



# International Journal of Orthopaedics Sciences

ISSN: 2395-1958  
IJOS 2017; 3(1): 165-171  
© 2017 IJOS  
www.orthopaper.com  
Received: 27-11-2016  
Accepted: 28-12-2016

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## Analysis of extra articular proximal third tibial fractures treated with interlocked intramedullary nailing

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DOI: <http://dx.doi.org/10.22271/ortho.2017.v3.i1c.27>

### Abstract

**Background:** Fractures of the proximal third of tibia shaft have historically higher malunion rates than those of the midshaft. These fractures have been notoriously difficult to treat. With the advent of deepened understanding of the surrounding anatomy, several techniques have been developed to help maintain proper alignment without early failure or malunion.

**Aims and Objectives:** To study the results of intramedullary interlocking nail fixation in proximal third tibial fractures.

**Method:** A total of 20 patients were treated with intramedullary interlocking nail fixation and were followed up from 3 months to 3 years and their results were assessed according to Modified Klemm and Borner scoring system.

**Results:** According to Modified Klemm and Borner scoring system, we had 80% excellent to fair results and 20% poor results due to delayed union or non-union at the fracture site.

**Conclusion:** Interlocked intramedullary nailing of proximal third tibial fractures is an accepted modality of treatment. Stable and adequate intraoperative anatomical reduction is the key to early union and yields superior functional outcome.

**Keywords:** Tibia fracture, proximal third, intramedullary nailing

### 1. Introduction

Tibial shaft fractures are the most common of all the long bone fractures. Incidence of tibia fractures is nine times more common than femoral fractures. This is because 1/3rd of its surface is subcutaneous throughout its length. Fracture of tibia occurs most commonly in the distal 2/3<sup>rd</sup> of the bone whereas proximal third tibial fractures are relatively uncommon, the incidence of occurrence of proximal third tibial fractures being 5-11% [1]. Non articular proximal third tibial fractures continue to pose vexing problems for orthopedic surgeons due to their high morbidity and treatment dilemma.

Non articular proximal tibial fractures should be distinguished from more distal injuries. These fractures frequently result in malunion with apex anterior and valgus deformity [2, 3]. There has been continuous debate regarding the classification, management, biology of these fractures. However, selecting the best modality of treatment for the patient is still debatable [4]. Several authors have recommended changes to standard intramedullary nailing technique to attempt to prevent malunion in these fractures. These include keeping the knee in semi extended position to decrease the pull of quadriceps on the proximal fragment [5]. Using an entry point more lateral than the standard nailing [6].

Understanding the pertinent anatomy, classification systems, diagnostic modalities, and results of treatment with each modality should increase the appreciation of the difficulty of treating a given fracture and help to avoid the complications and pitfalls of various treatment methods. Since not many investigators have reported on such fractures, the current study attempts to analyse such fractures and their outcome with associated complications.

### 2. Materials and Methods

This study was carried out at Sri Ramachandra Medical College And Research Institute, Chennai.

**Type of Study:** Prospective

**Duration:** September 2002 till August 2005

**Total No of Patients:** A total of 20 patients were included in the study

**Duration of Follow up:** 3 months to 3yrs

**Mean Follow up:** 2 years

**2.1 Inclusion criteria**

- All proximal third tibial fractures treated with interlocking intramedullary nailing
- Fractures of proximal tibia extending to the proximal diaphysis
- Segmental fractures of tibia with proximal fracture in proximal third
- Closed fractures
- Open clean fractures with adequate soft tissue coverage

**2.2 Exclusion criteria**

- Tibial plateau or condylar fractures of tibia
- Proximal third tibial fractures with ipsilateral supracondylar femur fractures (floating knee )
- Open contaminated fractures without soft tissue coverage (Gustilo Anderson grade III A, B and C fractures).
- Proximal third tibial fractures treated by other modalities
- Pathological Fractures
- Patients without Epiphyseal Closure

All patients history was noted with particular importance to mode of injury and associated medical and surgical illness.

Fracture pattern was assessed with X-ray in AP and LATERAL view of the leg with knee and ankle and classified according to the AO classification (Figure 1).

Soft tissue injury pattern were assessed and classified according to the Gustilo Anderson’s classification.

Relevant X-rays of any associated bony injuries were taken and further management planned.

All patients were immobilized with Thomas Splint or plaster of paris slab in the Emergency Room as soon as they presented.

All open fractures were given thorough wound wash in Emergency Room and immediately started on I.V. broad spectrum antibiotics

Depending upon the medical conditions, associated injuries and assessing the severity of soft tissue injury, patients were taken up for Interlocked Intramedullary Nailing as early as possible.

In case of delay in surgery patients were immobilized with calcaneal skeletal traction

Time Gap between Injury to Surgery: < 5 days: 12 Patients

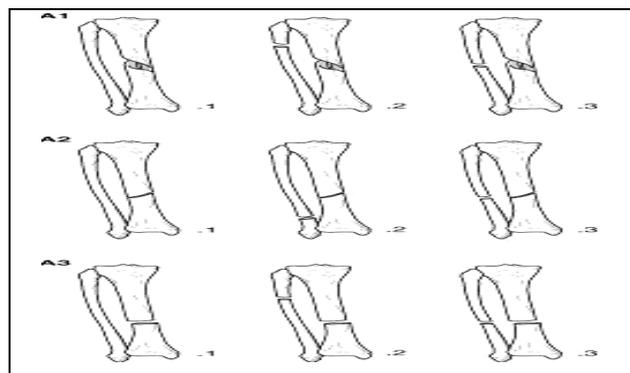
> 5 days: 8 Patients

Routine AP and Lateral X-rays of the leg including both knee joint and ankle joint

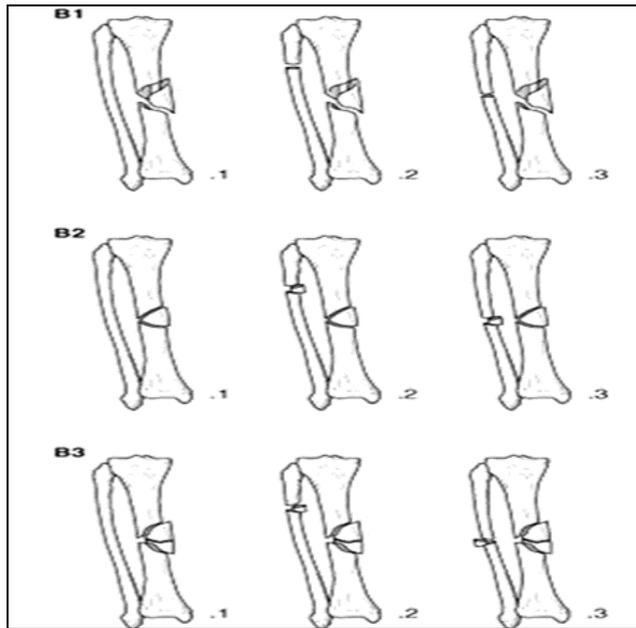
**2.3 Length of Nail:** Tibial tuberosity to center of tibial plafond on the normal side.

Average surgical Time: 1.5 hrs to 2 hrs

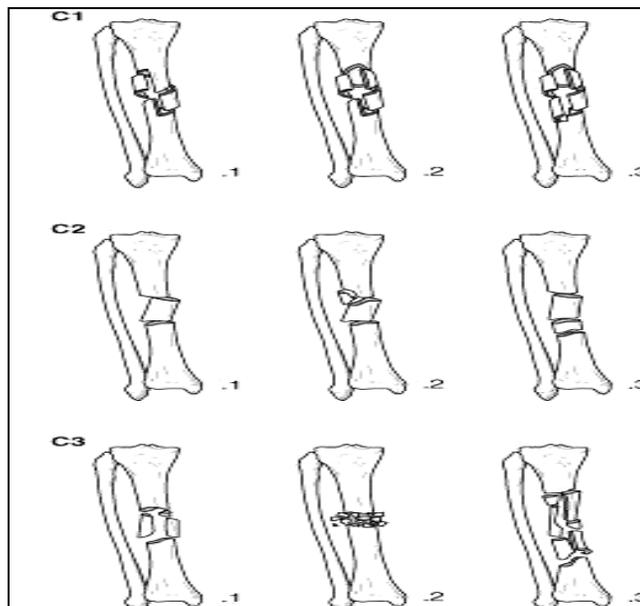
All patients were operated under the guidance of Image Intensifier.



Type A: Unifocal fractures	
Group A1	Spiral fractures
Subgroups	A1.1 Intact fibula
	A1.2 Tibia and fibula fractures at different level
	A1.3 Tibia and fibula fractures at same level
Group A2	Oblique fractures (fracture line >30 degrees)
Subgroups	A2.1 Intact fibula
	A2.2 Tibia and fibula fractures at different level
	A2.3 Tibia and fibula fractures at same level
Group A3	Transverse fractures (fracture line <30 degrees)
Subgroups	A3.1 Intact fibula
	A3.2 Tibia and fibula fractures at different level
	A3.3 Tibia and fibula fractures at same level



Type B: Wedge fractures		
<b>Group B1</b> Intact spiral wedge fractures		
Subgroups	B1.1	Intact fibula
	B1.2	Tibia and fibula fractures at different level
	B1.3	Tibia and fibula fractures at same level
<b>Group B2</b> Intact bending wedge fractures		
Subgroups	B2.1	Intact fibula
	B2.2	Tibia and fibula fractures at different level
	B2.3	Tibia and fibula fractures at same level
<b>Group B3</b> Comminuted wedge fractures		
Subgroups	B3.1	Intact fibula
	B3.2	Tibia and fibula fractures at different level
	B3.3	Tibia and fibula fractures at same level



Type C: Complex fractures (multifragmentary, segmental, or comminuted fractures)		
<b>Group C1</b> Spiral wedge fractures		
Subgroups	C1.1	Two intermediate fragments
	C1.2	Three intermediate fragments
	C1.3	More than three intermediate fragments
<b>Group C2</b> Segmental fractures		
Subgroups	C2.1	One segmental fragment
	C2.2	Segmental fragment and additional wedge fragment
	C2.3	Two segmental fragments
<b>Group C3</b> Comminuted fractures		
Subgroups	C3.1	Two or three intermediate fragments
	C3.2	Limited comminution (<4 cm)
	C3.3	Extensive comminution (>4 cm)

Fig 1: AO classification of proximal third tibial shaft fractures

**2.4 Surgical Technique**

All the patients were operated under spinal anaesthesia in supine position on a non-fracture table with knee bend at 90 degree. The patellar tendon splitting approach was used and reduction achieved by manual or gravity assisted traction method. Entry point for the nail was made in proximal tibial cortex 1 to 1.5cm below the joint line above center of tibial tuberosity. Reaming was done in all cases. Proximal locking was done using image intensifier with proximal jig and distal locking with free hand technique.

**2.5 Post-Operative Protocol**

Adequate antibiotic coverage was given to all patients. Most Patients were started on non-weight bear walking with walker support on 2nd post-operative day. Knee Flexion on the 2nd post-operative day after the first wound inspection and satic quadriceps drill Gradually degree of flexion was increased day by day. Serial dressings were done on the 2nd & 7th post-operative days. Suture removal was done on 11th post-operative day and patient discharged.

**2.6 Follow Up Protocol**

Patient was reviewed once in 6 weeks from date of surgery for 3 to 6 months and then 3 months thereafter. Check X-Rays were taken at each review. At the end of 6 weeks, patient was allowed partial weight bearing with walker upto 12 weeks post-surgery and Full weight bearing with walker from then on. At the end of three months if adequate callus formation was there radiologically, patient was allowed to walk without support. Knee and ankle movements were noted during follow-up. Patients with associated injuries were ambulated as per their conditions. The outcome of each patient was analyzed according to the Modified Klemm and Borner scoring system (Table 1)

Table 1: Modified Klemm and Borner scoring system

Final Score	ROM Knee & Ankle	Muscle Atrophy	Alignment	Pain	Union
Excellent	4	3	4	4	4
Good	3	2	3	3	3
Fair	2	1	2	2	2
Poor	1	0	1	1	1

Excellent: 15-19  
Good: 10-14

Fair: 5-9  
Poor: 4-8

**2.7 Observations**

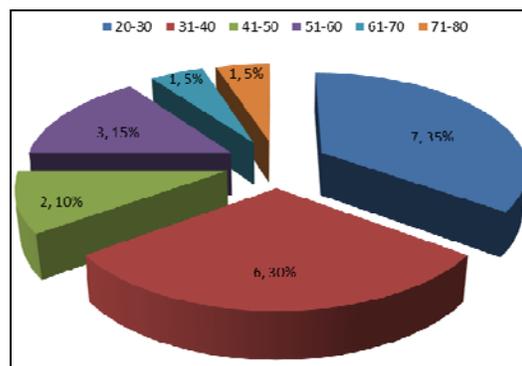


Fig 3: Male- Female Ratio

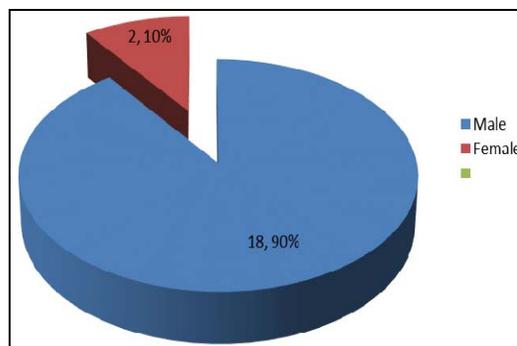


Fig 4: Side of Fracture

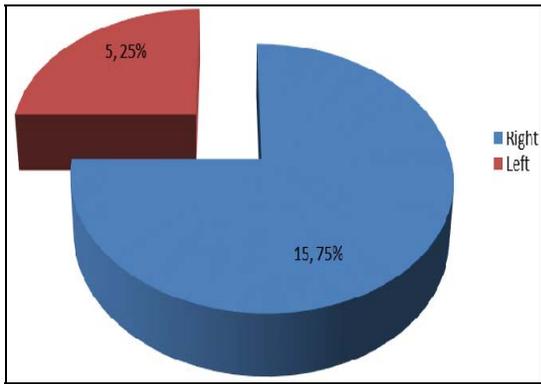


Fig 5: Mode of Injury

Table 2: Type of Fracture

Type Of Fracture	No. of Patients	Percentage
Closed	13	65%
Open	7	35%

Table 3: Soft Tissue Injury Pattern (According to Gustilo Anderson's Classification)

Soft Tissue Injury Pattern	No. of Patients	Percentage
Grade I	8	40%
Grade II	12	60%

Table 4: Fracture Pattern (According to AO Classification)

Fracture Pattern	No. of Patients	Percentage
A1	2	10%
A2	7	35%
A3	1	5%
B1	2	10%
B2	0	0%
B3	5	25%
C1	0	0%
C2	2	10%
C3	1	5%

Table 5: Complications

Complications	No. of Patients	Percentage
Anterior knee pain	4	20%
Restriction of knee ROM	4	20%
Infection (Superficial)	2	10%
Non union	1	5%
Delayed union	3	15%

Table 6: Functional Outcome (According to Modified Klemm and Borner Scoring System)

Result	No. of Patient	Percentage
Excellent	6	30%
Good	3	15%
Fair	7	35%
Poor	4	20%

3. Results

In our study population, patients were in the age group of 20-80 years with the mean age being 36 years (Figure 2). The male to female percentage of our study population was 90% to 10% respectively (Figure 3). Right side of the limb was more commonly involved (75%) than left side (25%) (Figure 4). Road traffic accident (80%) was most common mechanism of injury in our study population (Figure 5).

Closed fracture constituted 65% of our study group and the remaining 35% was open fractures (Table 2). According to Gustilo Anderson's classification of open fractures we had 40% grade I and 60% grade II injuries in our study population (Table 3). According to AO classification of fractures, type A2 was most common (35%) followed by type B3 (25%) (Table 4). Anterior knee pain was the most common complication in our study (20%) and all there 4 patients also developed restriction of range of motion at knee joint. 2 patients (10%) developed superficial wound infection which healed with regular dressing of the wound. 3 patients (15%) went into delayed union of the fracture and 1 patient (5%) went into non-union of the fracture. All these 4 patients were of the open fracture type and that too grade II fracture (Table 5). According to Modified Klemm and Borner Scoring System we had 80% excellent to fair results while 4 patients (20%) had poor results (Table 6). These were the same 4 patients which went into delayed and non-union.



Fig 5A: Pre-operative AP and Lateral view. Fig 5B: Immediate post-operative AP and lateral view. Fig 5C: Final follow up X-ray in AP and lateral view showing fracture healed.



Fig 6A: Clinical photograph of the patient at final follow up. Fig 6B: Extension at the knee joint at final follow up. Fig 6C: Flexion at the knee joint at final follow up.

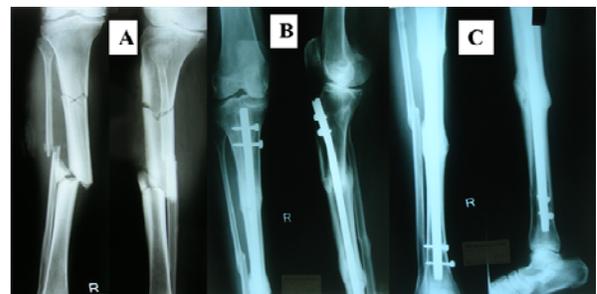


Fig 7A: Segmental fracture upper third tibia. Fig 7B, C: 1 year post-operative x-rays showing complete fracture healing.

#### 4. Discussion

In our series majority of our cases were less than 40 years of age, the mean age being 36 years. 90% patients were males because females are less exposed to outdoor activities. In majority of cases, the mode of injury was road traffic accident signifying high velocity injury. Involvement of right leg was more than left side.

In our series time gap between injury and surgery was < 5 days in 12 cases and > 5 days in 8 cases. 10 of the 12 cases (83%) that underwent early surgery had excellent to good result and superior functional and radiological outcome. Eight cases that underwent surgery > 5 days period, the functional limitations in these cases were higher.

Lang *et al* [4] in their series of 32 proximal tibia fractures assessed the functional limitations for 21 patients with 22 fractures, reported 68.18% of cases with full knee R.O.M. The incidence of cases with <25% restriction of knee ROM was 22.72%. In our study 80% of cases had full knee R.O.M., and the incidence of cases with <25% restriction of knee ROM was 20% (4 patients).

All these 4 cases presented with anterior knee pain. Two cases developed infection (10%) as an early complication. All these 2 cases were open fractures. In these cases there was instability at fracture site resulting in anterior knee pain, lower knee R.O.M. and subsequent development of infection. In open fractures the rate of infection was higher.

Lang *et al* [4] in their series showed normal ankle R.O.M. in 64% of cases, with some degree of restriction in 32% of cases. In our series there was full ankle R.O.M. in all cases. The incidence of equinus contracture in the series by Lang *et al* was 4.5%. In our series the incidence of equinus contracture was none.

Paul. J. Duvelius [7] in their series, observed delayed union in 10% of all closed tibia fractures and in 3% of proximal tibia fractures. In open fractures incidence of delayed union in all open tibia fractures was 33% and about 11% in proximal tibial fractures.

In our series delayed union was observed in 15% (3 cases) of all cases. Of these all were open fractures. One case underwent additional unicortical plate fixation with bone grafting, one more case underwent bone grafting by the end of 20 weeks as there was no signs of union. Union was achieved after bone grafting in this case.

In our series incidence of non-union was 5% (1 case). The patient had nonunion due to persistence of fracture gap of >5mm and due to bad comminution and infection. Lang *et al* reported 6% incidence of non-union in their series.

Greitbauer *et al* [8] in their series reported an average union time of 18 weeks for all open fractures of proximal third tibia. In our series time to fracture union averaged 23 weeks in open fractures.

In most of the open fractures union time varied between 12-24 weeks.

3 cases of open fracture had a delayed union ( $\geq 28$  weeks) whereas 1 cases of open fracture had a non-union. Remaining 3 cases of open fracture had an average union time of 22 weeks.

Greitbauer *et al* [8] in their series reported an average union time of 17 weeks for all closed fractures of proximal third tibia.

In our series time to fracture union averaged 13 weeks in closed fractures

In most of closed fractures union time was early  $\leq 12$  weeks

All closed fractures united within 20 weeks

Closed fractures that underwent closed nailing had early union

Most cases that underwent open nailing showed union time at 12 – 24 weeks with three cases going for delayed union

Lang *et al* [4] in their series noted no infection in all the closed fractures, and 14% infection rate in the open fractures with two cases of superficial and one case with deep infection.

In our series no infection was noted in all the closed fractures. Among the open fractures rate of infection was noted in 2 of our patients. It was seen in patients who had inadequate fixation or had loss of fixation subsequently. In these cases with superficial infection wound debridement followed by antibiotics taken for six weeks the wound subsequently healed with a delayed union of fracture

Wiss *et al* [9] in their series documented proximal screw back-out in 3% of cases (4 cases)

In our series there was no incidence of screw backout.

Vaisto *et al* [10] reported 67% of cases with anterior knee pain in their series

Brown *et al* in their series reported 40.8% of cases with anterior knee pain

In our series anterior knee pain was observed in 4 cases (20%)

All cases had pain at nail insertion site with restriction of ROM of knee <25%.

#### 5. Conclusion

Interlocked Intramedullary nailing of proximal third tibial fractures is an accepted modality of treatment.

Stable adequate intraoperative anatomical reduction is the key to early union and yields superior functional outcome.

However favorable clinical and radiological outcome can be achieved by judicious patient selection and avoiding technical errors during surgery.

Interlocked nailing for proximal third tibia fractures is a technically demanding procedure.

Hence a sound knowledge of the technique is a must, lacking which alternative forms of fixations should be considered.

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