



Study to analyze the efficacy of closed intramedullary interlocking nail in achieving anatomical reduction, stable fixation and early return to function among patients with diaphyseal fractures of tibia

First Author: Dr. Kaustubh Gate, Assistant Professor, Department of Orthopaedics, Rajarshi Chhatrapati Shahu Maharaj Government Medical College, Kolhapur, INDIA.

Second and Corresponding Author: Dr. Sanjay More, Professor, Department of Orthopaedics, Rajarshi Chhatrapati Shahu Maharaj Government Medical College, Kolhapur, INDIA.

Email: sanjaysmore@yahoo.com

Third Author: Dr. Rahul Bade, Professor and HOD, Department of Orthopaedics, Rajarshi Chhatrapati Shahu Maharaj Government Medical College, Kolhapur, INDIA.

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Abstract

Background: Fracture tibia is common among young population. Present study was aimed to study efficacy of closed intramedullary interlocking nail in achieving anatomical reduction, stable fixation and early return to function among patients with diaphyseal fractures of tibia. **Material and Methods:** Present study was single-center, prospective, observational study, conducted in patients of age > 18 years, either gender, having closed fracture of the diaphysis of the tibia, posted for the dynamic interlocking nailing. **Results:** In present study, 120 patients of fractures leg bones were studied, 88 patients were male and majority of the cases were < 45 years of age (70 %). Road traffic accidents were found to amount for most of the injuries (73%) as compared to other modes. Most of the fractures in the study were non comminuted (51 %) and with mild comminutions (31 %). About 100% of the fractures of upper third united by >16 weeks while about 80% of the fractures of middle third united by 16 weeks and about 90% by 20 weeks (average 17 weeks). While about 60% of the distal third fractures united within 16 weeks and 100% by 18 weeks (average 16.5 weeks). Early complications observed were superficial wound infection of the proximal incision site (nine patients), deep infection (one patient), stiff knee joint (two patients), implant failure (two patients), compartment syndrome (one patient), neurovascular injury/ neuropraxia (one patient) and thromboembolism/ fat embolism (one patient). All patients recovered with conservative treatment. **Conclusion:** Closed intramedullary interlocking nail for management of diaphyseal fractures of tibia, had achieved good anatomical reduction, stable fixation and early return to function as noted by functional assessment.

Keywords: intramedullary, interlocking nail, diaphyseal fractures of tibia, union rate

Introduction: Fracture tibia is common among young population and also a matter of concern because, tibia has precarious blood supplies due to inadequate muscular envelope. The presence of hinge joints at knee and ankle, allows no adjustment for rotatory deformity after fracture.^{1,2} The use of non-operative treatment of tibial fractures that are widely

displaced or that are the result of high-energy forces is associated with a high prevalence of malunion, stiffness of the joint, and poor functional outcome.³ The traditional treatment of tibial shaft fractures has been long term immobilization in plaster of Paris cast and functional cast brace this is in itself an invitation to the well known "Fracture - disease".⁴

Later, as a result of ability to lock the nail proximally and distally, closed intramedullary nailing became an accepted treatment for closed shaft fractures during the ninth decade.⁵ However side effects of conventional reaming- technique had been noted probably due to mechanical, thermal and biological factors impairing the endosteal blood supply.⁶

The method of closed nailing without reaming followed by early ambulation and weight-bearing has positive advantages over all existing methods, significantly lower complication rate and has comparable results. Interlocking nailing has proven to be the method of choice for fixation of these fractures.⁶ The intramedullary nailing under image intensifier fulfills the objective of stable fixation with minimal tissue damage resulting in better and quicker fracture unions. Present study was aimed to study efficacy of closed intramedullary interlocking nail in achieving anatomical reduction, stable fixation and early return to function among patients with diaphyseal fractures of tibia.

Material And Methods

Present study was single-center, prospective, observational study, conducted in department of orthopaedics, at XXX medical college and hospital, XXX, India. Study duration was of 2 years (October 2014 to October 2016). Study approval was obtained from institutional ethical committee.

Inclusion criteria

- Patients of age > 18 years, either gender, having closed fracture of the diaphysis of the tibia, posted for the dynamic interlocking nailing. Patients selected were fit for general anaesthesia i.e., had no major head, chest or abdomen injury. tibial fractures, closed intramedullary interlocking nailing,

Exclusion criteria

- Patient having compound tibial shaft fracture, tibial shaft fracture treated conservatively
- Patient who is not ready to give consent.

Study was explained to patients in local language and written consent was taken for participation and study. Initial Management and Resuscitation was done in the emergency and a groin to toes slab was applied by simply aligning the bone. On admission in the ward, detailed history was taken, noting mode and severity of the injury, extent and type of the trauma to the tissues and detailed examination of the affected extremity. Skiagrams were studied in detail so as to classify the fracture and level of fracture:

All cases were operated within 7 days of the injury. All cases were done in the orthopaedic operation theatre. Close intramedullary nailing was done without opening the fracture site and with or without reaming.

A specially constructed intramedullary interlocking nail was used for the purpose in all cases. A suitable length of the nail is chosen by measuring from the tibial tuberosity to the base of the medial malleolus on the unaffected side. The diameter of the nail is decided according to the size of medullary canal on the X-ray or by reaming.

The interlocking nail was introduced over guide wire with its eye anteriorly and the slot kept posteriorly. The fracture is close reduced under IITV and the nail is negotiated into the distal fragment with the gentle taps of the hammer over the nail head, keeping the nail dead parallel to the axis of the limb. Impaction may be done, if needed, by padded gentle strokes over the heel. The distal locking of the nail is done as under IITV using the free hand technique. An appropriate length of 4,5mm cortical screw is used for locking.

Post Operatively limb was kept elevated at all times and active toe movements are

encouraged. The patient is watched for excessive swelling, pain and distal circulation. The first dressing is done after 5 days of the operation. If suture line is clean, suture removal done after 10 to 12 days under full asepsis. The compression bandage and GT slab is removed a crepe bandage is applied from knee to the ankle. Active knee and ankle mobilization is started immediately after the dressing. Partial weight bearing with 2 axillary crutches started. Gait training on the parallel bars if possible, can also be done review after 1 month. Advice regarding full weight-bearing is given on the basis of pain and the stability of the fracture fixation.

The patient was followed up at 4 weeks, 8 weeks, 16 weeks, 20 weeks, 6 months. Check X-rays are taken at every visit and patient is assessed clinically for fracture union. The results are assessed on the basis of Alho and Ekeland criteria and functional assessment was done on the basis of Resumption of the activities of daily living, Resumption of the occupation, Pain free movements and walking and squatting and sitting cross legged.

Data was collected and compiled using Microsoft Excel, analysed using SPSS 23.0 version. Statistical analysis was done using descriptive statistics.

Results

In present study, 120 patients of fractures leg bones were studied, 88 patients were male and majority of the cases were < 45 years of age (70 %). Road traffic accidents were found to amount for most of the injuries (73%) as compared to other modes.

Table 1: General characteristics

Characteristics	No. of patients	Percentage
Age groups (in years)		
17-24	18	15
25-34	39	32
35-44	27	23
45-54	20	17
55 and above	16	13
Gender		
Male	88	72
Female	32	28
Mode of Injury		
R.T.A.	88	73
Fall from height	11	9
Fall on floor/stairs	18	15
Assault	3	3

Most of the fractures in the study were non comminuted (51 %) and with mild comminutions (31 %). Cases included in the study 79 % were close fractures. Among compound fractures Grade I -Gustilo's (17%) were more while Grade - II Gustilo's (3%). 2 patients had associated head injury which led to delay in the surgery while four patients had associated fracture shaft femur (2) / supracondylar (2) and one associated with fracture of medial malleolus. Most of the fractures requiring fixation were either in the middle third of the shaft (52%) or distal third (34%).

Table 2: Fracture Characteristics

Characteristics	No. of patients	Percentage
Fracture comminution		
Non-comminuted	61	51
Mild comminution	37	31

Moderate comminution	14	11
Severe comminution with loose fragments	8	7
Grade of Fracture		
Close Fracture	95	79
Compound Fracture	25	21
Grade I	20	17
Grade II	4	3
Grade III A	1	1
Level of Fracture		
Proximal third	17	14
Middle third	62	52
Distal third	41	34
Associated Injuries		
Fracture of Metacarpal or Phalanx	4	3
Fracture of upper limb long bones	3	3
Ipsilateral femur fracture	2	2
Contralateral fracture both bones leg	2	2
Fracture of skull bones	2	2
Fracture superior rami of pubis	1	1
Fracture of cervical spine	1	1

Partial weight bearing was started with the help of two axillary crutches. The average duration of partial weight bearing was two weeks (range 2 to 4 weeks). Average duration of full weight bearing was six weeks (range 6-12 weeks).

Table 3: Time of Weight Bearing

No. of Patients	Partial weight bearing	No. of patients	Full weight bearing
17	2 - 4 weeks	89	6-12 weeks
74	4-6 weeks	28	13- 16 week
19	> 6 weeks	3	> 16 weeks

The union of the fracture was assessed by standard radiological and clinical criteria.^{6,7} Due to presence of nail we couldn't stress the fracture site; hence loss of pain on walking was deemed a better clinical indicator of union.⁵

Depending upon the level of fracture in the tibial shaft, the union time varies. About 100% of the fractures of upper third united by >16 weeks while about 80% of the fractures of middle third united by 16 weeks and about 90% by 20 weeks (average 17 weeks). While about 60% of the distal third fractures united within 16 weeks and 100% by 18 weeks (average 16.5 weeks).

Table 4: Union Time with Grade of Fracture

Grade of Fracture	Total	14-16 Weeks	16-18 weeks	18-20 weeks	>20 weeks	Mean (weeks)
Close Fracture	95	34	43	12	6	17
Compound Fracture	25	-	-	-	-	-
Grade I	20	14	5	0	1	15
Grade II	4	2	1	1	0	17
Grade III A	1	0	0	1	0	19
Level of fracture						
Proximal one-third		0	19	7	0	17

Middle one-third		8	36	18	0	17
Distal one-third		4	20	12	5	19

Early complications observed were superficial wound infection of the proximal incision site (nine patients), deep infection (one patient), stiff knee joint (two patients), implant failure (two patients), compartment syndrome (one patient), neuro vascular injury/ neuropraxia (one patient) and thromboembolism/ fat embolism (one patient). All patients recovered with conservative treatment.

Delayed complications noted were delayed union (8 patients), pain (8 patients), ankle range of motion (5 patients), mal union (two patients), non-union (two patients), shortening limb >1cm (two patients), hardware failure - nail breakage/bent nail (two patients), knee range of motion - <20 % restriction of full flexion (two patients), locking bolt breakage (two patients), angular deformities (one patient) and rotational deformities (one patient). Few patients experienced anterior knee pain, pain at fracture site and locking bolt in treatment phase, most of them recovered after sound union, physiotherapy and analgesics.

Table 5: Post - Operative Complications

Complications	No. of patient
Early Complications	
Infection	
• Superficial	09
• Deep	01
Stiff knee joint	02
Implant failure	02
Compartment syndrome	01
Neuro vascular injury/ Neuropraxia	01
Thromboembolism/ Fat Embolism	01
Delayed Complications	
Delayed union	08
Pain	08
Ankle Range of motion	
• <25% restriction	04
• 25-50% restriction	01
Mal union	02
Non-union	02
Shorting Limb >1cm	02
Hardware failure - Nail breakage/Bent nail	02
Knee Range of motion - <20 % restriction of full flexion	02
Locking bolt breakage	01
Deformities	
• Angular	01
• Rotational	01

As per Alho and Ekeland criteria, at final follow – up parameters examined were as follows.

- Tibial Malalignment and Shortening One of the patients treated with interlocking nail had valgus angulation [less than 10 degree]. None of the patient had gross rotational deformity (>10 degree) one patient had mild external rotation.
- Two patients had shortening of 1 cm. because of associated ipsilateral fracture of the shaft of femur in one patient and One patient had shortening because of severely

communitated fracture.

- Range of Knee Motion 98% of the patients had knee flexion > 120 degree. None of the patients had any extension leg. Only two patients had mild restriction.
- Range of Ankle Motion 96% of the patients had ankle dorsiflexion >20 degree while 96% had planter flexion >30 degree i.e., full range.
- Range of Foot Motion - There was however, no difference in the foot motion as compared to normal. Pain About 10% of the patients complained of pain in the leg around ankle and anterior knee which too was tolerable or occasionally needed oral analgesic.
- Swelling About 30% of the patients had minor swelling around ankle and foot which gradually subsided with mobilization and was never significant to become worry some to the patient.

Table 6: Final Follow - Up

Sr. No.	Criteria	Grade 1 Excellent	Grade II Good	Grade III Fair	Grade IV Poor
A	Tibial malalignment and shortening				
	Varus Valgus(degree)	0	1	0	0
	Shortening(cm)	2	1	0	0
B	Range of Knee motion				
	Flexion	117	2	1	0
	Extension deficit	2	0	0	0
C	Range of ankle motion				
	Dorsiflexion	115	4	1	0
	Planter flexion	116	3	1	0
D	Foot motion (as compared to normal)	119	1	0	0
E	Pain in the limb				
	Ant. Knee Pain	104	11	4	1
	Pain at fracture site	116	4	0	0
F	Swelling	108	9	3	0
	Percentage of Cases	85 %	12 %	2 %	1 %

Discussion

The conventional method used among patients with diaphyseal fractures of tibia is towards closed reduction of displaced tibial fractures and then application of groin-to-toe cast for the full period of clinical and radiological healing. This results in patients lying on bed without weight bearing for many months leading to complications like joint stiffness, muscle atrophy, osteoporosis and prolonged recumbence and its side effects (Cast syndrome).^{3,4}

Fractures of the tibia are the commonest among the major long bone's fractures. Very often, they are open owing to the subcutaneous location of the tibia. The commonest cause of the fracture being high velocity road traffic accidents. in our series, 73% of the fracture's groups were due to high velocity road traffic accidents. In these accidents, a tremendous amount of energy is dissipated to the surrounding soft tissue thus causing severe damage. Also, all grades of comminution are encountered.⁸ About 49% of the tibial fractures in our series were comminuted ranging from mild to severe grade.

In present study, 8 cases of delayed union in which, after waiting for about 16 weeks when abundant callus was not visible in the skiagram and the patient had persistent tenderness over the fracture site. Phemister bone grafting was done in Four. Two of the cases had

hypertrophy type of non-union. The reason in the cases was probably was a small diameter nail (8 mm) which was used. Not Phemister bone grafting and groin-to-toe cast used in these cases severed both the purposes. This indicates that a proper diameter, well-fitting nail should be used in all cases.⁹

Healing was judged to have occurred when the fractures was clinically stable and did not elicit pain on palpation or manual stress. Olerud and Karlstrom¹⁰ used compression plating for their study and reported nonunion/delayed union rate of 3.73%. Melher¹¹ used AO unreamed tibial nail and reported a case of non union (5%). Court Brown et al⁸ reported 20% incidence of nonunion with unreamed AO-UTN nail while none with reamed Grosse-Kempf nail.

Puno et al.,⁹ compared closed nailing with conservative treatment and observed average union of 10.8 weeks and 16.68 weeks respectively. Court Brown et al.,⁸ showed shorter union time with reamed nails (15.4 weeks) than unreamed (22.8 weeks). The union time of present series 17 weeks is comparable with the above studies.

Final evaluation must take into account both functional and anatomic parameters. In present series early weight bearing was promoted without plaster as in other series of interlocking nails. We did not see any significant joint stiffness and according to the present series parameters all were near to normal as compared with other series of interlocking nails. Some residual joint stiffness seen in few of the series could probably be due to ischemic muscle damage i.e. compartment syndrome.¹²

Sarmiento¹³ had demonstrated that early weight bearing did not increase initial shortening. In present series, 2 patients had shortening of 1 cm, both were having severe comminution. Shortening in different series of interlocking nail were mostly due to screw breakage incidence.

Court Brown et al.,¹⁴ reported excellent result of reamed interlocking nail. Olerud and Karisfrom's series¹⁰ represented AO-compression plate method which required technical expertise and complications were due to technical failures. Hence the statements seemed reasonable that the compression plate method is not a suitable and routine method in tibial shaft fractures.¹⁰ On the other hand, closed unreamed interlocking tibial nailing gives favorable end result functionally and anatomically.

Conclusion

Closed intramedullary interlocking nail for management of diaphyseal fractures of tibia, had achieved good anatomical reduction, stable fixation and early return to function as noted by functional assessment. Closed intramedullary interlocking nail has high union rate, low infection rate, allows earlier weight-bearing leading to earlier fracture union with less morbidity, thus recommended for treatment for diaphyseal tibial fractures.

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