SURGICAL MANAGEMENT FRACTURE SHAFT TIBIA BY INTRAMEDULLARY INTERLOCKING NAIL

A STUDY DONE AT BHANU ORTHOPAEDIC HOME KARIMNAGAR [A.P.] 505001 INDIA

DISSERTATION SUBMITTED TO UNIVERSITY OF SEYCHELLES AMERICAN INSTITUTE OF MEDICINE [USAIM]

Partial fulfillment of the requirements for the degree

M.Ch [ Orthopaedic Surgery]

By

Dr.D.NARSIMLULU

M.S. [Ortho]

2013
### LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>AO</td>
<td>Arbeitsgemeinschaft fur Osteosynthesefragen</td>
</tr>
<tr>
<td>AISF</td>
<td>Association for the study of Internal Fixation</td>
</tr>
<tr>
<td>AP</td>
<td>Antero-posterior</td>
</tr>
<tr>
<td>BP</td>
<td>Blood pressure</td>
</tr>
<tr>
<td>DCP</td>
<td>Dynamic Compression Plating</td>
</tr>
<tr>
<td>IM</td>
<td>Intramuscular</td>
</tr>
<tr>
<td>IV</td>
<td>Intravenous</td>
</tr>
<tr>
<td>NBM</td>
<td>Nothing by mouth</td>
</tr>
<tr>
<td>TPR</td>
<td>Temperature, Pulse, Respiratory rate</td>
</tr>
<tr>
<td>G.A</td>
<td>Gustilo Anderson</td>
</tr>
<tr>
<td>ARDS</td>
<td>Adult Respiratory distress syndrome</td>
</tr>
<tr>
<td>HS</td>
<td>Hora Somni</td>
</tr>
</tbody>
</table>
### Key to Master Chart

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>Male</td>
</tr>
<tr>
<td>F</td>
<td>Female</td>
</tr>
<tr>
<td>Fa</td>
<td>Fall</td>
</tr>
<tr>
<td>Rt</td>
<td>Right</td>
</tr>
<tr>
<td>Lt</td>
<td>Left</td>
</tr>
<tr>
<td>RTA</td>
<td>Road Traffic Accident</td>
</tr>
<tr>
<td>PT</td>
<td>Proximal Third</td>
</tr>
<tr>
<td>MT</td>
<td>Middle Third</td>
</tr>
<tr>
<td>LT</td>
<td>Lower Third</td>
</tr>
<tr>
<td>IF</td>
<td>Ipsilateral Fibula Fracture</td>
</tr>
<tr>
<td>IFM</td>
<td>Ipsilateral Femur Fracture</td>
</tr>
<tr>
<td>D.U</td>
<td>Delayed Union</td>
</tr>
<tr>
<td>M.U.</td>
<td>Malunion</td>
</tr>
<tr>
<td>N.U.</td>
<td>Non union</td>
</tr>
<tr>
<td>LLD</td>
<td>Limb length discrepancy</td>
</tr>
<tr>
<td>MM ©</td>
<td>Medial malleolus contralateral</td>
</tr>
<tr>
<td>MM (i)</td>
<td>Medial malleolus ipsilateral</td>
</tr>
<tr>
<td>F (seg)</td>
<td>Fibula Segmental</td>
</tr>
<tr>
<td>H</td>
<td>Humerus</td>
</tr>
<tr>
<td>IC</td>
<td>Iliac crest</td>
</tr>
<tr>
<td>CM</td>
<td>Comminuted #</td>
</tr>
<tr>
<td>Comp</td>
<td>Compound</td>
</tr>
<tr>
<td>Gr</td>
<td>Grade</td>
</tr>
<tr>
<td>LLD</td>
<td>Limb length discrepancy</td>
</tr>
<tr>
<td>MM ©</td>
<td>Medial malleolus contralateral</td>
</tr>
<tr>
<td>Scn</td>
<td>Scapula neck</td>
</tr>
<tr>
<td>P.R</td>
<td>Pubicramus</td>
</tr>
<tr>
<td>ILN</td>
<td>Interlocking nailing</td>
</tr>
<tr>
<td>T (seg)</td>
<td>Tibia segmental</td>
</tr>
<tr>
<td>ShO</td>
<td>Short Oblique</td>
</tr>
<tr>
<td>Tr</td>
<td>Transverse</td>
</tr>
<tr>
<td>Ob</td>
<td>Oblique</td>
</tr>
<tr>
<td>Ex Fix</td>
<td>External Fixator</td>
</tr>
<tr>
<td>B.G</td>
<td>Bone Grafting</td>
</tr>
<tr>
<td>Fib Os</td>
<td>Fibula Osteotomy</td>
</tr>
<tr>
<td>PBR</td>
<td>Pubicramus</td>
</tr>
<tr>
<td>I/T</td>
<td>Intertrochanteric</td>
</tr>
<tr>
<td>SL</td>
<td>Static locking</td>
</tr>
<tr>
<td>MC</td>
<td>Metacarpal</td>
</tr>
<tr>
<td>E</td>
<td>Excellent</td>
</tr>
<tr>
<td>G</td>
<td>Good</td>
</tr>
<tr>
<td>F</td>
<td>Fair</td>
</tr>
<tr>
<td>P</td>
<td>Poor</td>
</tr>
<tr>
<td>NU</td>
<td>Non union</td>
</tr>
<tr>
<td>E</td>
<td>Excellent</td>
</tr>
<tr>
<td>S.I</td>
<td>Superficial Infection</td>
</tr>
<tr>
<td>D.I</td>
<td>Deep Infection</td>
</tr>
</tbody>
</table>

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INTRODUCTION

Intramedullary nailing is one of the oldest surgical fracture treatments. Aztecs used wooden intramedullary nails. Ebony plugs used by Egyptians. Sinn, Lambotte, Heygroves used ivory, bone, metallic nails. Kuntscher Father of intramedullary nailing laid down the principles 1 closed reduction 2 stable fixation 3 early weight bearing 4 no external fixation.

Locked nail devised by Kuntscher at the end of his life Detensionsnagel. Klemm and Schellmann Germany Grosse and Kempf France developed the concepts put into practice.

Tibia is the most commonly fractured long bone Because of the exposed surface makes it vulnerable for injury by road traffic accident fall, assault and compound injuries

Because of lack of muscle cover all around and precarious blood supply tibial fractures give a special challenge to orthopaedics. The presence of hinge joints knee ankle at the end allows no adjustment for rotatory deformity. Because of high rate of complications it poses challenges in treatment

There are various modalities of treatment like manipulation and reduction above knee pop below knee pop Sarimiantos function bracing .open reduction internal reduction by plates, screws & nails K nails Enders nails and interlocking intramedullary nails with or without reaming.

Closed intramedullary interlocking nailing is accepted by most of the orthopedic surgeons, as the treatment of choice in diaphyseal fractures but it is also associated with a number of complications.

There are many controversial issues in the management of fractures of tibial shaft with closed intramedullary nailing. The question of reaming, its role in proximal third fractures and open fractures, is still being debated. Its role in distal third fractures is fairly established provided two distal locking screws are put at right angles to each other and associated fibular fracture is fixed to avoid angulation.

This is a prospective study to evaluate the results of reamed intramedullary interlocking nailing in tibial diaphyseal fractures and to study the results and complications of the procedure.
AIMS AND OBJECTIVES

To evaluate the results of reamed intramedullary interlocking nailing in diaphyseal fractures of tibia.

To study the complications of reamed intramedullary interlocking nailing of fractures shaft of tibia.
MATERIALS & METHODS

A prospective study of results and complications following reamed intramedullary interlocking nailing in diaphyseal fractures of tibial shaft was done in Bhanu Orthopaedic Home Karimnagar A.P. India for the past more than 10 years.

100 patients with fracture of tibial shaft were selected for the study.

Inclusion Criteria:
1. Ages between 17 to 80 (closed epiphyses)
2. Grade 1 & Grade 2 compound fractures
3. Polytrauma cases where early mobilization of patient is required
4. Transverse, short oblique, spiral and comminuted fractures.

Exclusion Criteria:
1. Open epiphyses
2. Old fractures with complications like infection.
3. Grade 3 open fractures.

In total 100 patients admitted, there were 82 Males (82 %) & 18 Females (18 %) with Males 83 fractures, Females 19 Fractures.

The age of patient ranges from 17 to 80 with a mean age of 36.47 years. Most of the fractures are caused by road traffic accidents accounting for RTA-90% and Fall-10%. Proximal Third – 4 (4%) Middle Third – 92 (91%) & Lower Third – 6 (5%) The predominant fracture patterns were Oblique fractures- 36 (35%) and Comminuted fractures – 26 (25%)
Preoperative preparation of patients:

Patients were kept NBM for 6-8 hours before surgery

IV fluids as per the need were given

Adequate amount of compatible blood arranged if needed

Preparation of whole extremity, private parts and back was done

Written and informed consent was taken

Soap water enema HS

Tranquilizers HS

IV antibiotics half hour before surgery

Shifting of the patients 30 minutes before surgery to operation theatre

Preoperatively the length of the nail is calculated by subtracting 3 to 4 cm from measurements taken from the knee joint line to tip of the medial malleolus clinically and medullary canal is measured at the isthmus on X-rays. Accordingly a stock of interlocking nails 2cm above and below the measured length and 1mm above and below the required diameter were always kept. We have used canulated tibial nails in our cases.
Position of the Patient:

Patients were operated under spinal / general anaesthesia. Patient is placed in supine position over a radiolucent operating table. The injured leg is positioned freely, with knee flexed to relax the gastro soleus muscle. The table is adjusted to a comfortable operating height.

The affected limb is thoroughly scrubbed from mid thigh to foot with betadine scrub and savlon. The limb is painted with betadine solution from mid thigh to foot. Reset of the body and other limb is properly draped with sterile drapes. Sterile gloves are applied to the foot and serge-drape over the leg form knee joint to ankle.

Determination of Nail Length:

Hold the radio graphic ruler parallel to the tibial shaft in such a way that the proximal end comes to lie at the level of the insertion point. Mark the skin at appropriate point. Position the image intensifier over the distal tibia. Align the measuring ruler at the skin marking. With correct reduction, we can now read of the required nail length on the image intensifier picture at the level of epiphyseal cartilage.

Another way to measure the length of Hollow and Tubular nails is to subtract the exposed length of the guide rod from its total length of 950mm.

Determination of Nail Diameter:

The marking on the radiographic ruler may be used to determine the diameter of the medullary canal. Position the square marking over the isthmus. If the transition to the cortex is still visible both to the left and right of the markings, the corresponding nail diameter may be used.

Procedure:

Make a vertical patellar tendon splitting incision over the skin extending from centre of the inferior pole of patella to the tibial tuberosity, about 5 cm long. In the first few cases we have retracted patellar tendon laterally to enter in to the tibial tuberosity. We are using patella splitting approach. Patella is split in the midline and retracted to reach the proximal part of tibial tuberosity. Next step is to determine the point of insertion. As a general rule, the insertion point should be slightly distal to the tibial plateau, slightly medial and exactly in line with the medullary canal. If the insertion point is too distal, there is danger of fracturing the distal cortex of the main proximal fragment, particularly in the case of proximal fractures.
On the other hand, inserting too far proximally bears the risk of opening the knee joint, patella comes in the way of zig or removal of nail may be difficult. After selecting the point of insertion, curved bone awl is used to breach the proximal tibial cortex in a curved manner, so that from perpendicular position, its handle comes to be parallel to the tibial shaft. In the metaphyseal cancellous bone, create an entry portal, marking sure it is in line with the centre of medullary canal. Point of entry is widened with curved tibial awl.

In the early practice of surgery, we used to ream the tibia with V nail later used straight canulated reamers. For the past few years we are using powered reamers. After widening the medullary canal of proximal third, the ball tipped guide wire 3mm diameter X 950 mm length passed into the medullary canal of proximal fragment and the fracture fragments reduced under image intensifier by maintaining longitudinal traction in the line of tibia.

After reduction, the tip of ball tipped guide wire is adjusted to pass in the distal fragment up to 0.5-1cm above the ankle joint under image intensifier. Confirm its containment within the tibia by anteroposterior and later views. Medullary canal is then reamed starting from 8mm reamer size to 0.5 to 1mm larger than the diameter measured using the radiographs. Reaming is done in 0.5mm increments, initially with the end cutting reamer and then replaced by side cutting reamer. Then the ball tipped guide wire is exchanged with smooth guide wire using the teflon tube. Next step is to pass an assembled nail into the medullary canal over the smooth guide wire.

Insert the connecting screw through the insertion handle and coupling block, then screw this assembly into the proximal end of the selected nail. Ensure that the notches of the insertion handle fit into the grooves of the coupling block. The coupling blocks ensure a torque-resistant connection between insertion handle and nail. The insertion handle guides the nail and control rotation during insertion. Apply the insertion handle to the medial side of the tibia for insertion and proximal locking. Tighten the whole assembly with a combination wrench. Check that the assembly is firmly screwed together. Over tightening should not be done.

Now introduce the tibial nail as far as possible manually into the medullary canal with the help of mounted insertion instruments. Use the image intensifier to check passing of the nail through the fracture site. Insertion can be aided by gentle blows with the slotted hammer. Insert the nail until it is slightly counter sunk in the bone. Confirm the placement of the nail in situ under image intensifier in both AP and lateral planes.

Routinely we go for distal locking first by freehand technique under image intensifier (C arm) control. In the initial practice when C arm was not available we have done under X-ray control with the help of wire mesh and same size nail using as a guide. As C arm is available now the C arm is positioned so that the locking hole appears as perfect circle on the monitor.
If the image is not round oval it must be corrected to achieve the round circle.

Adjust the image intensifier until the most distal hole is round. The nails which we have used are having distal locking holes in medio lateral plane. Few nails are having additional one anteroposterior hole. These types of nails are used mostly in distal third fractures, where we used all three holes.

Place a scalpel on the skin with the top of the blade over the centre of the hole to determine the stab incision point. Make a stab incision. Place the tip of 2.5mm ‘K’ wire centered in the locking hole image. Adjust it until the K wire is in line with the X-ray beam and appears as radio opaque solid circle in the centre of the outer ring. Hammer the K wire or Steinman pin into the bone. The DCP drill sleeve is passed over the K wire and the sleeve is held firmly over the bone. The K wire is removed and the hole drilled through both cortices with drill bit. The drill bit or Steinman pin position is confirmed by tapping with the guide wire where we get the metallic tap sound. Measure the hole with depth gauge for locking bolts. Add 2mm to this to ensure that locking bolts engage the far cortex. Insert the locking bolts confirm again by tapping with guide wire. This locking is done from distal to proximal to get the tap sound for each locking bolt. This is further confirmed with each proximally moving locking bolt the length of the guide wire which taps the bolts lessens. This is confirmed again by image intensifier.

The fracture site is visualised if there is a distraction, compression is carried by gentle hammering the heel. It is important to maintain compression at the fracture site, because a gap of 1mm will take at least 10 Months to fill up.

After distal locking we go for proximal locking. The insertion handle or proximal locking jig is in the medial position. This jig locates the proximal holes. The skin is incised. Insert the trocar into the protection sleeve and push it down unto the surface of tibia through the corresponding hole in the insertion handle. Remove the trocar and insert the drill sleeve. To prevent the drill bit from sliding off the tibial surface, ensure that the drill guide is sitting firmly on the bone and is not deflected by skin or soft tissue. Drill through both cortices using the drill bit. Locking bolts are passed such that they are engaging the far cortex.

Incised wounds are washed with saline betadine, patellar tendon sutured with delayed absorbable sutures skin is sutured or stapled. Sterile dressing is applied compression bandage is given. Elastocrepe bandage is applied for stable fractures. Above knee slab is given routinely for comminuted fractures. Tourniquet is deflated, capillary filling and peripheral arterial pulsations checked.
Postoperative Care

Immediate:

NBM 4-6 hours postoperatively

IV fluids/blood transfusions if necessary

IV antibiotics: In most cases injection Ceftriaxone and injection Tobramycin were given intravenously for 5 days followed by oral. Antibiotics if needed

IM analgesics

Tranquilizers HS

Limb elevation over pillows

Active toe movements

TPR/BP chart hourly

Input/output chart

Check X-ray of the operated tibia full length both AP and lateral views.

Post operatively active toe ankle knee hip movements encouraged. Primary dressing is done on 2nd postoperative day. Depending on the ability patient is allowed to walk on the normal limb after the sutures are removed on 10 to 14 days except in comminuted fractures. Depending on the wound condition antibiotics are stopped. Partial weight bearing is delayed till 4 to 6 weeks, depending on the type of fractures, radiological evidence and associated injuries

Further follow up is done at 4 weekly intervals i.e. at 8, 12, 16, 20, 24 weeks and each patient is assessed clinically and radiologically as per the standard protocol.

The management protocol in this study was as follows

1. Surgery done in elective manner.
2. Life threatening injuries were given priority.
3. Limb saving measures taken.
4. Whenever needed physicians, neuro surgeons, plastic surgeons, vascular surgeons help sought.
5. We used CARM in most of the cases.
6. All fractures were treated with intramedullary nails.
7. Wound inspection done on 2nd postoperative day, sutures removed on 10th-14th day.
We followed Klemm & Borner’s criteria for evaluation of final results after tibial fractures.

Klemm & Borner’s criteria

<table>
<thead>
<tr>
<th>Functional Results</th>
<th>Excellent</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Full knee and ankle motion No muscle atrophy Normal radiological alignment</td>
<td>Slight loss of knee and ankle motion (&lt;25 degrees) Less than 2cm of muscle atrophy. Angular deformity (&lt;5%)</td>
<td>Moderate loss of knee and ankle motion (25 degrees) More than 2cm of muscle atrophy Angular deformity (5-10 degrees)</td>
<td>Marked loss of knee or ankle motion (&gt;25 degrees) Marked muscle atrophy Angular deformity (&gt;10)</td>
</tr>
</tbody>
</table>
OBSERVATIONS AND RESULTS

A total of 100 patients with fracture shaft of tibia (102 fractures) with intramedullary nailing in Bhanu Orthopaedic Home Karimnagar, A.P. (India) were studied for the past 10 years. The patients are followed for at least 6 to 8 months. The patients who are available for follow up are only included.

Preoperatively the following factors were observed and tabulated as follows:

Incidence according to age distribution

<table>
<thead>
<tr>
<th>Age group</th>
<th>No of cases</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-20</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>21-30</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>31-40</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>41-50</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>51-60</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>above 60s</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Average = 36.47

Incidence according to sex

<table>
<thead>
<tr>
<th>sex</th>
<th>%</th>
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<tbody>
<tr>
<td>M</td>
<td>82</td>
</tr>
<tr>
<td>F</td>
<td>18</td>
</tr>
</tbody>
</table>

Incidence according to side of fracture

<table>
<thead>
<tr>
<th>Side of fracture</th>
<th>No of cases</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Side</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Left Side</td>
<td>42</td>
<td>40</td>
</tr>
</tbody>
</table>

Right tibia was fractured more commonly than the left side.
Side of Injury

![Side of Injury Graph]

Mode of Injury

<table>
<thead>
<tr>
<th>Mode of Injury</th>
<th>No of Cases</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTA</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Fall</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

According to level of fracture

<table>
<thead>
<tr>
<th>Level of fractures</th>
<th>Proximal 3rd</th>
<th>Middle 3rd</th>
<th>Distal 3rd</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of cases</td>
<td>4</td>
<td>92</td>
<td>6</td>
</tr>
<tr>
<td>Percentage</td>
<td>4</td>
<td>92</td>
<td>6</td>
</tr>
</tbody>
</table>

Pattern of Fractures:
### Pattern of Fractures

- **Comp CM #**: 8 cases, 8%
- **CM# Comp Gr1**: 6 cases, 5%
- **CM# Comp Gr2**: 4 cases, 3%
- **Ob # Comp Gr2**: 1 case, 1%
- **Comp Trans#**: 1 case, 1%
- **CM# Segmental**: 1 case, 1%
- **CM#**: 26 cases, 25%
- **Seg #**: 1 case, 1%
- **Seg# Tibia**: 1 case, 1%
- **Ob #**: 35 cases, 35%
- **Spiral #**: 10 cases, 10%
- **Tr #**: 8 cases, 8%

#### Compound 20

- **Simple 82**
<table>
<thead>
<tr>
<th>Associated injuries</th>
<th>No of cases</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avulsion # Tibial spine (ipsi)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>I/T # Femur (ipsi)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Hanson's disease</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Depressed # lateral condyle of tibia (ipsi)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Medial Malleolus # (ipsi)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td># Base of 1st</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Segmental # Fibula (ipsi)</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td># Iliac crest (ipsi)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td># Shaft femur (ipsi)</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Hip dislocation post (ipsi)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Crush injury foot (ipsi)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Middle malleolus contra</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Colles # contra</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td># Base of 5th MT (ipsi)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Fibula Jn of upper &amp;</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CM# BB Rt leg</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td># Neck of scapula (ipsi)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Peroneal Tendon cut</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Humerus #</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Pubicramus #</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td># Base of 5th MT (ipsi)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ipsilateral fibula</td>
<td>98</td>
<td>98</td>
</tr>
</tbody>
</table>

Hip dislocation reduction was given a priority it was relocated then tibia fracture was managed.

I/T Fracture was fixed by DHS.

Fracture Shaft femur fixed by locking IM nail in two cases. 1) Compound comminuted fracture fixed by EX fix later fixed by IM nail. 2) One distal femur fracture fixed by Supracondylar nail.

Fracture Middle malleolus fixed by cannulated 4mm cancellous screws K wires.

Depressed # lateral condyle of tibia (Ipsi lateral) is fixed in the same sitting by cannulated cancellous screws.
Humerus fracture fixed by DC plate.

Peroneal Tendon cut repaired in the same sitting. Other injuries were treated conservatively.

**Associated injuries**

<table>
<thead>
<tr>
<th>Type of Anaesthesia</th>
<th>No of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>All cases</td>
<td>operated under spinal anaesthesia only.</td>
</tr>
</tbody>
</table>

**Approach:** Except 3 cases, all other cases were operated by patellar tendon splitting approach. Three cases were done by patellar retraction.

**Nail size and Locking:**

<table>
<thead>
<tr>
<th>Nail size</th>
<th>no of cases</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>8mm</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>9mm</td>
<td>51</td>
<td>50</td>
</tr>
<tr>
<td>10mm</td>
<td>50</td>
<td>49</td>
</tr>
</tbody>
</table>

In our study we used mainly 9mm & 10mm nails. In one case where medullary canal was narrow we used 8mm nail. We used static locking in all the cases, dynamized when needed.
Patient mobilization:

All cases were mobilized from the day one with quadriceps ankle foot toe exercises. In young patients with secure fixation, partial weight bearing started early. In comminuted fractures partial weight bearing delayed up to 6 weeks. Average period of full weight bearing was 13 weeks.

<table>
<thead>
<tr>
<th>FWB</th>
<th>No of cases</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 weeks</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>12 weeks</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>14 weeks</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>&gt;14 weeks</td>
<td>13</td>
<td>13</td>
</tr>
</tbody>
</table>

Union:

Average period of union was 17 weeks.

Primary procedure:

<table>
<thead>
<tr>
<th>Primary procedure</th>
<th>No of cases</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex Fix</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>ILN</td>
<td>81</td>
<td>81</td>
</tr>
<tr>
<td>ILN + B.G</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>ILN + B.G +Fibula osteotomy</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

The primary procedure was Ex Fix fixation in 5 cases of compound comminuted grade 2 & 3 fractures all the cases were converted to Interlocking Nailing afterwards. Closed Nailing done in 1 and in others open Nailing. In 2 cases Fibullectomy was done. Bone Grafting done in 4 cases. In 1 case dynamization was done after 12 weeks.
Non Union cases

In one case with Interlocking Nailing there was a gap at the fracture site. And it was dynamized, Bone Grafting and Fibulectomy done. In another case where there was a fracture gap with long proud nail with long distal anteroposterior screws causing neurological problem (tingling & numbness in the foot) exchange nailing and Bone Grafting done. In four cases Interlocking Nailing, Bone Grafting and Fibular Osteotomy done. In the rest of the seven cases Interlocking Nailing and Bone Grafting done.

Secondary Procedure:

<table>
<thead>
<tr>
<th>Procedure</th>
<th>No of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILN + B.G</td>
<td>2</td>
</tr>
<tr>
<td>Dynamization</td>
<td>6</td>
</tr>
<tr>
<td>ILN + B.G + Fibulectomy</td>
<td>1</td>
</tr>
<tr>
<td>Closed nailing</td>
<td>1</td>
</tr>
<tr>
<td>DM + Fibulectomy + B.G</td>
<td>1</td>
</tr>
<tr>
<td>Exchange nailing + B.G</td>
<td>1</td>
</tr>
</tbody>
</table>

In simple Interlocking Nailing cases (85) only 5 were dynamized between 12 – 16 weeks depending on the progress of fracture healing. Fibulectomy and Bone Grafting were done in only complicated compound fractures and Non Union cases. Fibular Osteotomy as secondary procedure done in only 2 cases, as a primary procedure in 4 cases of Non Union. Bone Grafting as a primary procedure was done 14 cases and secondary procedure in 5 cases. Out of these only 4 were uncomplicated cases.

Range of Motion:

<table>
<thead>
<tr>
<th>Range of motion knee (degrees)</th>
<th>No of cases</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>125</td>
<td>1</td>
<td>0.98</td>
</tr>
<tr>
<td>130</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>135</td>
<td>15</td>
<td>14.7</td>
</tr>
<tr>
<td>140</td>
<td>43</td>
<td>42</td>
</tr>
<tr>
<td>145</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>150</td>
<td>27</td>
<td>26</td>
</tr>
</tbody>
</table>

Average=140.567

The average range of Motion was 140.6 degrees. Full Knee motion was observed in 98 cases, 2 patients showed loss of more that 25% motion at the knee compared to the normal side. While 1 patient showed < 25% loss of joint motion.
Full ankle motion was observed in 87 cases, in 13 cases showed a loss of < 25 % of motion at the ankle compared to the normal side. 2 cases showed > 25 % of loss of joint motion. Average range of motion in the ankle joint was 80 degrees.

Muscle Atrophy:

More than 2 cms of muscle atrophy is seen in four cases less than or equal to 2 cms is seen in 12 cases.

Infection:

5 cases showed superficial infection 4 cases showed deep infection.

Malunion:

1 case of malunion was found with a valgus deformity of less than 5 degrees. No cases of significant rotational deformities were noted.

Implant failure:

2 cases of distal screw breakage were seen 2 cases of proximal screw breakage with (automatic dynamization) were seen which did not affect the fracture healing.

Knee Pain:

26 cases complained of pain the knee joint, it was a mild variety 1 case of knee pain needed removal of nail after the fracture consolidation.

Complication:

Per operative: There were few cases of drill bit breakage K wire breakage, guide wire breakage and reamer breakage were noted. We were fortunate enough to retrieve them with no untoward incident. There was 1 case of posterior cortical break which was indentified and corrected by placing the nail interiorly.

<table>
<thead>
<tr>
<th>Complications</th>
<th>No of cases</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delayed union</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Malunion</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Infection</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>LLD</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Implant failure screw breakage</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Knee pain</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>Deep vein thrombosis</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Venous mal formation</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Infection:

<table>
<thead>
<tr>
<th>Infection</th>
<th>No of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>S.I</td>
<td>5</td>
</tr>
<tr>
<td>D.I</td>
<td>4</td>
</tr>
</tbody>
</table>

There were 5 cases of Superficial Infection (S.I) & 4 cases of Deep Infection (D.I) which needed removal of Implants after Fracture Union.

Ankle motion:

<table>
<thead>
<tr>
<th>Ankle</th>
<th>No of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;25% loss</td>
<td>13</td>
</tr>
<tr>
<td>&gt;25% loss</td>
<td>2</td>
</tr>
</tbody>
</table>
Result:

<table>
<thead>
<tr>
<th>Functional result</th>
<th>No of cases</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>71</td>
<td>70</td>
</tr>
<tr>
<td>Good</td>
<td>27</td>
<td>26</td>
</tr>
<tr>
<td>Fair</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Poor</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Functional results

<table>
<thead>
<tr>
<th>Functional Results</th>
<th>No of cases</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>71</td>
<td>70</td>
</tr>
</tbody>
</table>
| Full knee and ankle motion
No muscle atrophy Normal radiological alignment | 71 | 70 |
| Good               | 27          | 26         |
| Slight loss of knee and ankle motion (< 25°)
Less than 2cm of muscle atrophy
Angular deformity | 27 | 26 |
| Fair               | 2           | 2          |
| Moderate loss of knee and ankle motion
More than 2cm of muscle atrophy
Angular deformity 5° to 10° | 2 | 2 |
| Poor               | 2           | 2          |
| Motion loss of knee and ankle > 25°
Marked muscle atrophy
Angular deformity more than 10° | 2 | 2 |

Function results were graded according to the criteria by Klemm and Borner (1986) 96% of cases achieved good or excellent results. Fair results were obtained in 2 cases. Poor results are obtained in 2 cases.
OUTCOMES

CASE NO: 1

**Name** : D. Sai Kumar  
**Date of Injury** : 16/07/2002

**Age** : 30 years  
**Date of operation** : 24/07/2002

**Sex** : Male  
**Date of discharge** : 14/08/2002

**Address** : Karimnagar

**Diagnosis** : Fracture shaft Tibia Left Middle 3rds

**Type of Fracture** : Compound Grade 1 Comminuted Fracture

**Associated Fractures** : Fracture Fibula

**Associated Diseases** : Nil

**Mechanism of Injury** : Road Traffic Accident

**Surgical Details** : Open reduction Internal fixation with Interlocking Nailing & Bone Grafting.

**Post operative period** : Uneventful

**Discharge advice** : No weight bearing for 6 weeks with quadriceps exercises.

**Results**

**Follow-up** : Full weight bearing from 12 weeks

**Fracture union** : 16 weeks

**Shortening** : Nil

**Deformity** : Nil

**Infection** : Nil

**Muscle Atrophy** : Nil

**Knee Range of Motion** : $150^\circ$

**Ankle Range of Motion** : Full

**Functional result** : Excellent
DISCUSSION

Tibia is the most commonly fractured long bone in the body and the exposed anatomical location makes it vulnerable to trauma. Open fractures are more common than in any other bone as 1/3 of it surface is subcutaneous throughout most of its length.

Fractures of the Tibia cannot be treated by a simple set of rules. By its very location it is exposed to frequent injury. The blood supply of the Tibia is more precarious than that of the bones enclosed by heavy muscles. The presence of hinge joints at the ends (knee & ankle) don’t allow adjustment for rotatory deformity after fractures and thus special care is necessary during reduction to prevent such deformity. Tibial fractures can be treated with cast, functional bracing and operative treatment. Operative treatment is indicated in unstable fractures open fractures and tibial fractures in poly trauma patients and patients with multiple fractures. An acceptable amount of malalignment and shortening also is controversial.

Operative treatment consists of V nailing, Open Reduction & Internal fixation with DC plating, IM nailing, locked IM nailing, presently there is resurgence of MIPO (Minimally Invasive Plate Osteosynthesis) technique with locking plates. In this era of biological plating, areas of comminution in the bone are bypassed. Often the dissection of the fragments devitalizes them, leading to delayed union and possible sepsis. Therefore the area of comminution should be bypassed or bridge plated. IM nailing without locking in tibial fractures is indicated in the middle third of fractures with bony contact i.e., stable fractures like transverse and short oblique fractures. The locked intramedullary nailing is indicating in unstable fractures with comminution or long spiral fractures. In open fractures the locked intramedullary nailing provides better mechanical stability for early soft tissue handling & healing. The introduction of ILN (Inter Locking Nailing) widened the applications to proximal and distal fractures, delayed, and non union cases.

The patients with tibial fractures should be clinically assessed for any associated injuries. The medical conditions for fitness for surgery should be evaluated. First life care later limb care measures should be taken as a priority. Head, abdominal and chest injuries must be attended by the appropriate surgeons. Local examination of the limb is done to rule out neuro vascular injuries and it must be documented. If there is any doubt about the vascularity, emergency angiography should be done to confirm vascular injury, if it is found vascular surgeons help is sought and tibial fractures should be fixed on emergency basis. As our centre is having limitations such cases are referred to higher centers.

Age and Sex Distribution:

The mean age of the patients in the present study was 36.47 years, majority of the patients were males accounting for 82 (82%) females 18 (18%). Total cases are 102 Males-83 (83%) & Females-19 (17%). The average age of patients was 37.2 years in a study of epidemiology of tibial fractures by Court-Brown at al. The average age in a study of 50 fractures of tibia conducted by Whittle et al was 34 years.
<table>
<thead>
<tr>
<th>Study</th>
<th>Average age of Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Court Brown et al</td>
<td>37.2</td>
</tr>
<tr>
<td>Whittle et al</td>
<td>34</td>
</tr>
<tr>
<td>Our study</td>
<td>36.47</td>
</tr>
</tbody>
</table>

The increased incidence of tibial fractures in young males corresponds with their activity level and whereas the incidence again increases in elderly due to osteoporosis.

**Mode of injury:**

The leading cause of the injuries was RTA (Road Traffic Accidents) in the present study accounting for 90% of cases. The commonest cause of tibial diaphyseal fractures was RTA (40.7% of open fractures) in Court Brown et al study, whereas Bonatus et al reported that 54.16% of their causes were due to RTA. This indicates incidence can be brought down by road safety measures.

<table>
<thead>
<tr>
<th>Study</th>
<th>RTA %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Court Brown et al</td>
<td>40.7 %</td>
</tr>
<tr>
<td>Bonatus et al</td>
<td>54.16%</td>
</tr>
<tr>
<td>Our study</td>
<td>90.0%</td>
</tr>
</tbody>
</table>

**Associated injuries:**

Majority of the fractures involved middle third of the tibia 92 cases (90.20%). Proximal third 4 cases (3.92%) Lower third 6 cases (5.88%). The outcomes of isolated fractures of tibia was not different from rest of the fractures. In all cases fibula was fractured. The fibula was intact in 6.8% of fractures in Court-Brown et al study. In four cases there was segmental fracture of fibula.

Other associated injuries were fracture shaft femur 4 cases (4%), I/T fractures 2 cases (2%), fracture medial malleolus 2 cases (2%), hip dislocation 1 (1%), fracture pelvis 2 (2%), (fracture iliac crest 1 case, fracture pubic rami 1 case), contra lateral humerus fracture 1 case. 1 crush injury foot, 1 peroneal tendon cut injury. 1 patient was having associated Hanson’s disease, (ipsilateral)

**Nail size and Locking:**

Average diameter of the nails in the present study was 9.48mm. 9mm (50%), 10mm (49%). In 1 case 8mm nail was used where the medullary canal was very narrow. Keating et al used nails with an average diameter of 11.5mm for reamed nailing in their study compared to 9.2mm in case of unreamed nailing. Blachut et al reported 11.3mm (9mm for undreamed nailing) & Finkemier et al reported using 8-11 diameter nails for reamed nailing.

Reaming allows insertion of larger diameter, stronger nails with larger bolts which produce tight bone implant contact that provide load sharing and resistance to bending or angulation at the fracture site. Unreamed small diameter nails, despite interlocking may not provide adequate stability, especially in proximal and distal third fractures and after dynamization. The reamed nails can be dynamically locked in stable fracture configurations such as middle third transverse fractures without comminution, allowing early weight bearing without the fear of screw breakage.
We used 9 & 10mm nails mostly which is much smaller when compared to Western studies because the diameter of the medullary canal of Indian patients is smaller.

Patient mobilization:

Patients were encouraged to move knee and ankle joints on the first post operative day after the patient has recovered from anaesthesia. In young patients with secure fixation, partial weight bearing started early. In comminuted fractures partial weight bearing delayed up to 6 weeks. Average period of full weight bearing was 13 weeks. In 3 cases full weight bearing started at 10 weeks, in 75 cases full weight bearing started at 12 weeks, in 9 cases full weight bearing started at 14 weeks & in 13 cases full weight bearing started after 14 weeks because of various reasons like comminution, associated fractures, infection and poor general condition.

Keating et al\textsuperscript{28} in their study advised the patients to remain non weight bearing for the first 6 weeks after injury.

Larsen et al\textsuperscript{34} allowed partial weight bearing for 6 weeks in early post operative period.

\begin{table}[h]
\centering
\begin{tabular}{|l|l|}
\hline
\textbf{Study} & \textbf{No of Weeks} & \textbf{Non Weight Bearing} \\
\hline
Keating et al\textsuperscript{28} & 6 weeks & \\
Larsen et al\textsuperscript{34} & 6 weeks & \\
Our study & 4 to 6 weeks & \\
\hline
\end{tabular}
\end{table}

Patients should be advised to do isometric and isotonic quadriceps exercises along with ankle movement during this period of 4-6 weeks to prevent joint stiffness.

Union:

Donald et al reported a union time of 28 weeks in closed fracture treated by reamed nailing.

Cole et al\textsuperscript{9} reported an 100\% union rate in closed fractures treated by reamed nailing.

Finkemier et al\textsuperscript{21} reported as 83\% union rate in fracture treated by reamed nailing at the end of 12 months.

Puno et al reported an average union time of 15.9 weeks in fracture treated reamed intramedullary nailing with 94\% union rate.
Study | Union time
---|---
Donald et al | 28 weeks
Puno et al\(^{36}\) | 15.9 weeks
Court Brown et al\(^{20}\) | 22 weeks
Our study | 17 weeks

Study | Union Percentage
---|---
Cole et al\(^{9}\) | 100%
Finkemier et al\(^{21}\) | 83%
Puno at al\(^{36}\) | 94%
Our study | 100%

The results of the present study are comparable with those other studies. The union rate in our studies was 100% with average union time of 17 weeks. In 12 cases union time was 20 weeks, in 5 cases it was more than 22 weeks. The delay in union was seen in mostly open grade 3 fractures and non union cases.

Secondary procedure:

Dynamization allows the fracture site to be compressed during the early weight bearing and enhance fracture healing.

Templeman et al dynamized between 6-12 weeks. Singer et al recommended dynamization between 8-12 weeks if the healing is delayed.

Dynamization was done by removing either the proximal or distal bolts depending on the fracture healing. In 5 direct interlocking nail cases dynamization was done 12-16 weeks. In 1 case of compound Grade 3 comminuted fractures dynamization was done after 12 weeks when there was no union progression. In 1 case of post of ILN with gap at fracture side fibulectomy and dynamization was done (non union case).

Study | Dynamization time
---|---
Templeman et al\(^{39}\) | 6-12 weeks
Singer et al\(^{38}\) | 8-12 weeks
Our study | 12-16 weeks

Approach and knee pain:

Anterior knee pain is the most common complication after intramedullary nailing of the tibia. Dissection of the patellar tendon and its sheath during nailing is thought to be a contributing cause of anterior knee pain. Toivenan et al concluded that a paratendinious approach for nail insertion does not reduce the prevalence of chronic anterior knee pain or functional impairment. Keating et al found a 57% incidence and Court Brown et al documented 56.2% incidence of knee pain. We used PTS approach in 97 cases in 3 cases Patellar retraction approach was used.
The cause of anterior knee pain may be prominent (proud) nail, heterotrophic ossification of patellar tendon, injury to menisci or ligaments or due to degenerative changes in the joint. If the knee pain is severe, nail removal will be lead to improvement of the symptoms.

<table>
<thead>
<tr>
<th>Study</th>
<th>Incidence of Anterior knee pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keating et al²⁸</td>
<td>57%</td>
</tr>
<tr>
<td>Court Brown et al²⁰</td>
<td>56.2%</td>
</tr>
<tr>
<td>Our Study</td>
<td>27.0%</td>
</tr>
</tbody>
</table>

This study indicates the incidence of anterior knee pain our study is less compared to others.

**Range of motion:**

Average range of knee motion was 140.57° (range 128°-161°) & that of Ankle movements was 84° (range 45°-109°). In tibial Fractures treated by reamed nailing in a study reported by Larsen et al.

Keating et al reported restriction of knee movements in 7% of cases & loss of ankle motion in 14% of cases.

The average range of Motion was 140.6 degrees. Full Knee motion was observed in 98 cases, 2 patients showed loss of more that 25% motion at the knee compared to the normal side. While 1 patient showed < 25% loss of joint motion.

Full ankle motion was observed in 87 cases, in 13 cases showed a loss of < 25 % of motion at the ankle compared to the normal side. 2 cases showed > 25 % of loss of joint motion. Average range of motion in the ankle joint was 80 degrees.

<table>
<thead>
<tr>
<th>Study</th>
<th>Average ROM knee</th>
<th>Average ROM Ankle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larsen et al²⁴</td>
<td>141°</td>
<td>84°</td>
</tr>
<tr>
<td>Keating et al²⁸</td>
<td>146°</td>
<td>87°</td>
</tr>
<tr>
<td>Our study</td>
<td>140.57°</td>
<td>80°</td>
</tr>
</tbody>
</table>

Post operative ROM at knee & ankle in present study is comparable to that of other studies.

**Complications:**

One case of compartmental syndrome resolved after surgery. There were no cases of fat embolism or peroneal palsy in our study. There were few cases of Tourniquet induced neuropraxia which resolved in few weeks. There was a case of Deep vein thrombosis treated by vascular surgeon. It was diagnosed around 6-10 weeks when the swelling was not coming down conformed by color Doppler study. There was 1 case of venous anamoly refered to vascular surgeon.
McQueen et al reported no evidence of increased incidence of compartmental syndrome with reamed intramedullary nailing.

Christie et al noted that tibial reaming nailing did not result in respiratory problems due to fat embolism.

**Malunion:**

Malunion is a common problem proximal 3rd fractures due to large Discrepancy in size between nail & Diaphysial marrow.

Larsen et al reported malunion in 2 of 22 patients with reamed ILN.

Freedman & Johnson found that 58% of Proximal Fractures were malaligned compared to 7% of Middle 3rd & 8% of Distal 3rd.

Singer et al stated that it is imperative that the fracture be held reduced during nail insertion in case of Proximal tibial Fractures through the use of bone clamps & blocking screws.

1 case of malunion was found with a valgus deformity of less than 5 degrees. No cases of significant rotational deformities were noted.

<table>
<thead>
<tr>
<th>Study</th>
<th>Malunion%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larsen et al</td>
<td>16%</td>
</tr>
<tr>
<td>Freedman &amp; Johnson</td>
<td>8%</td>
</tr>
<tr>
<td>Our study</td>
<td>1%</td>
</tr>
</tbody>
</table>

Malunion Percentage in the present study is less when compared to other studies. Refinements in Technique, precise placement of entry portal extending during insertion of nail in Proximal Fractures using a nail with a more proximally located Herzog’s bend use of blocking screws & unique cortical plates can be used to reduce the malalignment.

**Infection:**

Blachut et al reported an infection rate of 0% in Closed fractures in reamrd nailing & 2% in closed fractures in undreamed nailing.

Court Brown et al reported an infection rate of 6.9% in Gustilo type I fracture & 6.6% in type II fracture with reamed nailing.

Finkemier et al reported 5% infection rate in his study.

Singer et al recommended use of antibiotics for 2-6 weeks in cases of infection with ILN.

There were 5 cases of Superficial Infection (S.I) & 4 cases of Deep Infection (D.I) which needed removal of Implants after Fracture Union. In 1 case of Sequential nailing after removal of Ex Fix & Functional cast bracing failed to unite the fracture Deep infection was found. This subsided after removal of nail after fracture was united.
In 3 closed ILN cases, 2 cases needed removal of Implant to contain the infection. In 1 case removal of nail is awaited to control the Infection. In these cases it took nearly 16-22 weeks to unite the fracture.

5 cases of Superficial Infection were treated by appropriate antibiotics selected after culture & sensitivity tests, & regular dressings & fractures united around 16-22 weeks.

<table>
<thead>
<tr>
<th>Study</th>
<th>Infection%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blachut et al(^3)</td>
<td>0%</td>
</tr>
<tr>
<td>Finkemier et al(^2)</td>
<td>5%</td>
</tr>
<tr>
<td>Our study</td>
<td>9%</td>
</tr>
</tbody>
</table>

Infection rates in our present study are comparable to other studies.

**Implant Failure:**

In our study 4 cases of Screw breakage or screws backing out were seen causing auto dynamization leading to fracture union. In 1 case of Proximal fracture 2nd Proximal bolt breakage was seen with collapse at fracture site with eventual union.

Finkemier et al observed that the bolt failure might sometimes result in auto dynamization leading to quick Fracture healing.

Keating et al reported a 9% incidence of Screw breakage with reamed nailing compared with 29% in undreamed group in their study.

Larsen et al reported 1 screw failure in 22 cases treated by reamed nailing.

Finkemier et al reported no screw breakage in reamed nails compared to 6 cases of screw failure with undreamed nails.

Blachut et al reported 2% incidence of screw failure in reamed nailing & 16% incidence of screw failure in undreamed nailing in 154 closed tibial fractures.

Various comparative studies have demonstrated a significantly increased incidence of screw failure with undreamed nails. The increased risk of screw breakage is directly related to small diameter of the so called undreamed nails & screws, which are more prone to fatigue failure.

<table>
<thead>
<tr>
<th>Study</th>
<th>Screw breakage%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keating et al(^2)</td>
<td>9%</td>
</tr>
<tr>
<td>Larsen et al(^4)</td>
<td>4.3%</td>
</tr>
<tr>
<td>Finkemier et al(^2)</td>
<td>0%</td>
</tr>
<tr>
<td>Blachut et al(^3)</td>
<td>2%</td>
</tr>
<tr>
<td>Our study</td>
<td>4%</td>
</tr>
</tbody>
</table>

Screw breakage percentage is same as the other studies.
<table>
<thead>
<tr>
<th>Studies</th>
<th>No.</th>
<th>Type</th>
<th>Union (wk)</th>
<th>Infection (%)</th>
<th>Non union (%)</th>
<th>Malunion (%)</th>
<th>Infection (%)</th>
<th>Screw breakage (%)</th>
<th>Knee pain (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Klemm &amp; Borner(^{30}) (1986)</td>
<td>267</td>
<td>Closed open (Gr I)</td>
<td>-</td>
<td>2.2</td>
<td>1.1</td>
<td>-</td>
<td>-</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>Henley(^{25}) (1989)</td>
<td>24</td>
<td>Closed open (Gr I,II)</td>
<td>24</td>
<td>0</td>
<td>0</td>
<td>4.2</td>
<td>-</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Court Brown et al(^{12}) (1990a)</td>
<td>125</td>
<td>Closed open (Gr I)</td>
<td>16.7</td>
<td>1.6</td>
<td>1.6</td>
<td>2.4</td>
<td>7.2</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>Alho(^{2}) et al (1990)</td>
<td>93</td>
<td>Closed open (Gr I,II)</td>
<td>15</td>
<td>3.2</td>
<td>3.2</td>
<td>10.7</td>
<td>9.7</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>Hooper(^{27}) et al (1991)</td>
<td>29</td>
<td>Closed open (Gr I)</td>
<td>15.7</td>
<td>0</td>
<td>0</td>
<td>3.4</td>
<td>13.7</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td>Habernek(^{24}) et al (1992)</td>
<td>109</td>
<td>Closed open (Gr I,II)</td>
<td>-</td>
<td>1.8</td>
<td>6.4</td>
<td>12.8</td>
<td>-</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>Our study</td>
<td>102</td>
<td>Closed open (Gr I,II,III)</td>
<td>17</td>
<td>9</td>
<td>0</td>
<td>0.98</td>
<td>16.6</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

**Functional results:**

Functional results were graded according to the criteria by Klemm & Borner (1986). 96% of cases achieved good or excellent results, Fair result was obtained in 2% cases & poor result was in 2% cases.
Analysis

102 cases (100 patients) of fractures of Tibial shaft treated with reamed intramedullary nailing were studied for the past >10 years formed the basis of present study.

Average age of the patients was 36.47, with majority of the patients were in the age group of 21-50. Males accounted for 82%, Females for 18%. Right side is more than left side 60 & 42. RTA was the main culprit accounting for 90%. Middle 3rd of Tibia was involved in 92 cases. Oblique fractures were 35% followed by Comminuted Fractures. All cases are associated with fibula fracture. Patellar Tendon splitting approach is used in 96% cases.

9mm & 10mm are the commonest used nails. Dynamization was done in 7 cases. All the fractures united with union rate of 100%.

Average ROM of knee joint was 140.570. Full movement was observed in 99 cases. 3 patients showed loss of motion. Average ROM of ankle joint was 800. Full ankle motion was observed in 87 cases, in 13 cases showed a loss of < 25 % of motion at the ankle compared to the normal side. 2 cases showed > 25 % of loss of joint motion. Average range of motion in the ankle joint was 80 degrees.

There were 4 cases of Deep Infection & 5 cases of Superficial infection. Overall functional grading was excellent in 71 cases (70%), good in 27 cases (26%), Fair in 2 cases (2%), Poor in 2 cases (2%).
Conclusions & Recommendations

Fractures of tibia represent a complex problem & optimal management is essential if the patient is to regain significant preinjury level of function.

- Careful preoperative planning & respecting the principles of reamed Interlocking nailing technique are essential for obtaining good results.
- The surgeon should try to overcome the learning curve for performing intramedullary interlocking nailing.
- High union rates, low incidence complications including infection & good functional results suggested that reamed interlocking nailing technique is a satisfactory method of treating of closed & open Gr I, II & few Gr III tibial fractures.
- Most complications following interlocking intramedullary nailing are minor & can be easily treated.
- Reamed intramedullary interlocking nailing is a safe & effective technique for management of closed & open tibial fractures. In compound fractures it can be used as sequential nailing after removal of External fixator. The method is safe & effective in achieving solid union with least number of complications.
- This can be used in non union cases & as an Exchange nailing with Bone Grafting in cases of non union with interlocking nailing.
REFERENCES

34. Larsen LB, Madsen JE, HoinessPR, Ovre S. Should insertion of intramedullary nails for tibial fractures be with or without reaming? A prospective, randomized study with 3.8 years follow up. J Orthop Trauma 2004; 18: 144-149.


CASE 2

Name : Smt. Kamala
Date of injury : 28/01/2012

Sex : F
Date of Admission : 28/01/2012

W/O : Sri. Kanakaiah
Date of operation : 31/01/2012

Age : 45 years
Date of Discharge : 07/02/2012

Address : Karimnagar

Diagnosis : Fracture shaft Right Junction of Middle & Lower 3rds

Type of Fracture : Closed Spiral Fracture

Associated Fractures : Fracture Fibula

Associated Diseases : Nil

Mechanism of Injury : Fall

Surgical Details : Closed reduction & Interlocking nailing done

Post operative period : Uneventful

Discharge Advice : No weight bearing for 6 weeks with quadriceps exercises

Results

Follow-up : Full weight bearing from 12 weeks
Fracture union : 16 weeks

Shortening : Nil
Deformity : Nil
Infection : Nil

Muscle Atrophy : Nil
Knee range of motion : 145°
Ankle range of motion : Full
Functional grading : Excellent
CASE 3

Name       : Smt. Sarala                     Date of Injury       : 17/08/2011
W/O          : Satyanarayana                Date of Admission    : 17/08/2011
Sex           : F                             Date of operation     : 22/08/2011
Age            : 47 years                    Date of Discharge     : 31/08/2011
Address       : Karimnagar

Diagnosis     : Comminuted Fracture Both bones
Type of Fracture : Closed Middle 3rds
Associated Fractures : Fracture Fibula
Associated Diseases : Nil
Mechanism of Injury : Fall
Surgical Details : Closed Reduction ILN Fixation
Post operative period : Uneventful
Discharge Advice : No weight bearing for 6 weeks with quadriceps exercises

Results

Follow-up : Full weight bearing from 12 weeks
Fracture union : 16 weeks
Shortening : Nil
Deformity : Nil
Infection : Nil
Muscle atrophy : Nil
Knee Range of Motion : 150°
Ankle range of motion : Full
Functional grading : Excellent
Pre operative X ray

Post operative X ray

Follow up at 12 weeks

At union
CASE 4

Name       : Mahendhar       Date of Injury : 22/11/2012
S/O           : Mallaiah       Date of Admission : 22/11/2012
Sex           : M       Date of operation : 28/11/2012
Age           : 26 years       Date of Discharge : 06/12/2012
Address   : Elagandal
Diagnosis    : Fracture Both bones Right leg
Type of Fracture   : Comminuted Fracture Middle 3rds
Associated Fractures : Nil
Associated Diseases : Nil
Mechanism of Injury : RTA
Surgical Details : Closed reduction ILN fixation.
Post operative period : Uneventful
Discharge Advice : No weight bearing for 6 weeks with quadriceps exercises

Results

Follow-up : Full weight bearing from 12 weeks
Fracture union : 14 weeks
Shortening : Nil
Deformity : Nil
Infection : Nil
Muscle atrophy : Nil
Knee Range of Motion : $150^0$
Ankle range of motion : Full
Functional grading : Excellent
Pre-operative X ray

Post operative X ray

Follow up at 12 weeks

At union
CASE 5

Name : Pushpalatha  Date of Injury : 29/10/2009
W/O : Laxma reddy  Date of Admission : 29/10/2009
Sex : F  Date of operation : 06/11/2009
Age : 50 years  Date of Discharge : 17/11/2009
Address : Kothapally
Diagnosis : Comminuted fracture both bones Left leg Lower 3rds
Type of Fracture : Spiral fracture
Associated Fractures : Nil
Associated Diseases : Nil
Mechanism of Injury : Fall
Surgical Details : Semi closed ILN fixation + Bone Grafting.
Post operative period : Developed Deep vein thrombosis with swelling of whole lower limb. She was referred to vascular surgeon.
Discharge Advice : No weight bearing for 6 weeks with quadriceps exercises

Results
Follow-up : Full weight bearing from 12 weeks
Fracture union : 16 weeks
Shortening : Nil
Deformity : Nil
Infection : Nil
Muscle atrophy : Nil
Knee Range of Motion : 130°
Ankle range of motion : Full
Functional grading : Good
Pre-operative X ray

Post operative X ray

Follow up at 6 weeks

At union
CASE: 6

Name : Rajaiah  Date of injury : 18/01/2007
S/O : Kankaiah  Date of Admission : 18/01/2007
Age : 34 years  Date of operation : 20/01/2007
Sex : M  Date of Discharge : 27/01/2007

Diagnosis : Fracture both bones Rt Leg Middle Thirds.
Type of Fracture : Short oblique fracture
Associated fractures : Nil
Associated diseases : Nil
Mechanism of injury : Closed reduction & ILN fixation.
Post operative period : Uneventful
Discharge advice : No weight bearing for 6 weeks with quadriceps exercises

Results
Follow-up : Full weight bearing from 12 weeks
Fracture union : 14 weeks
Shortening : Nil
Deformity : Nil
Infection : Nil
Muscle atrophy : Nil
Knee Range of Motion : 150°
Ankle range of motion : Full
Functional grading : Excellent
Pre operative X ray

Post operative X ray

At union

At union
ABSTRACT

Background & Objectives:

Fracture Shaft of Tibia are increasing due to high velocity trauma and industrialization. They are one of the commonest fractures and difficult to treat. There are different modes of treatment like V nailing, plating, external fixation. They are having their own limitations like prolonged immobilization, infection, delayed union, non union, mal union. The introduction of intramedullary interlocking nail has overcome some of these, and encouraged early mobilization of patients. This study has been done to evaluate the results and complications of intramedullary interlocking nailing in tibial shaft fractures.

Methods:

Hundred adult patients with 102 fractures were treated surgically with interlocking nailing for the past 10 years.

Results:

Among the 102 cases treated with interlocking nailing fractures united with the union rate of 100%. 2 cases showed delayed union 1 slight mal union. 4 cases had screw breakage. 4 cases of deep infection, 5 cases of superficial infection were noted. 27 patients showed had anterior knee pain. Functional results were graded according to the criteria by Klemm & Borner. 96% of patients achieved good or excellent results, 2 patients fair & 2 patients poor results.

Conclusion:

This study with fractures of the tibia (closed, open Gr I, Gr II & sequential nailing in Gr III after removal Ex fix) treated with intramedullary interlocking nailing is a safe effective method of technique for management of any type of tibial shaft fracture with high union rates, low incidence of complication. Good functional results are achieved by careful preoperative planning and respecting the principles of reamed intramedullary nailing.

Key Words:

Reaming, intramedullary, interlocking nailing.
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First of all I must remember and thank my teachers, Professor Dr. Subbarao, Professor Dr. Markandeya who taught me the principles and practice of orthopedics in my initial stage.

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Dr. D. Narsimlu
M.S. (Ortho)
Bhanu Orthopedic Home
Karimnagar – A.P
Operative Procedure

Draping

Incision

Splitting Patellar Tendon

Entry hole

Passing Guide Wire

Reaming the Medullary canal
Exchange tube used to change ball tipped guide wire to smooth guide wire

Nail & jig assembly

Passing the Nail

Distal locking (K wire in the centre of the hole)

Stein man pin in the distal hole

Proximal Screws in situ
Nail in the canal with distal screw

Closure

THE TEAM

INSTRUMENTS & IMPLANTS