

Study of Functional outcome of compound Tibia Fracture in Adults treated with Primary Interlock nailing.

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Abstract:*The management of fractures of shaft tibia has always been a challenge to the Orthopaedic surgeons. The significant increase in the number of cases is noted due to increase in incidence of high velocity road traffic accidents resulting in fractures of shaft tibia in young adults.*

Various modalities of internal and external fixation have been tried to get the best possible results but no single method has given best results. Out of the various modalities primary interlocking nailing has minimal damage to the soft tissues. The purpose of this study was to evaluate the management of the fractures of shaft tibia by primary interlocking nailing .In our study 30 adult patients were treated with primary interlocking nailing in between May 2012 to June 2013. The post operative results were assisted with help of JohnerandWruh's criteria.

At the mean follow up of 14 months post operatively,there were 30% excellent,40%good results,13.33%poorresults.None of them developed osteomyelitis.

Date of Submission: 01-10-2018

Date of acceptance: 15-10-2018

I. Introduction:

Tibia is the most commonly fractured long bone of the body.¹One third of the tibial surface is subcutaneous and hence open fractures of tibia predominate.25% of all tibial fractures are compound fractures.²With increasing speed of life and automobiles open fractures of tibia is a challenge before orthopaedic surgeon who is expected to take care of badly injured and contaminated soft tissue as well as nature of tibial fractures. Open tibial fractures usually result from high energy trauma and need to be treated as surgical emergencies.²

The management of open tibial fractures remains controversial despite advances in both operative and non operative methods .Dissatisfaction with conventional methods of treatment and the implication of losing a young active member of the population in terms of personal, social, and economic losses to the family led to development of newer techniques of intramedullary nails in open fractures of tibia.³

High energy open tibial fractures are mostly associated with severe soft tissue laceration , neural and vascular injury, compartmental syndrome etc. Delayed union ,non union and infections are common complications. Presence of hinge joints at knee and ankle makes no adjustment for rotatory deformity.

The treatment of open tibial fractures remains controversial till today. Treatment options include wound debridement, reduction and immobilization with cast, open reduction and plate fixation ,external fixation and intramedullary nailing. Closed treatment with casting and functional bracing is effective method which avoids potential complications of surgical intervention but axial and rotational malalignment and shortening caused cosmetic deformities and development of posttraumatic arthritis. Infection is difficult to control by conservative management by casts.

External fixation of open fractures with severe soft tissue injury has been standardized during 1980s but the process of external fixation has many complications as pin tract infections, aseptic nonunion ,refracture, malalignment and frequent reoperations.³ Kuntscher's intramedullary nailing has been used for fixation of variety of fractures of tibia. Although this device in shape of V nail does not have advantage of locking its place in armamentarium of fixation of tibia fractures is undisputed , specially because it allows vertical compression and is the most economic amongst all intramedullary implants. But it does not provide rotational stability. In open fractures it may lead to septic nonunion.³

Late fixation in compound fractures of tibia is associated with unacceptable infection rates and skin necrosis unless used as a stage procedure¹. Plate fixation was uniformly found to be worst of all methods of internal fixation . Although plating a fracture that is exposed may be tempting the risk of nonunion ,malunion and deep infection is high to justify it.

Encouraged by excellent result obtained by us with primary intramedullary interlocking nailing in compound fractures of tibia, we studied 30 patients in our set up during last one and half years .Definitive surgery at first sitting was carried out with higher antibiotic coverage, proper wash and debridement of the wound during surgery.Flap surgery was undertaken at primary or secondary sitting as per wound condition. Interlocking nails being load sharing device ,weight bearing and mobilization was started early compared to conventional methods of treatment.Primary intramedullary interlocking nailing along with adequate soft tissue management offers advantage of rigid fixation ,low incidence of infection ,nonunion and good functional results and early return to work .⁴

II. Materials and Methods:

The present study was under taken at the department of Orthopaedics SVNGMC Yavatmal,after obtaining ethical clearance.

Study period :May 2012 to June 2013.

Study design :Randomised clinical trial.

Inclusion criteria:

Male and female patients >18 years of age,with open fractures of tibial shaft of type I,II,IIIA and IIIB according to Gustilo Anderson classification.[5]Compound tibial shaft fractures within 4 cms distal to the tibial tuberosity to 4cm proximal to the ankle joint in tibia in which the medullary canal was large enough to accept a minimum 8mm nail.

Exclusion criteria:

Age less than 18 years .

Associated intraarticular fractures of proximal /distal tibia.Closed fractures and Gustilo type IIIC fractures.

Metaphyseal and Epiphyseal fractures of tibia.Patients with associated injuries and fractures.

The following protocol was used in the management of these fractures.

On admission,general condition of the patient was assessed with regards to hypovolemia,associated orthopaedic or other systemic injuries and resuscitative measures were taken accordingly .A thorough clinical examination was performed including detailed history relating to age,sex,occupation ,mode of injury, past and associated medical illness.Emergency irrigation and debridement of the open wound was done and preoperative swabs were taken from the wound and sent for culture and sensitivity, antibiotics were started accordingly.

Wounds were examined and primary closure was done ,a sterile dressing applied and limb immobilized using above knee plaster of paris cast. Routine investigations and anesthesia fitness was obtained. Patients were evaluated clinically and radiographically to assess other injuries and operated as early as possible, once stable and fit for surgery.Preoperatively the length of the nail was calculated measuring distance between between the tibial tuberosity and medial malleolus clinically and medullary canal measured from AP and laterl radiographs. Accordingly a stock of the interlocking nails 2 cm above and below the measured length and 1mm above and below the measured diameter was always kept.

Surgical Technique.

Patients position:Patients were operated under spinal/general anaesthesia . Position was supine on radioluscenttable.The affected leg position was 90 degree flexion and was operated under tourniquet. The affected limb was thoroughly cleaned by antiseptic solution.

Entry point- Made a vertical patellar tendon splitting incision from centre of patella to the tibial tuberosity , split the patellar tendon vertically to reach the proximal part of tibial tuberosity. (As a rule ,the insertion point should be slightly distal and medial to the tibial plateau exactly in the line of medullary canal.If the insertion point is too distal and too far proximal there are the chances of complication like creating iatrogenic fractures and opening the knee joint). After selecting the point of insertion curved bone awl was used to bridge the proximal cortex of tibia in curved manner .

Nail Insertion:

After widening one third rimming was done and guide wire of 3mm diameter x 950 mm passed. Reduction was done under image intensifier..After reduction the guide wire was passed into the distal fragment.In our study we used guide wire for Indian tibial nails.

Distal locking :

It was always done first .sleeves were passed in matching holes ,holes were made in the tibia with a4mm drill bit. 4.9 mm interlocking screws were tightened under C-Arm .

Proximal Locking:

It is also done similar to distal lock with the help of Jig provided by matching proximal holes.4.9mm interlocking screw were used.In case of non union for bone grafting standard method was used.

Most of the grade III fractures were debrided on the first day of admission with internal fixation by interlocking nails. Temporary soft tissue coverage procedures were carried immediately during operation. Repeat debridement of necrotic tissue was carried out within 7 days of trauma. Early soft tissue coverage is associated with decrease in infection rate. Delayed soft tissue coverage is associated with a higher rate of infection. [12]

Follow up : We followed our patients for 3 weeks interval for first 2 months and 6 weekly interval for next 6 months. All were assessed clinically and radiographically with following terms-

- Tenderness at fracture site.
- Abnormal mobility
- Wound infection
- Pain on movement of knee and ankle joints.
- Antero-posterior and lateral radiographs of the leg.

The Results were assessed as per Johner and Wruhs criteria.

Criteria	Excellent	Good	Fair	Poor
Nonunion/infection	None	None	None	Yes
Deformity	None	Minimal	Moderate	severe
Varu/valgus	None	2-5 degrees	6- degrees 10	>10degrees
Pro/recurvatum	0-5degrees	6-10 degrees	11-20 degrees	>20
Rotation	0-5 degrees	6-10 degrees	11-20degrees	>20 degrees
Shortening	0-5mm	6-10mm	11-20mm	>20mm
Mobility				
Knee	Full	>80degrees	>75degrees	<75 degrees
Ankle	Full	>75degrees	>50degrees	<50 degrees
Subtalar	>75%	>50degrees	<50 degrees	degrees
Pain	None	Occasional	Moderate	Severe
Gait	Normal	Normal	Mild limp	Significant
Activities				
strenous	Possible	limited	Severely limited	Impossible

III. Observation and Results.:

Table no I : Age and sex distribution

Age group	Male	Female	Total	Percentage
20-29	6	3	9	30%
30-39	7	4	11	36.67%
40-49	2	1	3	10%
50-59	4	1	5	16.67%
>60	2	0	2	6.67%
Total	21	9	30	100%

Table no 2: Mode of trauma

Trauma	No. of cases	Percentage
Motor vehicular accidents	20	66.67%
Fall from height	6	20%
Assault	2	6.67%
Other injuries	2	6.67%
Total	30	100%

Table no 3 :Side of fracture

Side	No. of cases	Percentage
Right	20	66.67%
Left	10	33.33%

Table no 4 :Interval between trauma and arrival at hospital and surgery

Interval	betweenTrauma and arrival period		trauma and surgery	
	No.of cases	Percentage	No of cases	percentage
<24hrs.	21	70%	7	23.33%
24-48hrs	8	26.67%	17	56.67%
48hrs-7 days	1	3.33%	30	20%
total	30	100%	30	100%

Table no 5: Type of fracture according to Gustilo Anderson classification

Type	No.of cases	Percentage	Union time in weeks
Grade I	10	33.33%	16
Grade II	15	50%	21
GradeIII A	3	10%	30
Grade IIIB	2	10%	42
Total	30	6.67%	

Table no:6 Duration from surgery to starting knee mobilization

Duration	No.of cases	Percentage
<1 week	26	86.67%
1-2 weeks	1	3.33%
2-3 weeks	1	3.33%
>3weeks	2	6.67%
Total	30	100%

Table no :7 Duration from surgery to starting protected weight bearing.

Duration	No. of cases	Percentage
<3 weeks	25	83.33%
3-6weeks	3	10%
>6weeks	2	6.67%
Total	30	100%

Table no:8 Duration from surgery to starting full weight bearing

Duration	No. of cases	percentage
8-10wks	10	33.33%
10-12 wks	14	46.67%
>12 wks	6	20%
Total	30	100%

Table no. 9: Knee range of motion

a)Knee flexion

Knee flexion in degrees	No. of cases	Percentage
<80	3	10%
80-110	3	10%
>110	24	80%
Total	30	100%

b)Knee extension:

Knee extension in degrees	No. of cases	Percentage
Full	24	80%
<10 degree deficit	3	10%
>10 degree deficit	3	10%
Total	30	100%

Table no 10: Complication

Anterior knee pain was found to be most common complication in 4 cases13.33% which in most cases resolved on subsequent follow ups.

Serial no.	Complications	Grade 1		Grade 2		Grade 3A		Grade 3B		Total	
		No. (n=10)	%	(n=15)	%	(n=3)	%	(n=2)	%	(n=30)	%
1.	Superficial infection at insertion site	0	0	0	0	0	0	0	0	0	0
2.	Superficial infection at fracture site	0	0	1	6.67%	1	33.33%	0	0	2	6.67%
3.	Deep infection at fracture site	0	0	0	0	1	33.33%	1	50%	2	6.67%
4.	Shortening>1 cm	0	0	1	6.67%	1	33.33%	1	50%	3	10%
5.	Angulation Varus/Valgus>5 degree	1	10%	1	6.67%	0	0	0	0	2	6.67%
6.	Bending of nail	0	0	0	0	0	0	0	0	0	0
7.	Breaking of nail	0	0	0	0	0	0	0	0	0	0
8.	Screw backout	0	0	1	6.67%	0	0	0	0	3	3.33%
9.	Ankle stiffness	0	0	1	6.67%	1	33.33%	1	50%	3	10%
10.	Knee stiffness	0	0	1	6.67%	1	33.33%	1	50%	3	10%
11.	Delayed union	0	0	1	6.67%	1	33.33%	1	50%	3	10%
12.	Non union	0	0	0	0	1	33.33%	1	50%	2	6.67%
13.	Anterior knee pain	1	10%	1	6.67%	1	33.33%	1	50%	4	13.33%

Males were affected twice as females.

- Road traffic accidents was the commonest mode of trauma. Right sided extremity was twice as commonly affected than the left .ratio(1:2).
- Maximum number of cases (70%) arrived in the hospital within 24 hours of trauma.
- Most of the cases operated within 48 hours of trauma(80%).
- Fifty percent of cases were of grade II Gustillo Anderson type.
- The median operative time was one hour and twenty minutes with most cases finished in 90minutes.
- Almost all the cases were operated by medial parapatellar approach.
- Skin grafting was the most common secondary procedure carried out for soft tissue coverage.
- Union time was least in grade I compound fracture whereas maximum in grade IIIB fractures.
- In majority of cases (86.67%) knee mobilization was started within first week of surgery.
- For majority of cases period of hospitalization varied from 7 to 20 days average being 14 days.
- Complications encountered in the series were superficial infection at fracture site 6.67%; deep infection at fracture site 6.67%; shortening 10%; malunion 6.67%; screw backout 3.33%; ankle stiffness 10%; knee stiffness 10%; delayed union 10%; nonunion 6.67%; anterior knee pain 13.33%.
- According to Johner and Wruhsriter 9 cases (30%) showed excellent results ,12 cases (40%) showed good results,5 (16.66%) cases showed fair results and 4 (13.33%) showed poor results

IV. Discussion

Compound fracture of tibia are complex injuries ,an optimal management still continues to be a problem with several unanswered questions .The fractures if neglected or left untreated can cripple the patient and wreck his functional and physical activities. These fractures usually result from high energy trauma and have numerous problems like poor soft tissue coverage and limited vascular supply of the tibia which causes malunion ,infection and sometimes resulting in amputation. Recent improvements in wound coverage, techniques and fixation devices have decreased the prevalence of complication ,but the optimum management of open fractures of tibia is still evolving.

Intramedullary nailing in compound fracture of tibia has the advantages of maintaining length, alignment and rotation. Soft tissues are easily accessible for wound care which lowers the rate of infection and malunion thus expanding the use of intramedullary nails in compound fractures,metaphyseal fractures,severe comminution and soft tissue injuries. Advanced imaging techniques and modern plastic surgery procedures allow better understanding of compound fractures and permit the surgeon to use this knowledge intraoperatively.

In present series of thirty cases of compound fractures treated primarily by interlocking nails we evaluated our results as follows:

1)Age and sex : Bonatus T et.al⁶.in his study reported average age of 30.3 years with 52 men and 20 women. Kazuhiko. Y .et al⁷ found the mean age to be 34.6years (15-86), In our study average age of 37 years , common age group 30- 39 years and range was 20-65 years with 21 males and 9 females .(Table no-1)

2)Mode of trauma :

Singer RW.et al⁸ found the mode of injury to be motor vehicular accidents, Faschingbauer M² in their study that 59% cases were caused due to road traffic accidents.

Our study correlated well with the above studies ,most common cause for fractures was vehicular accident 66.67% of cases.(Table no :3)

3)Side of fracture:

Whittle AP et al.⁹ in their study found 24 (48%) fractures were on right side and 26(62%) were on left side.

In our study 20 cases (66.67%) involved right side and 10(33.33%) involved left side. (Table no :3)

4)Interval between trauma,arrival at hospital and timing of surgery: Boltuc W S.et al.¹⁰ in their study claimed ,14 cases(50%) were operated within 24 hours of injury.

In our study the average time for surgery was 30 hours(range 8 hrs to 7days),23.33% of surgeries were carried within 24 hours a,56% within 48 hours.The delay in surgery was mainly due to late reported cases and hospital setup.(Table no:4)

5)Types of Fractures according to Gustilo Anderson classification.

K.A.Siebenrock¹¹ in his study observed that 50% were grade three compound fracture,whereas 31.25% fractures were grade II.Boltac W.S.et.al¹⁰ found 15 cases i.e.53.60% of grade II fractures and 13.46% were grade III compound fractures.

In our study 15 cases i.e 50% of grade II, 10 cases (33.33%) of grade I and 5 (27.66%) cases of grade III. Classification is based on subjective description and not on any objective criteria based on scoring system (Table no :5)

6) Secondary procedures:

Kuzuhiko Yokoyama⁷ studied 99 cases and reported skin grafting in 4%, Local flap in 18.2% and free flap in 5.1% cases. Azam Q et al.¹² reported that 51.4% cases skin grafting was done and 14.2% case flap cover was done.

In our study skin grafting was done in 7 cases (23.33%), local flap in 2 cases (6.67%) and cross leg flap in 1 case (3.33%)

7) Fracture type and union rate:

Boltuc W S et al¹⁰ in 28 patients found that grade II fractures union was observed in average 20 weeks duration and in grade III fracture average union time was 28 weeks, in grade IIIB fracture union time 42 weeks.

Jain V⁴ found that average union time was 60.9 weeks.

In our study the average time of grade I fracture was 16 weeks, for grade II fracture was 21 weeks, for grade IIIA fractures was 30 weeks and for grade IIIB was 42 weeks. (Table no :5)

8) Duration of Surgery:

Faschingbauer, M. et al.² They found out the average duration of surgery was 82 minutes (58-164) minutes including initial soft tissue debridement and osteosynthesis with fixation.

Hassan .D. et al¹³ found out the operative time ranged from one and half hour to 3 hours with an average of 2 hours 15 mins.

In our study average duration of surgery was one hour 20 minutes with 77% cases finished in less than one and half hour, 2 cases required more than 2 hours as soft tissue reconstructive procedure was carried out in the same setting.

9) Period of Hospitalisation :

Faschingbauer, M. et al.² observed that compound fractures with primary wound closure remained hospitalized for 11 days while that with secondary wound closure stayed for 20 days.

In our study mean hospitalization was 14 days of which 26.66% were discharged in 10 days and 33.33% cases stayed for more than 20 days due to secondary procedures carried out on them.

10) Duration from surgery to starting knee mobilization .

Pankaj. K. et al.³ started knee mobilization 48 hours post operatively. Vineet J. et al.⁴ started the knee mobilization in one to five days after surgery.

In our study (3.3% patients knee mobilization was done in 5 days, in one case knee mobilization was started in 3 weeks, he underwent a cross leg flap for soft tissue injury. (Table no :6)

11) Partial weight bearing:

Pankaj. K. et al.³ started partial weight bearing within 2 weeks. Vineet .J et al.⁴ allowed partial weight bearing after 6 weeks post operatively.

In our study we started partial weight bearing in 3 weeks in majority of patients (83.33%) which were mostly grade I and Grade II fractures. Early weight bearing is beneficial for soft tissue healing as well as early union. (Table no :7)

12) Full weight bearing :

Vineet J. et .al.⁴ increased weight bearing to full extent at 7 to 8 weeks using radiological evidence.

In our study most of the patients were started with full weight bearing before 16 weeks postoperatively after subsidence of pain and evidence of callus formation in radiographs.

A significant variation was observed in duration of full weight bearing due to great difference in biology of healing of tibial fractures in different individuals. (Table no:8)

13) Infection :

Kanu O. et al.¹⁴ observed that intramedullary nailing was associated with lower rate of infection 13% compared with 21% following external fixation. Vineet J. et al.² found infection in 1 case of grade II and one case with grade III fractures.

Kazuhiko .Y .et al.⁷ observed 6.1% of open tibial patients developed deep infection with overall chronic infection rate to be 4% . No infection was found in Grade I,II,IIIA fractures whereas 13% was observed in grade IIIB fractures.

In our study superficial infection was present in 6.6% in Grade I,II, and IIIA.Deep infection was seen in 6.67% maximum seen in grade IIIB fractures.(Table no:10)

14) Malunion:

Malunion was defined as angulation more than 5 degree in AP view and more than 10 degree in lateral view.

Kanu .O .et.al¹⁴ found that intramedullary nailing was associated with a lower rate of malalignment (8%) compared with 31% following external fixation .

Vineet .J.et al.⁴ did not find any case of malunion in their study.

In our study malunion was found in 2 cases 6.67% which was mostly in grade I and II fractures. (Table no:10)

15)Delayed union : was defined as failure of callus formation and full weight bearing after 5 months of operation¹⁵

Boltuc W.S.et.al¹⁰ reported a delayed union in 10.8% patients in Gustillo type II ,14.28% in type IIIA and 50% in type IIIB.

Vineet .J e .al .⁴ observed a delayed union rate of 8.8%.

In our study 3 cases i.e 10% went into delayed union. (Table no:10)

16) Non union :

Was defined as failure of bridging callus in radiographs and inability in full weight bearing as well as mobility at the fracture site.Kazuhiko Y.et.al⁷ observed that 20.3% of open tibial fractures developed nonunion i.e grade I and II had a malunion rate of 9.4% ,IIIA,IIIB had a non union of 9.1% and 55% .

In our study nonunion was found in 2 cases (6.67%).Non union was seen in 33.33% in IIIA and 50 % in grade IIIB fractures.(Table no:10)

17) Shortening :

Pankaj K.et.al³ observed shortening in one patient with external fixation and none with intramedullary nailing.

In our study 3 cases developed shortening one in each case in grade II,III A and III B . The probable cause of shortening could be comminution at fracture site and overlapping of fragments during fixation. (Table no:10)

18)Anterior knee pain :

Court B.et.al.¹⁶ reported anterior knee pain in 56.2% of cases and reported it as the commonest complication.

Keating et.al.¹⁷ found anterior knee pain to be the commonest complication and in 46% the nail had to be removed.

In our study knee pain was found in 13.33% cases i.e 4 patients, it was very less compared to foreign studies probably because mostly the patients were from rural parts with a higher pain bearing capacity. (Table no:10)

V. Conclusion:

- Compound tibial fractures are complex injuries due to precarious blood supply and optimal treatment still remains controversial. Various modalities of treatment like casts, pins and plasters ,external fixators ,plating ,intramedullary nailing are available. Interlocking intramedullary nailing seems feasible in compound diaphyseal fracture of the tibia.
- It is possible to achieve early mobilization of the patient which helps in healing of fracture and prevents joint stiffness.
- Early weight bearing is possible .
- There is minimal blood loss and minimal risk of infection.
- Promotes early union as interlocking nails act as load sharing devices and does not disturb the anatomy and physiology of vascularity at the fracture site.
- Follow up visits are simpler for the patients with no need of frequent plaster changes, wedging and frequent check radiographs.
- Soft tissues are easily accessible and earlier soft tissue coverage is essential in compound fractures to prevent long term complications like infection, delayed union and nonunion.
- Strict adherence to technical principles during nailing reduces the chances of implant failure and malunion.
- Minimal hospital stay ,early return to activities ,less number of multiple operations provides cost effectiveness and reduces financial burden on the family of the patient.

- Acceptable complications rate as compared to other modalities of treatment overall reduce morbidity.
- Thus we conclude that primary interlocking intramedullary nailing in compound fractures of tibia is a feasible option than other modalities of treatment. Gustillo Anderson classification is based on subjective description and is not an objective criteria. Hence every compound tibial fracture should be analysed individually and planned accordingly. Adequate debridement, early soft tissue reconstruction and stable primary fixation are the key to success for compound tibial fractures.

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Dr. Sanjay .R. Bharti "Study of Functional outcome of compound Tibia Fracture in Adults treated with Primary Interlock nailing." *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*, vol. 17, no. 10, 2018, pp30-37.