate fixation and IMN.

As per AOFAS score, excellent to good outcome was reported in 90% cases of nailing as compared to 85% cases of plating. Poor outcome was reported in 15% cases in plating as compared to 10% in nailing group. The difference was statistically non-significant ($P = 0.59$).

Soni *et al.*^[28] observed that in patients of nailing group, 73.33% had excellent results, 13.33% had good, and 13.33% had poor results as per AOFAS scoring while in patients of plating group, 60% had excellent results, 20% had good, and 20% had fair results. The difference was statistically non-significant between the groups. In the study by Daolagupu *et al.*,^[14] functional results were assessed by Johner and Wruh's criteria. Results showed that majority (54.76%) of the patients in the study had excellent functional results (IMLN: 57.14%; and PLATING: 52.38%) and 21.42% had good results (IMLN: 14.28%; and PLATING: 28.57%). Using Chi-square test, these differences were not found to be statistically significant ($P = 0.6723$). Baral and Raj^[15] in their study also compared the functional outcome between IMIL and MIPO (PLATING). The study suggests that similar outcomes appear through IMIL nail and PLATING of distal extra-articular tibia fractures. Yu *et al.*^[16] and Sun *et al.*^[17] in their systemic reviews reported that there is no difference between the two treatment modalities with respect to the function outcome over a follow-up period of 1 year.

CONCLUSION

Both procedures have shown a reliable method of fixation and preserving most of the osseous vascularity, fracture hematoma which provide biological repair and can be used safely to treat distal metaphyseal fractures of the tibia. In our study, IMN group was associated with early weight bearing and union rate, lesser incidence of infection and failure which makes it a preferable choice

for fixation of extra-articular distal tibial fractures. The decision to fix the fibula was based on intraoperative reduction of tibia fracture. If significant malalignment was still persisting after fixation of tibia, only then the decision to fix fibula fracture was made. Thus, we do not recommend fibular fixation routinely because the essential benefit of closed IMN and plating in the avoidance of soft tissue dissection might be compromised in this way and also reduces strain over the tibial fracture, which heightens the potential for delayed healing or nonunion but to support this, larger trials are needed.

Limitations of Our Study

We acknowledge that with more number of cases in this study, the results and observations would have been more accurate and statistically significant. Number of the patient, duration and follow-up of our study was shorter due to limited time period. We think more time is required for proper assessment of final clinical and functional outcome. An RCT, possibly triple blinded or at least double blinded in nature, involving a large number of patients with long-term follow-up is clearly needed to bring the differences between the two techniques.

Mean time for fracture union was significantly shorter in nailing group as compared to plating (19.20 vs. 23.8 weeks; $P < 0.01$).

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Uqwt eg'qhlUwr r qt v<Nil. Eqphle w'qhlkpvgt guv<None declared.

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