A Comparative Study of Distal Tibia Metaphyseal Fractures in a Series of 50 Patients: Intramedullary Nailing (IMN) Vs Minimally Invasive Plate Osteosynthesis (MIPO)

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Abstract

Introduction: Multiple treatment modalities have been described for distal tibia metaphyseal fractures but there is no consensus regarding optimal treatment. The purpose of this study was to compare the management of these fractures by intramedullary nailing (IMN) and minimally invasive plate osteosynthesis (MIPO) technique by assessing the functional and radiological outcomes and complications.

Methods: 50 patients having distal tibia fractures were studied and divided into two equal groups of IMN and MIPO with a follow-up period of one year. Functional assessment was done using SF-36, LEFS and VAS scores; radiological assessment was done by evaluating the union type and radiological deformity, and complications in both procedures were studied. Various fracture patterns were also considered.

Results: SF-36 showed no statistical significance with regard to treatment mode and fracture type. LEFS score reduced with increase in complexity of fracture and also indicated that both IMN and MIPO groups regained comparable functional capacity after a year. IMN cases (96%) showed better chances of primary union than MIPO cases (72%), after a year. Varus was found in 16% and valgus in 20% of plating cases. AO Type fractures 43 A1 and 43 A2 were preferably treated with nailing whereas 43 A3, with plating.

Conclusion: While union time is shorter for IMN cases, there is a greater occurrence of deformity in MIPO patients. We concluded that both the techniques can provide a similar return of functional capabilities but as the complexity of the fracture increases, nail becomes difficult to use than a plate.

Keywords: IMN; Distal tibia metaphyseal; MIPO; Distal third tibia fractures.

Introduction

Distal tibia fractures are one of the most common fractures in adults with an incidence of 17 per 1,00,000 person-years [1]. They are common consequences of road traffic accidents, falling injuries or other high-energy trauma [2]. The challenge for any trauma surgeon in these fractures is delayed union or non-union [3].

If the distal tibia fracture is undisplaced, then it can be treated conservatively with reduction and above knee cast. Those fractures which need surgical intervention can be treated with intramedullary nailing (IMN), plating or external fixators. Indications for IMN in distal tibia fractures are elderly patients with thin skin, distal bone mass allowing insertion of two screws and patients with high risk of non-healing wound [4]. Plating is done when there is risk of malalignment and when IMN is not possible [4].

The IMN spares the extraosseous blood supply, thus contributing to low rate of infection and nonunion, allows load sharing and avoids extensive soft tissue dissection [5,6] but there are concerns regarding difficulties with reduction, anterior knee pain, implant failure and malunion [7]. Minimally Invasive Plate Osteosynthesis (MIPO) offers adequate fixation in a biological manner [8,9,10]. MIPO is technically demanding but has an advantage of minimal damage to the soft tissues and periosteal stripping. It preserves blood supply, thereby providing better conditions for fracture healing with callus. It also maintains axial alignment and is rotationally stable [11].

At present, there is no consensus regarding the preferred surgical option for distal tibia metaphyseal fractures with several studies being published focusing on various methods of treatment of these fractures [12-17]. The purpose of this study was to compare the management of these fractures by IMN and MIPO by assessing the radiological and functional outcomes and complications.

Material and methods

This study was done to evaluate and compare the outcomes of distal tibia metaphyseal fractures operated with IMN and MIPO in a tertiary care hospital. It was a prospective study carried out between October 2016 and October 2017. Approval of the Institutional Ethics Committee was obtained prior to the study.

Inclusion criteria were: age above 18 years, traumatic distal tibia metaphyseal fracture [18] and AO/OTA type 43 - A1, A2, A3) and compound injury of Gustilo Anderson type 1 & type 2.

The exclusion criteria were: an injury with a neurovascular deficit, association with other co-morbidities which affect the functional outcome (e.g.- head injury and injury of ipsilateral upper limb), pathological fractures and intra-articular fractures (AO/OTA type 43 - B & 43 - C).

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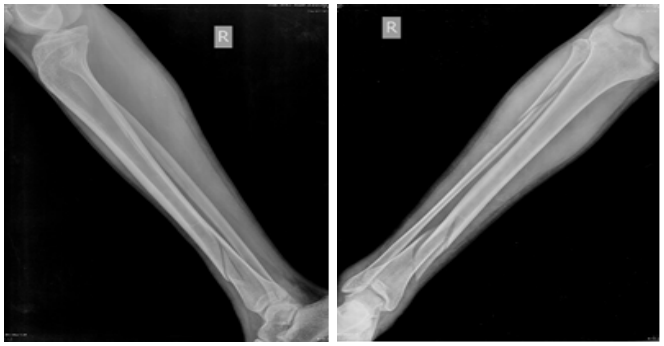

Figure 1: preoperative xray 40 yr female

Figure 2: Immediate post op x-ray operated with anterolateral plate

A thorough history was taken regarding the mode of injury, time since injury, any significant past or personal history and the same was documented on patient's arrival. Special attention was given to whether the fracture is open or closed and was classified according to the Gustilo Anderson classification for compound injuries. The diagnosis was confirmed by anteroposterior (AP) and lateral radiographs of the complete tibia including the knee and ankle joints. The fracture was stabilized by putting an above knee slab to the patient. Routine blood investigations were done as necessary. Physician and anaesthetist fitness were done for all the patients and cardiac fitness was done for those indicated. All the patients were counseled and explained regarding the surgical procedure and its need. Written and informed consents were taken from all. The patient underwent surgery once the skin condition was good and the swelling was within acceptable limits.

Three of the authors were the operating surgeons in this study. The mode of treatment (IMN or MIPO) was the surgeon's decision. 50 patients were studied, 25 of which underwent IMN and 25 underwent MIPO. The patients were given spinal anaesthesia. All cases of IMN were done by closed reduction using the patellar tendon splitting approach. Postoperatively no immobilization of the limb was done, only Gamjee roll and crepe bandage dressing was applied which was removed on postoperative day 2 along with the drain removal. IV antibiotics and analgesics were given for a period of 3 days after surgery and then shifted to oral medications. Sterile dressing of the surgical wound was done regularly and the sutures were removed between 11th-15th day post-operatively. Knee and ankle range of motion (ROM) exercises were started on the next day of surgery. The patient was made to walk non-weight bearing with either walker or crutch support till further advice.

Patients were called for follow-up at 1 month, 3 months, 6 months & 1 year and were evaluated clinically and radiologically. Functional assessment was done by SF-36 health survey, Lower Extremity Functional Scale (LEFS) and Visual Analogue Scale (VAS). The weight bearing was restricted till x-ray showed callus formation. At 6 weeks, AP and lateral x-rays were taken and signs of fracture union were checked. If the healing process was found to be satisfactory then the patient was advised to walk partial (25%) weight bearing with walker or crutch support for 2 weeks. Every 2 weeks, 25% weight bearing was increased gradually leading to full weight bearing by the 3 month follow-up. At 1 year, progress in terms of activities of daily routine like squatting, sitting cross-legged, etc. were checked. Follow-up x-rays were done at every visit to check for fracture union, the condition of the implant and any valgus or varus deformity of the distal part of the tibia.

Radiographic union was defined as 'radiographic' evidence of bridging cortical bone on at least 3 cortices. The types of union seen were primary, delayed or non-union. Delayed union was defined as healing that took longer than 6 months [19] while non-union was defined as no healing progress since 3 months in a total duration of 9 months [20]. Malalignment of the distal tibia was defined as more than 5° of varus / valgus angulation of distal tibia fragment from the axis of the proximal tibia segment [19].

The varus/valgus angle between the distal segment and the proximal part of the tibia was determined by measuring the angle between the line through the centre of tibia plateau down the middle of the proximal segment and the line from the centre of ankle up the middle of distal shaft in an anteroposterior X-ray view [21]. The measurement was done at 1 year follow-up after complete union of the fracture.

The mean age in our study was 42.7 ± 14.4 years. 23 patients (46%) included in the study were in the age group bracket of 31-50 years, 16 patients (32%) in the age group of above 50 years and 11 of the remaining patients (22%) were below 30 years. 38(76%) out of 50 were males and 12(24%) were females. Out of the 50 patients, 54% (27 cases) sustained injuries by road traffic accidents (RTA) while the rest of 46% (23 cases) had domestic injuries like slip and fall while walking, trauma to the leg, fall from height or assault. The mean time since injury (i.e. the time interval between injury and our hospital visit) for nailing cases was 7.3 hours while for the plating cases it was 27.2 hours.

Data analysis was done by using SPSS (Statistical Package for Social Sciences) version 20.0. The varus/valgus angles were measured using the MicroDicom Viewer software package. Qualitative data variables were expressed by using Frequency and Percentage (%) whereas quantitative data variables were expressed by using Mean, Standard Deviation (SD), Median etc. Chi-square test, Fisher's exact test, Unpaired t-test, Mann-Whitney U test and ANOVA test were the various tests used. The p-value < 0.05 was considered as significant.

Figure 3: follow up xray

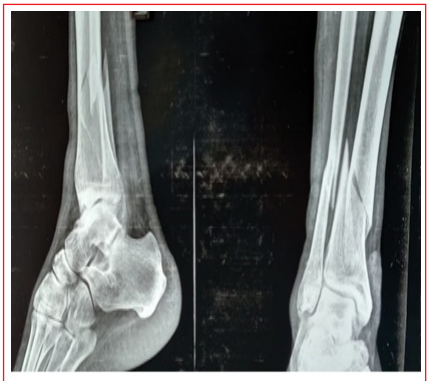

Figure 4: 30 yr male, preoperative x-ray

Figure 5: immediate post -operative x-ray- operated with intramedullary nail for tibia and fibula

Figure 6: follow up xray healed fracture

Results

The time duration between injury and procedure for nailing cases was 23.5 ± 13.8 hours (0.5 – 28 hours) whereas for plating cases it was 63.0 ± 75.2 hours (0.5 – 240 hours). This data was statistically significant (p-value 0.008). There were 2 patients of IMN group and 3 patients of MIPO group which presented in our hospital after 24 hours of their injury, hence leading to a drastic increase in the standard deviation. Mann-Whitney U test was applied so as to keep into consideration these 5 cases.

There were 26 patients (52%) of AO Type 43 A1 of which 18 underwent nailing and 8 underwent plating. 6 patients (12%) belonged to the Type 43 A2, 4 amongst them were treated with nailing and 2 with plating. 18 patients (36%) were of the Type 43 A3, 15 of them were managed by plating and 3 by nailing. This data was statistically significant (p-value 0.001).

The study of ankle ROM as per procedure (Table 1) and as per fracture type (Table 2) is given below:

The knee flexion in the nailing group was 121.4° ± 6.8° while in the plating group it was 123.8° ± 7.1°. The knee extension in the nailing group was 1.2° ± 3.6° while in the plating group it was 0.8° ± 2.8°. This data was statistically not significant for both flexion (p-value 0.230) and extension (p-value 0.663).

The median VAS score for knee pain at 1 month, 3 months, 6 months and 12 months in the nailing group was 5, 4, 1 and 0 respectively whereas it was 0 for all follow-ups in the plating group. On evaluating this data, statistical significance was found in follow-ups up to 6 months (p-values < 0.05) but not at the end of 1 year (p-value 0.286). The median VAS score for ankle pain at 1 month, 3 months, 6 months and 12 months in the nailing group was 7, 5, 2 and 0 respectively whereas it was 7, 5, 2, and 1 for the respective follow-ups in the plating group. This data was not statistically significant (p-values > 0.05).

On radiological evaluation, 84% (42 cases) of all the 50 cases underwent primary union, 14% (7 cases) had delayed union while 2% (1 case) went into non-union. Primary union occurred in 96% of the cases (24 patients) treated with nailing while those treated with plating had 72% of cases (18 patients) undergoing primary union. Delayed union was seen in 4% of nailing cases (1 patient) and 24% of plating cases (6 patients) whereas 4% of plating cases (1 patient) went into non-union at the end of 1 year while those treated with nailing showed no evidence of non-union in our study. This data was statistically significant (p-value 0.048). When we compared the type of union with the fracture type, the results showed that 96% (25 out of 26 cases) of the AO type 43 A1, 67% (4 out of 6 cases) of the type 43 A2 and 72% (13 out of 18 cases) of the type 43 A3 had a primary union. The incidence of delayed union was more in type 43 A3 (4 cases) than in type 43 A1 (1 case) and type 43 A2 (2 cases). Non-union was seen in only 1 case of type 43 A3 fracture amongst all the 50 cases. This data was statistically not significant (p-value 0.129).

Evaluation of the radiological deformities showed that varus was found in 4 cases (16%) of plating and valgus in 3 cases (12%) of nailing and 5 cases (20%) of plating. This data was statistically non-significant (p-value 0.091). 19% (5 cases) of AO type 43 A1 had valgus deformity, 17% (1 case) of type 43 A2 had valgus deformity while 22% (4 cases) of type 43 A3 had varus deformity and 11% (2 cases) of type 43 A3 had valgus deformity. This data was statistically non-significant (p-value 0.120).

The LEFS value for nailing group was 65 ± 6.6 whereas for plating group it was 63.6 ± 6.7. This data was statistically not significant (p-value 0.447). As per the type of fracture, AO type 43 A1 had a mean of 65.85 ± 5.69, type 43 A2 had a mean of 64.72 ± 6.29 and type 43 A3 had a mean of 56.50 ± 6.80 at the end of 12 months. This data was statistically significant (p-value 0.005).

When nailing and plating groups were compared, none of the 8 components of SF-36 scoring system showed any statistically significant data. When the comparison of SF-36 was done as per the fracture type, only one component of physical role limitation showed statistical significance (p-value 0.04).

16% of the nailing cases (4 patients) underwent an additional procedure apart from their primary surgery whereas 20% of plating cases (5 patients) underwent a second surgery. Hence a total of 18% of the cases (9 patients) in this study had an additional procedure done. This data was not statistically significant (p-value 0.999).

Table 1: Comparison of ankle ROM as per procedure

Ankle ROM (Unpaired t-test)	Nailing	Plating	p-value
Dorsiflexion	24.8° ± 4.4°	25.2° ± 4.9°	0.763
Plantar Flexion	38.6° ± 4.5°	37.6° ± 5.4°	0.48

Table 2. Comparison of ankle ROM as per fracture type

Ankle ROM at 12 months (ANOVA test)			
Fracture Type	N	Dorsiflexion (p-value 0.651)	Plantar flexion (p-value 0.027)
43 A1	26	25.19° ± 4.12°	39.81° ± 4.35°
43 A2	6	23.33° ± 4.08°	37.50° ± 4.18°
43 A3	18	25.28° ± 5.55°	35.83° ± 5.22°
Overall	50	25° ± 4.63°	38.10° ± 4.94°

Discussion

In our study, majority of the cases belonged to the AO Type 43 A1 and 69% amongst them underwent IMN. Next most common type was AO Type 43 A3 and 83% of them were operated with MIPO. 66% of the AO Type 43 A2 underwent IMN. After statistical analysis we can state that as the complexity of the fracture pattern increases, plating is a preferred mode of treatment as compared to nailing. IMN is a good option for simple fractures.

Both IMN and MIPO showed comparable results with respect to the

ankle movements. In a study by Im GI et al. [20] average dorsiflexion at final follow-up in nailing group was 14° and 7° in the plating group, which was statistically significant (p-value 0.001). Mudgal Ashwani et al. [22] stated ankle stiffness as the main complication in these fractures. At the end of 1 year, the dorsiflexion in various fracture types achieved similar functions but not the plantar flexion, with AO Type 43 A1 having maximum plantar flexion movement and Type 43 A3 showing the least. The knee ROM, on the other hand, showed similar results after one year in both the modalities.

The anterior knee pain post-operatively was found only in the nailing group and not in the plating group because of the obvious absence of any surgical involvement around the knee in MIPO. The ankle pain was comparable for both nailing and plating and in both the groups the pain at the end of 1 year was almost negligible.

Primary union is the most common form of union in these fractures. IMN showed a better chance of having a primary union as compared to MIPO at the end of 1 year. There was only one case in our study of AO type 43 A3, which went into non-union and it was primarily operated with MIPO. There was no significant correlation between the type of union and type of fracture. In a similar study, Kasper W. et al. [23] observed 2 cases (16.7%) of delayed union with plating. Sean et al. [5] in his series found 19.44% of delayed union, 11% united after dynamization and 8% required open bone grafting. None of the patients in the nailing group required dynamization in our study.

There was more occurrence of deformity in MIPO than with ILN patients. Various fracture types however showed no significant correlation with respect to radiological deformity.

Comparable data on LEFS meant that both nailing and plating have a good functional outcome at the end of 1 year. When we evaluated LEFS as per the type of fracture, we analyzed that as the complexity of fracture increased the LEFS score decreased. When SF-36 scores were evaluated it showed that both the treatment options led to a good return of functions after one year. When the comparison of SF-36 was done as per the fracture classification, then only one component of physical role limitation showed statistical significance (p-value 0.04). This meant that all aspects of physical, mental and social well-being of a patient, returns to normalcy after a year in all the fracture types.

The reasons for a second surgery in the plating group was non-union in one, infection and discharge from wound in one, implant failure and re-fracture in one, wound infection with exposed plate in one and patient demand of implant removal in one. Implant removal was done for 4 cases of nailing group for reasons like occasional knee pain in 3 patients and 1 patient wanted the foreign body (i.e. nail) removed. To sum it up there were more complications associated with the plating group as compared to that of the nailing cases. Krzysztof Piatkowski et.al. [24] in their study of 45 patients observed late infection reaching the metal implant in five patients (11.1%). Failure of implant in IMN is a reported complication in distal tibia fractures. Robinson et al. [25] had 1 failure of nail in their study. In our study there was no case of implant failure.

Conclusion

As the complexity of the fracture increases, plating is preferred over nailing and functionally the LEFS scores reduce as well. SF-36, on the other hand, showed that both nailing and plating have equally good results after a period of 1 year. So we can state that IMN is a good option for simple fractures and MIPO is a good option for complex fractures.

Radiologically, nailing showed a better chance of having a primary union as compared to plating. Varus was more common with IMN and valgus more common with MIPO. We also found that the rate of complications, need of additional surgeries and incidence of infection was higher with MIPO as compared to IMN.

Hence, we can state that both IMN and MIPO have equally good results at the end of 1 year but it may require a longer follow-up period and larger sample size to provide further useful analysis. Due to the lack of clinically significant difference between the two treatment modalities, we conclude that both the techniques can provide a similar return of functional capabilities.

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