Abstract

**Background:** Extra-articular proximal and distal metaphyseal fractures of tibia pose a significant challenge to the surgeons. Debate continues regarding choice of fixation devices. Evaluate these fractures fixation with intramedullary expert tibial nail and extramedullary locking plate and screws.

**Materials and methods:** This is a prospective interventional study which had been conducted in the Department of Orthopaedics & Traumatology, Chittagong Medical College Hospital, Chattogram from July, 2018 to June, 2019. Total 60 cases (30 cases in each group) with proximal and distal metaphyseal tibial fractures (AO/OTA 41A2 to A3 and 43A1 to A3) were taken. Functional assessment was done atleast 6th month of surgery using Tegner Lysholm knee scoring scale and Kaikkonen ankle scale.

**Results:** According to assessment scale, excellent outcome was observed in 20 (66.7%) patients, good in 05 (16.7%), fair in 03 (9.9%) and poor in 2 (6.7%) patients in ETN group while in LPS group, 18 (60%) patients were excellent, 05 (16.7%) good, 04 (14.3%) fair and 03 (9.9%) patients were poor. Difference in functional outcome in both the groups was statistically non-significant.

**Conclusions:** There was no significant difference statistically in functional outcome of patients treated with intramedullary and extramedullary fixation method.

**Key words:** Expert Tibial Nail (ETN); Extra articular; Kaikkonen ankle scale; Locking Plate and Screw (LPS); Poller screws; Tegner lysholm knee scoring scale.
Fractures of extra-articular distal metaphyseal area of tibia are classified as AO/OTA 43A which are subdivided into groups A1, A2, and A3. A1 fractures are simple which may be spiral A1.1, oblique A1.2 or transverse A1.3. A2 are wedge fractures including posterolateral impaction A2.1, anteromedial wedge A2.2 and fracture extending into diaphysis A2.3. A3 fractures are multifragmentary with 3 intermediate fragments A3.1, more than 3 intermediate fragments A3.2 and fracture extending into diaphysis A3.3.

Various treatment options have been evolved each having its own advantages and disadvantages: half-pin external fixation, hybrid or thin-wire external fixation, plate fixation, intramedullary implant or a combination of these techniques. But optimal method of fixation still remains debatable.

It was observed that open reduction and internal fixation with plate and screw has its own issue of devascularizing the bony fragments, injury to soft tissue and higher rate of infection while Minimaly Invasive Percutaneous Plate Osteosynthesis (MIPPO) threatens secondary skin necrosis due to the prominence of precontoured and angular stable plates.

Intramedullary fixation with standard interlocking nail has been found to be less invasive, load sharing, sparing extra-osseous blood supply and fracture hematoma by with early mobilization of patients with faster rehabilitation. Earlier the use of intramedullary tibial nail for metaphyseal fractures was not suggested by many series due to higher incidence of malalignment. Most common deformities in proximal tibial metaphyseal fractures as an apex anterior and valgus deformity due to pull of extensor mechanism in flexed position and forces of pull by hamstrings and iliotibial band along with spacious medullary canal at this level respectively. To overcome these deformities, various techniques for intramedullary interlocking nailing like proximal and lateral entry point, use of the semi extended position, poller screws, temporary unicortical plates, clamps and provisional K-wire reduction.

Due to the technical limitations of the available implants such as the Unreamed tibial nail for the stabilization of metaphyseal fractures, new intramedullary tibial implants have been developed. Proximal tibial nail, designed in 1999, offered proximal locking options in three different planes with near angular stability of the nail-screw construct and double threaded, 5mm enlarged core cancellous screw for better purchase in trabecular bone of the metaphysis. In 2004 Tibial Nailing System (TNS) was evolved in which four distal multidirectional locking options were available in addition to five proximal locking options. It was further modified by adding a 2° inclination to the 8° Herzog’s bend for easier insertion and a better fit in the wider medullary canal in metaphyseal region and hence termed as Expert Tibial Nail.

**Materials and methods**

This prospective interventional study was carried out in Department of Orthopedic Surgery of Chittagong Medical College, Bangladesh from July, 2018 to June, 2019. Purposive type of non-probability sampling technique was used and approval taken from the Ethical and Research Committee of Chittagong Medical College Hospital. Total 60 cases (30 cases in each group) with proximal and distal metaphyseal tibial fractures (AO/OTA 41A2 to A3 and 43A1 to A3) were taken. Functional assessment was done at least 6th month of surgery using Tegner Lysholm knee scoring scale and Kaikkonen ankle scale. Among the 30 cases of extra articular devises, 15 cases were proximal tibial fracture and 15 cases were distal tibial fracture.

Regarding inclusion criteria, patients with AO/OTA 41A2 to A3 & 43A1 to A3 fractures, 18 years & below 60 years of age and fracture age less than 2 weeks were considered while in exclusion criteria, closed fracture with Ostern and Tsherene grade II & III, open fracture with Gustillo and Anderson grade IIIB & IIIC, polytrauma patient (ISS > 16) pathological fracture other than osteoporosis, fracture with failure of treatment with other fixation devices.
As extra articular implants and fracture patterns are different for proximal and distal tibial fractures, may be done by another study for it. In this study our main concern was to find out the outcome between Extra articular and Intramedullary device.

Functional outcome assessment by Tegner Lysholm knee scoring scale for proximal metaphyseal tibial fracture and Kaikkonen ankle scale for distal tibial metaphyseal fracture were done at 1st, 3rd and 6th months follow up.

Data presented on categorical scale were expressed as frequency and corresponding percentage and were compared by chi-square test, while the quantitative data were presented as mean and Standard Deviation (SD) and were compared by student’s t-test. For all analyses, level of significance was set at 0.05 and p-value <0.05 was considered as significant.

Results
While considering age, most patients (63.33%) were in between 20 to 40 ages in both groups. Out of 60 patients, 48(80%) were male and 12(20%) were female. Among the patients 18(30%) were service holder, 05(8.3%) students, 08(13.33%) house wife. Regarding fracture type 20 % (12) were 41A2, 30 %( 18) were 41A3, 15 %( 09) in both 43A2-43A3 and 20% (12). Involvement of right side 48.3% (29) and left side 51.7% (31) was almost equal.

Mean (± SD) duration of operation was 85.33 (± 15.48) minutes for ETN group whereas in LPS group it was 99.00 (± 17.88) minutes which is statistically highly significant (p = 0.001). The mean (±SD) time taken for radiological union in ETN and LPS groups were 18.46 (±3.010) weeks and 20.00 (±3.16) weeks respectively.

Table I : Comparison of clinical outcome after 6 months

<table>
<thead>
<tr>
<th>Category</th>
<th>Expert tibial nail</th>
<th>Locking plate &amp; screws</th>
<th>Total</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Excellent</td>
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<td>66.7</td>
<td>18</td>
<td>60</td>
</tr>
<tr>
<td>Good</td>
<td>05</td>
<td>16.7</td>
<td>05</td>
<td>16.7</td>
</tr>
<tr>
<td>Fair</td>
<td>03</td>
<td>9.9</td>
<td>04</td>
<td>13.3</td>
</tr>
<tr>
<td>Poor</td>
<td>02</td>
<td>6.7</td>
<td>03</td>
<td>9.9</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>100</td>
<td>30</td>
<td>100</td>
</tr>
</tbody>
</table>

Statistical analysis was done by Chi-square test.

No significant statistical difference between expert tibial nail and locking plate and screws groups according to mechanism (p=0.72) side (p=0.80) and type (p=0.56) of injury. There was no significant difference between intervals from injury to operation time (p=1.00) in two groups.

Table II : Comparison of functional outcome after 6 months

<table>
<thead>
<tr>
<th>Category</th>
<th>Expert tibial nail</th>
<th>Plate and screw</th>
<th>Total</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Excellent</td>
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<tr>
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<td>6.7</td>
<td>03</td>
<td>9.9</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>100</td>
<td>30</td>
<td>100</td>
</tr>
</tbody>
</table>

- Statistical analysis was done by Chi-square test.
- p value > 0.05 indicates non-significant.
- ns= non-significant.
Discussion

In this study, mean (± SD) age of the participants was 36.13 (± 10.88) years within a range of 20-57 years which was compared favorably with other studies.\(^2,18,19\) This study had 48 (80%) male and 12 (20%) female which matched with other studies.\(^18-20\) According to side of injury, 29 (48.3%) patients had injury on right side and 31 (51.7%) on left side which is statistically not significant (\(p = 0.80\)) and similar to others.\(^20\).

Regarding the mechanism of injury, in ETN group, 51 (85%) patients suffered from RTA, 06 (10%) from fall from height and 03 (05%) from physical assault. So, RTA was the major cause of extraarticular proximal and distal fracture.\(^20\)

Regarding time taken for radiological union, mean radiological union time in ETN group was 18.46 (± 3.01) weeks in contrast to 20.00 (±3.16) weeks in LPS group. The result is statistically non-significant (\(p = 0.082\)). While other studies noted the average union time in between 16 to 20.8 weeks.\(^18,19,20,24\)

This study represents that, in ETN group 04 (13.3%) patients suffered from soft tissue infection, 02 patients (6.7%) from deep seated infection, 05 patients (16.7%) from delayed union, 02 patients (6.7%) from implant failure/non union and 02 patients (13.3%) from knee stiffness and ankle stiffness. In contrast, soft tissue infection was in 08 patients (26.7%), deep seated infection in 05 patients (16.7%), delayed union in 07 patients (23.3%), implant failure/non union in 03 patients (10%), knee stiffness in 04 patients (26.7%) in Proximal locking plate and ankle stiffness in 04 patients (26.7%) was observed in LPS group that matched with others studies.\(^18,19,21,22\)

At 6\(^{th}\) month follow up functional outcome of patients from both groups were divided into 4 categories- excellent, good, fare and poor according to Tegner Lysholm knee scoring scale and Kaikkonen ankle scale. In ETN group, 20 (66.7%) patient’s functional outcome was excellent, 05 (16.7%) good, 03 (9.9%) fair and 02 (6.7%) poor. In contrast, 18 (60%) patients were excellent, 05 (16.7%) good, 04 (13.3%) fair and 03 (9.9%) poor in LPS group. According to \(p\) value (0.866), functional outcome was non-significant between both fixation groups. This result is similar to the findings of other studies.\(^18,19,23\)
Limitations
The main weaknesses of the study were:
- Small sample size.
- Shorter duration of follow-up.
- Use of other implants for operative treatment.
- Outcome between proximal and distal locking plate systems was not evaluated.

Conclusion
The current study demonstrated statistically no significant difference in post-operative follow-up findings between both groups at the end of 6 months after surgery although mean radiological union time was non-significantly shorter in ETN group.

Recommendations
Both expert tibial nailing and locking plating may be an adequate treatment option for extra-articular proximal and distal metaphyseal tibial fractures. Multi-center studies with larger sample size and longer period of follow-up can be undertaken to draw any definitive conclusion. Also extra-articular implant for proximal and distal tibial fracture should be done in a separate study.

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Contribution of authors
MMRC - Conception design, acquisition of data, manuscript writing & final approval.
MMR - Acquisition of data, data analysis, drafting & final approval.
MAR - Acquisition of data, data analysis, drafting & final approval.
JJ - Data analysis, critical revision & final approval.
MQM - Interpretation of data, critical revision & final approval.

Disclosure
All authors declared no competing interest.

References


