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Comparison of functional and radiological outcomes in extraarticular fractures distal third tibia treated with intramedullary nailing or plating

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Abstract

Introduction: Tibial fractures are most common long bone fractures, while distal fractures are even more complicated due to its proximity to ankle, and with close relationship with thin soft tissue envelope and severe comminution. Distal tibial extraarticular fractures are a common consequence due to road traffic accidents or other high energy injuries.

AIM: To compare functional and radiological outcomes in extra articular distal third tibia fractures, treated with intramedullary nailing or plating.

Material and Method: Study comprised of 40 patients of distal tibia fracture without articular involvement, admitted in Geetanjali Medical College and Hospital, Udaipur, Rajasthan. After primary management of fracture stabilisation, patients were randomly selected for surgical fixation either with IMN or MIPPO plating. 20 patients were included from each study group.

Result: All the patients treated with either surgical modality were compared for time of fracture union, ROM at ankle joint, early weight bearing, non-union and malunion. ROM at ankle joint was assessed with AOFAS ankle score. The mean fracture union time for IMN was 4.5 month, whereas in plating group it was 6.5 month. Immediate weight bearing was advised for IMN group, while weight bearing was delayed for at least 6 weeks in plating group. AOFAS ankle score for the nailing group was 92.05 (EXCELLENT) while for plating group was 89.10 (GOOD). The difference between two score was found to be significant (p value =0.05).

Conclusion: Both the treatment modalities were equally good for treatment of distal tibia extra articular fractures, but IMN was better in terms of early weight bearing, early fracture union with excellent ankle score as compared to MIPPO plating.

Keywords: Distal tibia, fracture, Mippro, intramedullary nail, union, weight bearing

Introduction

Tibial fractures are most common long bone fractures, Extra-articular proximal tibia fractures account for approximately 5% to 11% of all tibial shaft fractures [1]. Distal tibial fractures represent less than 7% of all tibial fractures [2-3]. Often this fracture is comminuted and unstable. Extraarticular distal tibial fractures are among the most challenging fractures encountered because of its subcutaneous location, poor blood supply and less muscular coverage anteriorly. Complications such as delayed union, nonunion, wound infection, and wound dehiscence often present as a great challenge to the surgeon⁵. A spectrum of surgical method exists for the management of distal tibial fracture, including open reduction and internal fixation with screws or plates, external fixations with mono-lateral or ring external fixators and intramedullary nailing [6]. Considerable studies have endeavored to investigate the optimum strategy by comparing the efficacy of IMN and MIPPO plate osteosynthesis [7-9]. Advantage of intramedullary device is that it spares the extraosseous blood supply, allows load sharing, and avoids extensive soft tissue dissection. The disadvantages include technical difficulties due to anatomy of distal metaphyseal flare, proximity of the fracture to the ankle joint, and distal nail fixation. The medullary canal is hourglass shaped, and the nail fits only in mid-diaphysis and not in distal segment [10]. The advantages of MIPPO is it reduces the surgical soft tissue injury while preserving bone vascularity and fracture hematoma.

It provides stable fixation, promotes early limb functioning^[11-12]. This method mitigates disturbance of the fracture hematoma and the periosteal soft tissues^[13]. Fracture union occurs by indirect bone healing with formation of a bridging callus followed by osseous remodeling^[14-15]. Disadvantages of MIPPO technique is, it should be performed after the soft tissues heal. Minimally invasive plate osteosynthesis does not allow direct observation of the fracture fragments^[16]. There are many randomized control studies which favor MIPPO plating and there are other studies which favors IMN. We conduct a prospective randomized study of skeletally mature distal tibial fractures of 40 patients treated with MIPPO or IMN at our institute, Geetanjali Medical College and Hospital.

Materials and Method

Study was conducted between may2017 to january2019. 40 patients of distal tibia fracture without articular involvement diagnosed radiologically with the X-Ray for lower extremity, admitted in Geetanjali medical college and hospital. All fractures of distal tibia in which either intramedullary interlocking nail or plating could be implemented were considered. Informed consent was obtained from each patient before participation in the study.

Inclusion criteria for patient selection were, patients with age 18 years and above of either sex, all extra articular closed fracture of distal 1/3 tibia up to AO43A3, duration of injury up to 1 week, open and close fractures, intact neurovascular status, patients with no ipsilateral lower extremity fracture or deformity and patients who are medically fit for surgery. The exclusion criteria were, all the patients not meeting inclusion criteria, or with pathological fractures. Fractures with intra articular extension and those patients who did not give a valid consent.

Method of treatment

Provisional diagnosis was made clinically, observing the clinical symptoms. Neurovascular status of the patients was assessed along with soft tissue condition of the limb. Radiological investigation, X-Ray, of the extremity was done. Post radiological investigations, final diagnosis was established. Patients were given temporary splintage and were admitted in the Orthopedic department. Patients were given injectable analgesics and limb elevation was maintained to reduce swelling. Surgical intervention was planned when the swelling subsided and soft tissues started healing.

Operative procedure

Nailing: One pre-requisite for nailing procedure in our setup was that the patient's knee could be flexed up to 90 degrees. Radiolucent operating table was preferred for all cases. Patient was given supine position, painting and draping was done. Standard patellar tendon splitting incision was taken. Point of entry was confirmed using fluoroscopic guidance in both the planes i.e. AP and Lateral. Entry was made with an awl and sequential reaming of the medullary canal was done. Reaming was done up to one size (5mm) above the desired nail size. Appropriate sized nail was introduced with tibial zig, position and length of the nail was confirmed using

fluoroscopic guidance. Distal locking bolt were placed with free hand under fluoroscopic guidance, minimum 2 and maximum 3 bolts, out of which two were mediolateral and one was anteroposterior. Proximal locking with two bolts was done using the zig as the guide. Final nail and screw placement were assessed before a thorough wash and closure in layers was done.

Plating: For distal tibia MIPPO, 3.5 mm distal tibia LCP were used in all the patients. For the surgical procedure patient was taken on radiolucent operative table, in supine position panting and draping of affected extremity was done, a bolster/sandbag was placed under ipsilateral buttock to prevent rotation and for easy operative procedure and better C-Arm view. Marking was done for medial malleolus and ankle joint, an incision of 3-4 cm was given medial aspect of distal tibia, starting 1cm below and over the center of medial malleolus extended proximally over the tibia, bony periosteum was exposed and elevated, fracture reduction done under fluoroscopic guidance and plate was introduced subperiosteally over medial aspect of tibia, temporary fixation with K-Wire was done. Fracture alignment and plate offset were checked in both anteroposterior and lateral plane and once found acceptable, the plate was fixed with screws. Closure was done in layers and sterile dressing applied along with below knee splint.

Post operative protocol

Nailing

- Weight bearing was allowed 2nd day post operatively as tolerated if fracture reduction was satisfactory.
- Active knee and ankle exercises were started.
- For a comminuted fracture weight bearing was delayed for 2/3 weeks.
- Parenteral antibiotics were given for 3 days for closed injury, and for 5 days for open fractures.
- Patient was discharged on 7th post-operative day.
- Suture removal was done on 15th day post operatively.
- Follow up was done on 4th, 8th, 12th, and 24th week for clinical and radiological assessment.

Plating

- All patients were given below Knee splint.
- Active ankle and knee ROM started on 2nd Post-Op day.
- All the patients were kept non weight bearing for 6 weeks.
- Parenteral antibiotics were given for 3 days for closed injury, and for 5 days for open fractures.
- First follow up done at 15th Post-Op day for suture removal.
- Follow up for clinical and radiological assessment was done at 6th, 12th, and 24th week.
- Partial weight bearing was advised 6th week post-operatively.
- Full weight bearing was advised after callus formation.
- Ankle score assessment done at every follow up by means of AOFAS score.



Fig 1: Intramedullary nailing



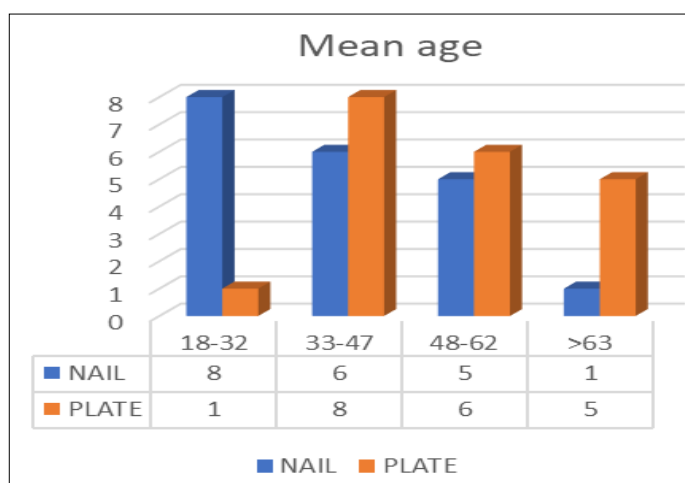
Fig 2: Distal tibia plating

Result

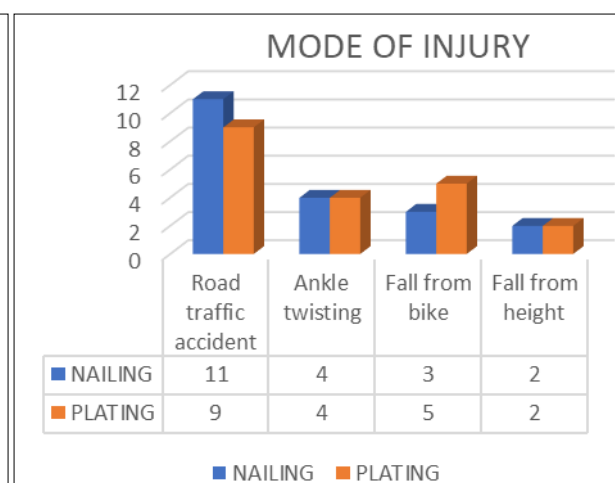
Statistical method

We used SPSS Ver.21, paired sample t test, Pearson Chi

Square statistical methods for data analysis and statistical significance was accepted when P value is <0.05.



Graph 1: Age Distribution



Graph 2: Mode of Injury

Table 1: Weight Bearing

| Weight Bearing | Nailing | | Plating | |
|-----------------|--------------------|---------------|--------------------|----------------|
| | No Of Patients (N) | Percentag (%) | No Of Patients (N) | Percentage (%) |
| Delayed [PWB] | 6 | 30 | 20 | 100 |
| Immediate [PWB] | 14 | 70 | 0 | 0 |

| | | | | |
|-------------|-------------|-----|----|-----|
| Total | 20 | 100 | 20 | 100 |
| T- value | 9.717 | | | |
| P-value | <0.01 | | | |
| Significant | significant | | | |

The weight bearing for the nail group is started after 48 hours for majority of patients as it is load bearing implants and the immediate weight bearing is initiated as patients.

In nailing group in 70% cases immediate weight bearing

started where as 30% cases it was delayed more than 2 weeks, but in plating group delayed weight bearing started in all cases. (t value = 9.717, P value <0.01)

Table 2: Ankle Rom

| Rom Ankle | nailing | | plating | |
|-------------|---------------------|----------------|---------------------|----------------|
| | No. Of Patients (n) | Percentage (%) | No. Of Patients (n) | Percentage (%) |
| Full | 16 | 80 | 14 | 70 |
| Near normal | 4 | 20 | 5 | 25 |
| Mid normal | 0 | 0 | 1 | 5 |
| Total | 20 | 100 | 20 | 100 |

Table 3: Complications

| Complications | Nailing | | Plating | |
|------------------------|--------------------|----------------|--------------------|----------------|
| | No of Patients (N) | Percentage (%) | No of Patients (N) | Percentage (%) |
| Delayed union | 2 | 10 | 4 | 20 |
| Non-union | 0 | 0 | 1 | 5 |
| Superficial infections | 2 | 10 | 3 | 15 |
| Wound dehiscence | 1 | 5 | 3 | 15 |
| Malunion | 0 | 0 | 0 | 0 |
| Plate exposed | 0 | 0 | 3 | 15 |
| Total | 5 | 25 | 14 | 70 |
| P- value | 0.314 | | | |
| Significant | Non-Significant | | | |

None of the case of malunion have been observed in both groups.

Table 4: Functional result

| | | | End Results | | Total |
|-------|---------|-------|-------------|-------|--------|
| | | | Excellent | Good | |
| Type | Plating | Count | 10 | 10 | 20 |
| | | % | 50.0% | 50.0% | 100.0% |
| | Nailing | Count | 13 | 7 | 20 |
| | | % | 65.0% | 35.0% | 100.0% |
| Total | | Count | 23 | 17 | 40 |
| | | % | 57.5% | 42.5% | 100.0% |

Table 5: Ankle Score Analysis

| | Type | N | Mean | Std. Deviation | Std. Error Mean | Mean Difference | 't' | p value |
|------------------|---------|----|-------|----------------|-----------------|-----------------|-------|---------|
| Aofas score | Plating | 20 | 89.10 | 5.180 | 1.158 | 2.950 | 1.859 | .071 |
| | Nailing | 20 | 92.05 | 4.850 | 1.085 | | | |
| Pain | Plating | 20 | 36.00 | 5.026 | 1.124 | 1.000 | .623 | .537 |
| | Nailing | 20 | 35.00 | 5.130 | 1.147 | | | |
| Activity/support | Plating | 20 | 8.95 | 1.468 | .328 | .300 | .677 | .503 |
| | Nailing | 20 | 9.25 | 1.333 | .298 | | | |
| Walking distance | Plating | 20 | 4.25 | .444 | .099 | .300 | 1.983 | .055 |
| | Nailing | 20 | 4.55 | .510 | .114 | | | |
| Walking surface | Plating | 20 | 3.75 | .967 | .216 | .100 | .324 | .748 |
| | Nailing | 20 | 3.85 | .988 | .221 | | | |
| Rom | Plating | 20 | 10.85 | 2.412 | .539 | 2.850 | 4.935 | .000 |
| | Nailing | 20 | 13.70 | .923 | .206 | | | |
| Alignment | Plating | 20 | 10.00 | .000 | .000 | .100 | 1.000 | .324 |
| | Nailing | 20 | 9.90 | .447 | .100 | | | |

AOFAS ankle score for the two group with mean of 92.05 for nailing, falls in EXCELLENT categories and 89.10 for plating group which falls in GOOD. The difference between the two score is significant (p value = 0.05).

Discussion

Distal tibia fractures result from low energy torsional to high

energy axial-loading mechanisms. High energy fractures are commonly associated with severe soft tissue injury, comminution of metaphyseal and articular fracture fragments of tibial plafond and comminuted distal fibula fractures. Treatment of distal tibia fractures can be challenging because of its subcutaneous location, poor vascularity and limited soft tissue coverage.

The main factor in treating these injuries is to estimate the degree of associated soft tissue injury. Since open and closed fractures were included in our study, we used Gustilo Anderson classification for soft tissue injury classification to assess and grade the severity of soft tissue injury. Definitive fixation is advisable and proceeded only when the soft tissue injury was managed properly. This is indicated by the skin wrinkle sign, once limb edema subsides. In our study, internal fixation was carried out according to the severity of soft tissue injury.

The key principles in the management of these fractures are –

1. Restoration of the length and limb axis by open reduction and internal fixation of tibia and fibula fracture.
2. The anatomical reconstruction of the articular surface of tibial plafond.
3. The filling of the defect resulting from impaction and the support of the medial side and prevent the Varus or Valgus deformity.

Among all 40 patients the 20 patients were treated with interlocking nailing with closed internal fixation and 20 patients are treated with MIPPO plating.

AO type classification 43A1, 43A2, 43A3 types were used for internal fixation for all the 40 patients, were included in our study.

Good reduction and strong fixation can be achieved by plating, the biomechanics of plating for distal tibia fractures are superior to those nailing because a plate provide a construct which is twice stiff as compare to IMN under an axial load, but plating technique tends to increase the risk of infection, delayed union, non-union by disrupting the periosteal blood supply.

With plate modality it was observed that the infection rate was 30% including wound dehiscence in 3 cases and deep infection leading to plate exposed in 3 case out of 20 cases, and 1 patient underwent intended non- union treated with MIPPO technique which later on required bone grafting to reach to complete union, 4 patients had delayed union > 10 month then average union time 6.5 month.

Table 6: Union Time

| Study | Modality | Union time |
|----------------------------------|------------------------|------------|
| Tyllianakis M <i>et al.</i> [17] | Intramedullary nailing | 4-5 months |
| Sean E Nork <i>et al.</i> [18] | Intramedullary nailing | 4-5 months |
| Our study | Intramedullary nailing | 4.5 month |

Table 7: Ankle Score: [Aofas Score]

| Study | Nailing | plating | Score[nailing/plating] |
|----------------------------|-----------|---------|------------------------|
| Shon OJ <i>et al.</i> [19] | excellent | Good | Excellent/good |
| Guo <i>et al.</i> [9] | 86.1 | 83.9 | Good/good |
| Our study | 92.05 | 89.1 | Excellent/good |

Anterior knee pain was main postoperative complication after IM nailing whereas soft tissue complications such as superficial infection diffuse pain around medial malleolus were associated with plating in the present study. Janseen KW *et al.*, also showed significant higher anterior knee pain as compare to plating [20].

In the study conducted by Tyllianakis M *et al.* [17] and Sean E Nork *et al.* [18], for distal tibia fracture treated with interlocking nail the average time for union was about 4-5 months. In our study the average time for union for nailing was 4.5 months and for plating was 6.5 months which is comparable.

As nails are weight sharing devices, immediate weight

bearing was initiated. For most of patients included for nailing immediate weight bearing were advised Whereas for all the patients treated with plating weight bearing were delayed for at least 6 weeks.

Conclusion

The results and observation obtained during the study indicate that both modalities of treatment deserve a place in treating distal metaphyseal extra articular fractures of tibia.

The operative technique in both the modalities were simple and short. Minimal complications were encountered in our study.

Average union rate assessment done by clinical and radiological criteria, in nailing group was 4.5 months where as in plating group it was 6.5 months.

The post-operative infection rate was not significant in both the group, but it was higher in plating group compared to nailing group.

The post-operative outcome as measured by ankle score and range of movements for both the modality, for the nailing group ankle score was excellent, whereas for plating group it was good to excellent.

Interlocked medullary nailing can be considered a very effective modality of treatment of distal tibia extra articular fractures as compared with plating.

The study concluded that interlocked nailing has got an edge over plating in terms of early union, no wound dehiscence, early weight bearing, better functional ankle score, less secondary interventions and less soft tissue trauma during surgery.

Locking plates were helpful to provide anatomic reduction and stable fixation for all extraarticular distal tibia fractures and fractures near to joint with comminution, where distal locking screw for nail couldn't give stable fixation. Locking plates have their drawbacks, soft tissue injury near fracture site, delayed weight bearing, delayed union time when compared with interlocking nails.

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