

Operative Management of Distal Tibial Extra-articular Fractures – Intramedullary Nail Versus Minimally Invasive Percutaneous Plate Osteosynthesis

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SUMMARY

Background. The ideal treatment of distal tibial extra articular fractures remains controversial. Minimally invasive percutaneous plate osteosynthesis and intramedullary nailing are the two most commonly used methods. We did a prospective randomized controlled study to assess the functional outcome of distal tibial extra articular tibial fractures by comparing these treatment methods.

Material and methods. Sixty patients with distal tibial extra articular fractures were randomly assigned to an IMN (intramedullary nailing) group and a MIPPO (minimally invasive percutaneous plate osteosynthesis) group. All patients were followed up for a period of one year. At final follow-up, clinical and radiological outcome was assessed by foot function index. Malunion, infection, implant removal, time to union and secondary interventions were compared between the two groups. The comparison of continuous variables was performed by using the Student t-test or Mann-Whitney U test in accordance with normality testing. A value of p less than 0.05 was considered statistically significant.

Results. All patients were followed up for a period of one year. Time to callus formation was equal in both groups. There was no non-union in our series. Malunion was more common in the nailing group. The foot function index was similar in both groups.

Conclusion. MIPPO and intramedullary nailing are effective treatment options in the management of distal tibial extra particular fractures, with comparable functional outcomes.

Key words: MIPPO, distal tibia, extra-articular fractures

BACKGROUND

Distal tibial fractures usually occur because of road traffic accidents or other high energy injuries. Complications are usually seen more commonly in these fractures than in mid-third or diaphyseal fractures because of their proximity to the ankle joint and small soft tissue coverage [1]. Intramedullary nailing is standard treatment for tibial diaphyseal fractures but reduction and stable fixation is technically challenging because of the wide medullary canal and small unstable distal fragment. This problem has been overcome to some extent by use of poller screws and new nail designs with screw holes at the tip of the nail and in multidirectional planes [2-5]. Open reduction and internal fixation with plating achieves good osteosynthesis but is usually fraught with soft tissue complications and infection which may lead to non-union. Minimally invasive percutaneous plate osteosynthesis is an advanced and biological technique to avoid soft tissue complications. Moreover, several locking screws can be used distally to achieve ideal fixation and stability in a small distal fragment and the whole construct behaves as an angle stable construct [6]. Currently, both MIPPO and IMN are the two most commonly used methods of treatment in distal tibial fractures, but each has been seen to develop complications historically. Malalignment and knee pain are frequently reported after IMN, whereas wound complications, and implant prominence have been associated with tibial plating in some series. However, which treatment is ideal is still controversial [7-9]. The purpose of this study is to compare the two ideal methods of treatment for distal tibial extra articular fractures.

MATERIAL AND METHODS

This is a prospective randomized study conducted from 2014 to 2016 at a tertiary care orthopedic trauma hospital catering for around 6,000,000 population. During this period we received around 98 patients with distal tibial extra articular fractures. All patients with closed distal tibial extra articular fracture in the age group of 21 to 60 years were included in the study and randomized into two groups. All polytrauma patients, patients with pathological fractures, compound fractures, ipsilateral or contralateral upper limb fractures, pediatric fractures and fractures with intraarticular extension were excluded from the study. Patients who were either lost to follow-up or did not provide their consent for the study were also excluded. This study was carried out in accordance with the ethical standards laid down in the 1964 declaration of Helsinki and its later amendments. Our institution-

al review board approved the study protocol and all patients gave written informed consent prior to their inclusion in their study.

Patients were randomized into two equal groups of 30 patients each by means of permuted randomization. In group I, patients were managed by interlocking intramedullary nailing while in group II, the MIPPO technique was used. Additional fibular fixation was done in patients from both groups depending on the level of a simultaneous fibular fracture. All surgeries were performed by a senior surgeon in order to avoid bias. All surgeries were performed under spinal anesthesia. The timing of surgery was decided on the basis of swelling and soft tissue component. A standard post-operative follow-up protocol was developed. Patients were followed up three weekly till fracture union and then 3 monthly for one year and twice in the year after. Patients were allowed weight bearing when callus was seen in two cortices either on an AP or lateral view. At final follow-up, clinical and radiological examination was done and patients were assessed by the Foot Function Index. Coronal and sagittal alignment was assessed by AP and lateral radiographs. Rotation was assessed clinically by foot-thigh angle and the difference measured by goniometer. Union was defined as consolidation of three or more cortices on radiography and lack of pain on weight bearing without assistance. Malunion was defined as a varus or valgus of more than 5 degrees in the coronal plane and procurvatum or recurvatum greater than 10 degrees in the sagittal plane (lateral x ray) or external or internal rotation of greater than 10 degrees (foot thigh angle). Any complication during the surgery and follow-up period was recorded.

Statistical Analysis

Continuous variables were stated as mean, median and standard deviation. The comparison of continuous variables between independent variables was performed by using the Student t-test or Mann-Whitney U test in accordance with normality testing. A value of p less than 0.05 was considered statistically significant.

RESULTS

A total of 60 patients were included in the study and all patients were followed up for a mean of 1 year. Of the 60 patients, 30 were treated with MIPPO and 30 were treated with interlocking intramedullary nailing. There were 18 female and 42 male patients with a mean age of 37±9.2 years. 16 patients had an associated fibular fracture and intergroup differences were not statistically significant. As per AO/OTA classification, 38 patients had the 42A1, 11 patients had 42A2

Tab. 1. Demographic characteristics

| Parameter | Treatment | | Significance |
|----------------------------|-------------|---------------|-----------------|
| | MIPPO(n=30) | NAILING(n=30) | |
| Age, Years±SD | 38.4±8.7 | 36.4±9.7 | Not significant |
| Sex (M/F) | 20/10 | 22/8 | Not significant |
| Side (R/L) | 18/12 | 16/14 | Not significant |
| Number of patients | 30 | 30 | Not significant |
| Associated fibula fracture | 8 | 6 | Not significant |
| AO/OTA classification | | | |
| 42A1 | 20 | 18 | Not significant |
| 42A2 | 2 | 9 | |
| 42A3 | 8 | 3 | |

Tab. 2. Parameters measured in both groups

| Parameter | Treatment | | Significance |
|------------------------------|-------------|--------------|-----------------|
| | MIPPO(n=30) | ILIMN(n= 30) | |
| Foot function index | 25.4±16.3 | 23.7±7.0 | Not significant |
| Follow-up, in months ± SD | 11.3±5.5 | 11.7±3.5 | Not significant |
| Union time, in days±SD | 134±5.1 | 129.1±13.5 | Not significant |
| Weight bearing time, days±SD | 43.6±20.9 | 37.5±15.8 | Not significant |
| Malunion | 3/30 | 5/30 | Not significant |
| Alignment | | | |
| Coronal plane | 1.8±2.7 | 2.7±2.3 | Not significant |
| Sagittal plane | 1.9±2.1 | 0.9±1.0 | Not significant |
| Rotation | 1.8±4.2 | 7.4±7.0 | P <0.05 |
| Superficial infection | 3 | 0 | Significant |
| Secondary procedures | 3 | 4 | Not significant |

and 11 patients had 42A3 type of fracture and the distribution between the two groups was insignificant. Both groups were comparable as far as other demographic characteristics were concerned (Tab. 1).

The time to callus formation was similar in both the groups; hence weight bearing was allowed at an approximately similar time in both the groups. We had no non-union in our series. Malunion was more frequent in the nailing group than the MIPPO. Two patients had an external rotation deformity of more than 10 degrees and one had a varus of 10 degrees in the MIPPO group while four patients had an external rotation deformity of more than 10 degrees in the nailing group and one had a varus of 12 degrees. Patients in the nailing group had significantly higher rotational malalignment. The Foot Function index was similar in both the groups at the final follow-up. Other parameters are shown in Table 2.

DISCUSSION

Distal tibial extra-articular fractures have many options of management. They have been managed successfully with external fixation, nailing or plating but at present the standard practice to treat these patients is either by intramedullary nailing or MIPPO [10,11]. Our study compared the outcome of two standard methods (nailing versus MIPPO) of treatment in terms of the clinical, radiological and functional outcome of these fractures.

The results of our study showed that both MIPPO and intramedullary nailing are equally effective in terms of functional outcome. Guo et al. compared MIPPO with intramedullary nailing in a series of 85 patients and found statistically similar AOFAS scores in both groups, which was consistent with our study [12]. Two-thirds of our patients in the nailing group reported anterior knee pain. Yang et al. compared the results of intramedullary nailing with open reduction and plating of distal tibial fractures and reported anterior knee pain in half of the patients [13]. Jansen et al. in a retrospective series found statistically more frequent anterior knee pain during kneeling and squatting in a nailing group [14]. It is a well-known fact that nailing results in more anterior knee pain than plating as MIPPO does not involve any incision around the knee. Ankle functional outcome is similar in both treatment groups but anterior knee pain seems to be a limiting factor in the nailing group.

Malalignment has been found to be a problem in distal tibial fractures because of the small distal fragment, which is difficult to control. An ideal treatment should provide anatomical or at least acceptable fracture alignment as this is going to lead to posttraumatic arthritis in the ankle joint [15]. In our study we did not find any significant difference in malalignment but malrotation was significant and more common in the nailing group. Malalignment was found to be equal in both the groups in studies performed by Guo et al.

and Li et al. [11,12]. A rate of malunion which exceeds the acceptable range was found to be more common in the nailing group than in the plating group in a study by Im et al. and Vallier et al. [10,16]. However, in both these studies open reduction and plating was used rather than the MIPPO technique. In open surgeries, there is direct visualization of the fracture site and anatomical reduction is done so the chances of malalignment are less. However, in both MIPPO and intramedullary nailing indirect methods of reduction are used. Thus we believe that malalignment is similar in both the groups but malrotation is better restored in the MIPPO group.

The rate of union in both of our groups was equal and is an important factor in the final clinical outcome. Both treatment methods are biological and minimally invasive as they do not hamper normal biological hematoma and fracture healing. We had no non-union in our series as was seen in a study by Guo et al. [12]. Li et al. reported two cases of non-union (1 in Nailing group and 1 in MIPPO group) in his series [11]. Union time was similar in both the groups as was seen in a review study by Xue et al. [17].

The incidence of infection in MIPPO was greater as compared to nailing in our study. The rate of infection is dependent on many factors apart from the surgical technique. Patient co-morbidities, skin and soft tissue contamination, operating room condition and the timing of surgery all play an important role in the development of an infection. The rate of infection is reported to be higher in plate fixation compared to nailing in situations where open reduction and plating has been used [1]. In a metaanalysis, the rate of infection has been found to be equal in both MIPPO and Nailing [18]. We recommend that MIPPO should be delayed till soft tissue condition improves.

Concomitant fibular fixation in distal tibial fractures is still a matter of debate. It has been seen that

concomitant fibular fixation in intramedullary nailing prevents malalignment but at the same time may result in non-union. In our series, 2 of our patients who had undergone nailing with fibula fixation developed delayed union. Dynamisation was done in these patients and they eventually united with good functional outcome. Routine fixation of fibular fractures has been recommended by Mosheiff et al. and Schmidt et al. in their studies to lessen the risk of malalignment [19,20]. However, no loss of reduction has been seen by Dogra AS et al. in their series demonstrating that it is not necessary to fix the fibula in distal tibial metaphyseal fractures [21]. We do not recommend routine fibular fixation with nailing. We recommend nailing with simultaneous fibular fixation only in cases with gross comminution of the tibia with a same-level fibula fracture and most distal fibula fractures which have an impact on the stability of ankle.

In conclusion, both MIPPO and intramedullary nailing have similar therapeutic efficacy regarding the functional outcome and can be used safely in distal tibial extraarticular fractures. However, intramedullary nail is advantageous over plate with lower incidence of infection and a comparable operating time, union time and hospital stay. Although we detected a significant difference in malrotation as far as nailing is concerned, it did not affect the final outcome in these patients. However, with the progression and development of biomedical engineering and biomechanical concepts, more implants continue to develop which may have an impact on the current balance.

CONCLUSION

MIPPO and intramedullary nailing are effective treatment options in the management of distal tibial extra particular fractures, with comparable functional outcomes.

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