A Comparative Study of Distal Tibia Fractures Treated with Intramedullary Nailing versus Plating by MIPPO

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ABSTRACT

BACKGROUND
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 Tibial shaft Fractures is two per 1000 individuals. Tibial fractures can cause a long morbidity and extensive disability unless treatment is appropriate. We wanted to assess extra-articular distal tibial fractures and compare the two surgical modalities of treatment i.e.; intramedullary nailing (IMN) and minimally invasive plate osteosynthesis (MIPPO). We also wanted to compare the clinical, radiological and functional outcome of these modalities of treatment.

METHODS
This is a prospective study conducted among 40 patients in the age group of 20-70 yrs., of both sexes taken up for intramedullary nailing/ MIPPO at Rajarajeswari Medical College and Hospital, Bangalore. Age group ranged from 22 to 62 years with majority of patients having RTA (77.5%). Duration of hospital stay in majority was about 10 days and IMN for 7 days. Union time in weeks for MIPPO group was about 20 weeks and in Intra Medullary Nailing group was about 18 weeks. Both intramedullary nailing and plating by MIPPO are the optimal methods of treatment in extra articular distal tibia fractures with no significant differences between union and complication rates. MIPPO is usually preferred in fractures which are within the AO muller square whereas IMN is preferred in fractures which are above it.

RESULTS
In MIPPO group, mode of injury was RTA in 70% and self-fall in 30% and in Intra Medullary Nailing group, mode of injury was RTA in 85% and self-fall in 15%. There was no significant difference in mode of injury between the two groups. In MIPPO group, 5% had Gustilo Anderson Grade 1 and in Intra Medullary Nailing group 10% had Gustilo Anderson Grade 1. There was no significant difference in Gustilo Anderson Grade 1 between the two groups.

CONCLUSIONS
Both intramedullary nailing and plating by MIPPO are the optimal methods of treatment in extraarticular distal tibia fractures with no significant difference between union and complication rates. MIPPO is usually preferred in fractures which are within the AO muller square whereas IMN is preferred in fractures which are above it.

KEYWORDS
MIPPO, Intramedullary Nailing, Fracture Union, Weight Bearing
BACKGROUND

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 Tibial shaft fractures is two per 1000 individuals. Tibial fractures can cause a long morbidity and extensive disability unless treatment is appropriate. The subcutaneous location of the anteromedial surface of the tibia means that severe bone and soft tissue injury is not infrequent, and there is a high incidence of open fractures compared with other long bones. From the diaphysis to the distal metaphyses the tibia transitions from a triangular to rounded shape. Distal tibial metaphyseal fractures is particularly prone for delayed and non-union because of its precarious blood supply.

The mechanism of injury and prognosis are different from pilon fractures and their proximity to ankle joint makes surgical treatment complicated. Most of these fractures are associated with fracture displacement, comminution and injury to soft tissue envelope. Conservative treatment of distal tibia fracture often results in a number of complications including malunion, non-union. Before 1970 studies advised conservative treatment for distal tibial extra articular closed fracture treated with slab, cast application for 4 to 6 weeks, and followed by functional bracing or patellar tendon bearing. The traditional treatment of tibia fractures has been long term immobilization in plaster of Paris cast and functional cast brace which in itself is an invitation to well known "fracture disease".

Currently, 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 (MIPPO) and intramedullary nailing (IMN) are the well accepted and effective methods. Precise reduction of articular fragments is achieved with ORIF and this method was traditionally used for surgical treatment; however, unfortunately it resulted in significant soft tissue stripping. The MIPPO technique has recently been recognized as an alternative technique that enables indirect reduction and stable fixation with minimal biological footprint. When applied subcutaneously, LCP does not endanger periosteal blood supply, respect fracture hematoma and also provides biomechanically stable construct.

We wanted to assess and compare the two surgical modalities of treatment i.e. intramedullary nailing (IMN) and minimally invasive plate osteosynthesis (MIPPO), compare the clinical, radiological and functional outcome of these modalities and study the complications associated with these modalities of treatment.

METHODS

The distal tibia was defined as the area within two Müller squares 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. 20 patients were selected for MIPPO and 20 patients for intramedullary nailing based on inclusion and exclusion criteria. All patients were evaluated clinically and radio graphically to assess for any injuries Antero-posterior and lateral radiographs were obtained for the classification and preoperative planning. The limb was immobilized in the form of above knee plaster of Paris posterior slab. Limb elevation over a pillow was given in all the patients. Patients in nailing group were operated as and when possible while patients in plating group were delayed due to swelling, operated after the swelling reduced. One hour preoperatively all patients receive intravenous third generation cephalosporin. Fibula was fixed first with either 3.5 mm one-third semi tubular plate and its fixation is independent of tibial method of fixation.

Inclusion Criteria
1) All closed and compound Grade I (Gustilo Anderson classification)
2) Extra articular distal tibia fractures as per Orthopaedic Trauma Association (OTA) classification 43A1, 43A2, 43A3.
3) Age more than 18 years.

Exclusion Criteria
1) Compound fractures with grade II and above (Gustilo Anderson).
2) Age less than 18 years.
3) Intra-articular extension.
4) Extremely distal fractures where two distal locking screws are impossible to insert.
5) Multiple fractures and all pathological fractures, non-union and neglected fractures.

Intramedullary Nailing Procedure
A vertical patellar tendon splitting incision was made over skin extending from Centre of the inferior pole of patella to the tibial tuberosity, about 5 cms long. The patellar tendon was split vertically in its middle and retracted it to reach the proximal part of tibial tuberosity. Next step was to determine the point of insertion, an entry portal was created in line with the Centre of medullary canal. Point of entry was widened with curved tubial awl, after inserting the guide wire, medullary canal was then reamed, Nail was inserted until it gets slightly counter sunk in the bone. Placement of nail was confirmed in situ under image intensifier in both AP and lateral planes. Then proximal and distal locking was done with locking bolts.

Surgical Procedure for Lateral Malleolus and Distal Tibia
Type a (extra articular) fractures were reduced by ligament taxis alone with indirect manipulation. Direct exposure was therefore not often necessary. The shape of the implant served as a reduction tool. A properly contoured plate applied according to a good preoperative plan, improved the chances of a good reduction. Fibular reduction and fixation
were the usual next step, but this reduction must be accurate, so that it did not prevent tibial reduction. Finally, the tibial plate was introduced with MIPO technique and final reduction of length, alignment and rotation was achieved. Posterior placement of one-third tubular plate, according to WEBER was done in distal tibial fractures with posterior displacement or if the patient is osteoporotic with poor bone stock. The short oblique fractures of the tibia were fixed with 3.5 mm cortical interfragmentary screws. For Tibia plating (MIPO) The optimum screw ratio: the number of screws used for fixation divided by the number of available screw holes-the recommended screw ratio used was 0.4 to 0.5 for bridging fixation with three or four screws on either side of the fracture gap. Length of the plate: three to four times the zone of the combination with MIPO plate constructs. It was preferable to choose as long an implant as possible for the widest distribution of load at the fracture site.

Indirect reduction with a distractor an appropriately positioned distractor or external fixator proved to be a very helpful tool for reduction, especially for length and rotation. Insertion of the plate by Medial approach Tibial length and rotation were restored indirectly with distractor or external fixation. Angulation may be approximated in the same way, but is definitively corrected by plate application. The plate insertion was performed through a small 5 cm medial incision by advancing the plate under the subcutaneous fat directly onto the periosteum, the plate was usually positioned on the antero medial aspect of the tibia.

Proximally, above the fracture zone, a small incision (2-3 cms) aided plate positioning. Temporary fixation of plate was performed with K-wires through the screw holes (or inserted drill sleeves) to approximate the final plate position before screw insertion. Once accurate position of the plate has been achieved, conventional screw was inserted in one of the most distal plate holes to approximate the plate close to the bone. Alternatively, the plate was manually pressed to the bone, allowing the insertion of a locking head screw (LHS) instead of the conventional screw. It is crucial that the plate is positioned very close to the bone, especially at the supramalleolar level, to prevent soft-tissue irritation by the plate. Plate and proximal screws were centered on the tibia as confirmed in AP and Lat. view of c-arm. Applying interfragmentary compression with a lag screw: For spiral and short oblique fracture patterns (A1.1 and A1.2) that were anatomically reduced, lag screw was placed either through the plate or outside the plate to enhance the overall construct stability. This screw was applied in a percutaneous fashion under image intensifier control. Note this technique changes the construct to one of absolute stability, so a perfect reduction must be achieved or a significant delay in fracture healing may occur. Compression with plate tension for transverse type A1.3 fractures, fracture compression was achieved by applying tension with the plate, using eccentric placement of screws in non-locking holes, or an external tension device. To ensure that the opposite side of the fracture remains compressed, it was necessary to add a subtle convex pretend to the implant at the fracture level. Finish plate fixation further proximal and distal screw insertion was completed. The number and position of the screws inserted was dependent on the individual fracture pattern and bone quality ideally the concept of “balanced” fixation should be tried to achieve. Usually, the metaphysis requires more screws (3-5) than the diaphysis (2-3). In osteoporotic bone, the number of screws must be increased on both sides of the fracture. Locking head screws (LHS) were used for fixation in osteoporotic bone and short per articular segments. The wound was closed on the lateral and medial sides in two layers using 1/0 Vicryl and 3/0 ethilon sutures or skin stapler. Care was taken to avoid any tension on the wound edges. A sterile bandage dressing was applied to the wound postoperatively elastocrepe bandage applied and the limbs elevation was given over pillows. I.V. antibiotics was given for 3 days postoperatively. Switch over the oral antibiotics is done on the 3rd postoperative day. Analgesics if required were given. Active knee, ankle and toe mobilization started after over come from anaesthesia.

Patient was allowed non-weight bearing crutch walking / walker on next post-operative day if associated injuries permits, general condition and tolerance of patient. Skin sutures were removed on the 14th postoperative day. Depending upon the culture report and wound condition antibiotics were stopped / continued. Partial weight bearing crutch walking / walker commenced depending upon the type of fracture, rigidity of the fixation and associated injuries. Further follow up was done at 6 weekly intervals and each patient is individually assessed clinically and radio graphically Partial weight was allowed when the x-rays show 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.

RESULTS

The present study was carried out in the department of Orthopaedics, Rajarajeshwari Medical College and Hospital, Bangalore. 40 patients in age >18 yrs. and patients of both sexes were enrolled in this prospective study at Raja Rajeshwari Medical College and Hospital Bangalore. The patients were selected based on those satisfying the inclusion criteria and were followed up in Post-operative period immediately and for one year.

In MIPPO Group, majority of subjects were in the age group <30 years and 41 to 50 years (35%) respectively and in Intra Medullary nailing group, majority of subjects were in the age group 31 to 40 years (35%). There was no difference in age distribution between two groups.

In MIPPO group, mode of injury was RTA in 70% and self fall in 30% and in Intra Medullary nailing group, mode of injury was RTA in 85% and self fall in 15%. There was no significant difference in Mode of injury between two groups.
In MIPO group, 5% had Gustilo Anderson Grade 1 and in Intra Medullary nailing group 10% had Gustilo Anderson Grade 1. There was no significant difference in Gustilo Anderson Grade 1 between two groups.

### Table 1. Age Distribution Comparison between MIPO and Intra Medullary Nailing

<table>
<thead>
<tr>
<th>Group</th>
<th>MIPO</th>
<th>Intra Medullary Nailing</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>%</td>
<td>Count</td>
</tr>
<tr>
<td>&lt;30 years</td>
<td>7</td>
<td>35.0%</td>
<td>6</td>
</tr>
<tr>
<td>31-40 years</td>
<td>4</td>
<td>20.0%</td>
<td>7</td>
</tr>
<tr>
<td>&gt;50 years</td>
<td>2</td>
<td>10.0%</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
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<td>100.0%</td>
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</tr>
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### Table 2. Mode of Injury Distribution Comparison between MIPO and Intra Medullary Nailing

<table>
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<th>Intra Medullary Nailing</th>
<th>Total</th>
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<tbody>
<tr>
<td></td>
<td>Count</td>
<td>%</td>
<td>Count</td>
</tr>
<tr>
<td>RTA</td>
<td>14</td>
<td>70.0%</td>
<td>17</td>
</tr>
<tr>
<td>Self Fall</td>
<td>6</td>
<td>30.0%</td>
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<tr>
<td>Total</td>
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<td>100.0%</td>
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### Table 3. Gustilo Anderson Grade 1 Distribution Comparison between MIPO and Intra Medullary Nailing

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<th>Group</th>
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<th>Total</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>%</td>
<td>Count</td>
</tr>
<tr>
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<td>5.0%</td>
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<tr>
<td>Total</td>
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<td>100.0%</td>
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### Table 4. Comparison of Complications between MIPO and Intra Medullary Nailing

<table>
<thead>
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<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>%</td>
<td>Count</td>
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<tr>
<td>Infection</td>
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<td></td>
<td>Yes</td>
<td>2</td>
<td>10.0%</td>
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<tr>
<td>Total</td>
<td>20</td>
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<tr>
<td>Non-Union</td>
<td>No</td>
<td>20</td>
<td>100.0%</td>
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<tr>
<td>Malunion</td>
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<td>100.0%</td>
</tr>
<tr>
<td></td>
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<td>0.0%</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>100.0%</td>
<td>20</td>
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### DISCUSSION

40 patients with distal tibia extra articular fracture, 20 of which were operated by using intramedullary nailing and 20 of which were operated by using minimal invasive plate osteosynthesis at Rajarajeswari medical college and hospital, Bangalore. Intramedullary (IMN) nailing and plating are the two major options for the treatment of distal tibia fractures. Indications of IM nailing are fractures in elderly people with thin skin or compromised soft tissue, patients with high risk of non-healing wound, and fractures with distal bone mass allowing insertion of two screws.\(^{10}\) Plating is indicated for fractures with risk of misalignments, fractures with simple articular involvement, and fractures in which IM nailing is not amenable.\(^{10}\) The two approaches have some theoretical disadvantages.\(^ {11,12} \) IM nailing frequently results in misalignment, malunion, and knee pain.\(^ {13,14,15} \) Tibia plating can achieve anatomic reduction, but it is associated with the risk of wound dehiscence and infection because of the minimal soft tissue cover over the anteromedial tibia.\(^ {13,16} \) There have been some controlled clinical trials that directly compared the two methods.\(^ {15,17} \) These trials also failed to show consistent results. Several studies were carried out to compare intramedullary nailing to plating, plating to external fixation and intramedullary nailing to external fixation.\(^ {18,19} \) Various clinical studies have compared IMN and MIPO\(^ {20,21,22} \) the former leads to a lower rate of soft tissue complications and infections and has been associated with a significantly shorter full weight bearing and a shorter union time. On the other hand, IMN appears to have been reported to lead to a higher rate of malunion and non-union because it may involve reduction issues\(^ {23,24} \). The present study was conducted to evaluate the functional outcome of distal tibia extra articular fracture operated with IMN and MIPO.

Union Time (weeks) was 18.95 ± 0.94 weeks in IMN group while it was 20.85 ± 2.13 weeks in MIPO group. Statistically analysis shows that difference in between healing time was statistically significant. (p= 0.001). Complications was 2 out of 20 (5%) patients had misalignments in IMN group while no patients in MIPO group had malalignment. Statistical analysis shows that the difference in malalignment rate was not significant (p=0.147). 2 out of 20 (10%) patients had infection in MIPO group while 1 out of 20 (5%) patients in IMN group had infection. Statistical analysis shows that the difference in infection rate was not significant (p=0.548). No cases of non-union were present in either groups. Delayed union was present in 2 out of 20 (10%) patients in MIPO group and no delayed union was seen in IMN group. Statistical analysis shows that the difference in delayed union rate was not significant (p=0.147). So, it shows that there is no statistically significant difference between the two treatment modalities of distal tibia extra-articular fracture.

### CONCLUSIONS

Both MIPO and IMN can be safely used to treat extra articular distal tibial fractures. It mainly depends on the surgeon’s confidence and his level of expertise. IMN has the advantage of significantly shorter duration of surgery and hospital stay. MIPO on the other hand offers more biological repair with indirect reduction and preserving fracture haematoma with lesser chances of malunion and non-union. In terms of complications both IMN and MIPO group had no significant differences. However, in distal tibia fractures above AO square all authors preferred intramedullary nailing as a better option.
REFERENCES


