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Case Series

Comparative study of open fractures of tibia (Interlocking v/s External fixator)

Anish Vernekar[1,*]

[1] *Goa Medical College, Bambolim, Goa, India*

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ABSTRACT

Background: Open/Compound fractures of tibia are the most common type of fracture to occur following road traffic accidents; however, sports injury, fall from height can also frequently produce these fractures. Open fractures of tibia (Type 3B) are quite challenging to treat, with respect to associated soft tissue injury and the decision for type of implant to be used by an orthopaedic surgeon. The decision making is based on the wound condition, the amount of muscle and soft tissue damage, type of fractures, and availability of equipments. This study was undertaken to evaluate the most optimal method for the management of compound fractures of tibia vis a vis comparing reamed tibia interlocking nail and external fixator in the management of type 3b compound fractures of tibia.

Controversy exists over whether the use of external fixation or tibial intramedullary nailing is optimal for the treatment of open tibial fractures. The aim of this study was to compare clinical outcomes in terms of postoperative infection, malunion, delayed union, nonunion and hardware failure between these two treatment methods.

Materials and Methods: The study was undertaken in the Department of Orthopedics, Goa Medical College. The study involved both male and female patients with open fractures of tibia, (Gustillo and Anderson, Type 3B). This was a prospective study conducted from month of September 2017 onwards. Hundred patients who had compound fracture of tibia (Type 3B) were evaluated. The patients were followed-up for duration of 6 to 10 months (Average 8 months).

Detailed analysis of function of the patient was done on the basis of following criteria by Johner and Wruh.

Conclusion: The study conducted on 100 patients, who suffered from compound fracture tibia (Type 3b), it was reported that patients who were operated with reamed tibia interlocking nail had better outcome and decreased morbidity, as compared to patients treated with external fixator.

1. Introduction

As urbanization is swiftly progressing every day, there is a sharp rise in road traffic accidents, which is responsible for increased frequency of open fractures, most commonly involving the tibia.

Fractures of tibial diaphysis, is the most frequently occurring fractures encountered by an orthopaedician.

At an average, there are about 26 tibial diaphyseal fractures per 1 lakh population per year. Males are more commonly affected than females with male incidence being about 41 per 1 lakh per year and female incidence about 12 per 1 lakh per year. [1]

Since most of the tibial surface lies superficially throughout, compound fractures are more commonly encountered in tibia, than in any other major long bone. Furthermore the blood supply of tibia is more precarious than that of bones enclosed by heavy group of muscles. [1]

* *Corresponding author*.
E-mail address: vernekaranish2013@gmail.com (A. Vernekar).

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The principle causes of open tibial fractures are due to: a) falls, b) sports injuries, c) direct blows or assaults, d) motor vehicle accidents and e) gunshot injuries.

2. Need for the Study

Epidemiological studies propose that road traffic accidents are commonly responsible for tibial shaft fractures, next to sports injuries.

Severity of soft tissue injury is directly related to the amount of high energy trauma.

Diverse techniques are now accessible for treatment of diaphyseal fractures of tibia. Modern orthopedic surgeons must be attentive to the advantages, disadvantages and limitation of every technique available, to select the ideal line of treatment for each patient.

There is a tremendous amount of uncertainty amongst orthopaedic surgeon, in deciding the type of implant to be used for compound fractures tibia (type 3B).

The common fear among surgeons includes:

1. Chances of intramedullary osteomyelitis following tibia interlocking nail in a type 3b tibia fracture.
2. The tibia interlocking nail, being an intramedullary implant, has a higher chance of developing acute followed by chronic osteomyelitis.
3. The use of external fixator which causes increased morbidity and delay in patients return to activities of daily living.

Hence, there is a need to determine the ideal line of treatment in type 3b compound fractures tibia that is, whether tibia interlocking nail has an advantage compared to external fixator; the external fixator being the preferred modality for treatment of compound fractures.

3. Materials and Methods

The study was undertaken in the Department of Orthopedics, Goa Medical College. The study involved both male and female patients with open fractures of tibia, (Gustillo and Anderson, Type 3B).

This was a prospective study conducted from month of September 2017 onwards. Hundred patients who had compound fracture of tibia (Type 3B) were evaluated. The patients were followed-up for duration of 6 to 10 months (Average 8 months).

3.1. Inclusion criteria

1. Age between 20-50 years.
2. Open fractures type IIIB according to Gustillo Anderson classification.
3. Isolated diaphyseal fractures of tibia.

3.2. Exclusion criteria

1. Less than 20 years and more than 50 years of age.
2. Associated intra-articular fractures of proximal /distal tibia.
3. Gustillo type IIIA and IIIC fractures.
4. Polytrauma patients with head injury, blunt abdominal trauma and blunt chest trauma.

3.3. Management

3.3.1. Rapid primary survey

In the casualty, a rapid survey was conducted and emergency measures were undertaken to combat pain, hemorrhage, and shock with proper sedation, analgesic, intravenous infusion or transfusion of blood when required.

3.3.2. Detailed secondary survey

1. History and thorough clinical examination.
2. Assessment of soft tissue injury.

Protocols were followed according to Ganga Hospital protocols. At casualty level, general state of the patient was assessed. Primary survey, with recording of vitals was done, with emphasis on hypovolemia, associated orthopedic or other systemic injuries. Resuscitative measures were taken. All the patients received analgesics via I.M injections, Injection tetglob 500 I.U and I.V antibiotics, covering both gram + and gram –ve bacteria.

All patients within the criteria were shifted for saline irrigation and debridement. Wound swabs were collected for culture and sensitivity. Wounds were subjected to thorough saline wash. Subsequent wound care and antibiotic treatment was determined by severity of the open fractures.

Routine investigations were carried out for all patients. Fractures were evaluated clinically and radiographically. Radiographs were taken in two planes, A-P and Lateral view. I.V antibiotics, cephalosporins and aminoglycosides were started for all the patients.

Patients were separated into 2 groups. Group A patients consisted of patients treated with intramedullary nailing (50 patients) whilst group B consisted of patients treated with external fixator. (50 patients)

Selection of patients into respective groups was done arbitrarily, keeping in my mind the extent and type of contamination of the wound.

3.3.3. Wound debridement

A scrupulous, layer by layer debridement of the open wound was initiated, beginning from the skin and subcutaneous tissue. A thin layer of healthy skin was excised surrounding the wound.

Debridement of the wound was carried out, respecting the soft tissue such as blood vessels, nerves, and tendons. All foreign materials were debrided, either by washing or by excision of the tissue.

Antibiotics were started intravenously before surgery, and continued for 2 weeks of postoperative period routinely and further extended depending upon the status of the wound and culture sensitivity report.

Post debridement, the open wounds were enclosed using sterile dressing pads soaked with normal saline. The fractures were immobilized by using an above knee pop slab.

3.3.4. Intervention

Except for the selection of the fixation device, open fracture care was similar in the two treatment groups. All patients underwent emergency irrigation and debridement along with swab for culture sensitivity with concomitant skeletal stabilization. Patients were randomly allocated into one of the two treatment groups.

1. In Group A patients: Reamed tibia interlocking nail was used as primary fixation device.
2. In Group B patients: External fixator was used as stabilization device. Depending on the level of fracture and fracture geometry three types of frames were constructed using 4, 5 and 5.5 mm Schanz pins, universal rods and clamps:

   (a) Unilateral uniplanar frame
   (b) The delta frame
   (c) Joint frame

3.4. Postoperative care

Non-adherent, antibiotic covered dressings were used to cover open wounds. Local wound irrigation with normal saline was carried out. Occurrence of wound infection evaluated using parameters like, temperature, as well as white blood cell count and wound inspection.

Regular wound debridement and dressings were carried out, to obtain a healthy granulation bed. Antibiotics were altered according to the sensitivity report.

Check X-rays were done and consequently alteration in the frame was done if necessary in external fixation. Physiotherapy was encouraged with active and passive range of movements of the ankle and knee joint and quadriceps strengthening exercise *i*nitiated without more ado following the surgery. As early as patient could tolerate, he/she was encouraged to start partial weight bearing.

3.5. Fracture healing

“Fracture healing in fractures stabilized by external fixator or intramedullary nail occurred by callous formation. Callous was stimulated by progressive force transmission across the fracture site. After soft tissues granulation, patients were encouraged to initiate partial and then full weight bearing.

3.6. Follow-up

The patients under study were evaluated at every 2 weeks interval.

They were evaluated both clinically and radiologically and serial X-rays were ordered at 2 weeks interval. Secondary procedures such as dynamization and/or bone grafting were undertaken at the end of 20 weeks, when fracture union was not satisfactory.

3.7. Rehabilitation

Physiotherapy was initiated immediately after 1 st postoperative day.

Patients were assisted to do quadriceps exercises, active straight leg raise and knee bending exercises. After achieving good healing of the soft tissues and check X-ray showed satisfactory callus, the patient was started on full weight bearing and removal of fixator.

Patients having knee or ankle stiffness were treated with dedicated physiotherapy which also included; local ultrasonic therapy and wax bath was advised for 10-14 days to avoid muscle spasm.

External fixator was removed after 3-6 months, subsequently PTB cast was utilised for 4-8 weeks. Weight bearing was gradually increased according to patient’s tolerance level.

The study group were frequently examined both clinically and radiologically, till complete union was achieved.

Standard considered for the time of union were as follows:

1. Regular union - union occurring before 30 weeks
2. Delayed union - union occurring after 30 weeks
3. Non-union - no signs of union even after 9 months.

The fracture was accepted as united when:

1. Fractured tibia was clinically stable on physical examination.
2. Sufficient callus seen on the roentgenogram showed.
3. No discomfort/pain or need of support while weight bearing.

4. Results

The study includes 100 cases of Gustillo type 3b fractures of the tibial shaft from September 2017 onwards. The patients were followed up for duration of 6-10 months.

Minimum age of the patient was 20 years. Average age of the patient was 30.7 years.

Road traffic accidents were the bulk mode oinjury causing tibial shaft fractures, accounting for 71% of all tibial fractures.

The commonest site of fracture was located at the middle-third of the tibia. This constituted 62% of tibial

Table 1: Age distribution according to sex

Age	Male	Female
20-25	28	8
26-30	17	6
31-35	10	2
36-40	8	3
41-45	7	4
46-50	5	2
Total	75	25

Table 2: Mode of injury

Mode of injury	Number of patients	Percentage
RTA	71	71
Fall	17	17
Crush injury	12	12

Table 3: Anatomical location of fracture

Anatomical location of fracture	Number of patients	Percentage
Upper and middle third junction	13	13
Middle third	62	62
Middle and lower third junction	22	22
Lower third	3	3
Total	100	100.00

fractures. The diaphysis is a more rigid bone, so fractures are common in middle third of tibia.

Table 4: Type of fracture

Type of fracture	Number of patients	Percentage
Transverse	18	18
Oblique	17	17
Wedge(butterfly)	10	10
Spiral	17	17
Communited	35	35
Segmental	3	3
Total	100	100.00

In the study, communited fractures were noted in 35% of patients, subsequently transverse fractures in 18% of patients and oblique fractures in 18% of patients. Spiral fractures constituted 17% and 10% of patients, suffered from wedge fractures. Communited fractures are common because of high energy trauma.

Table 5: Type of implant used

Type of implant	Cases	Percentage
Tibia Interlocking nail	50	50
External Fixator	50	50
Total	100	100

50% of cases were treated with tibia interlocking (Group A) and other 50% by external fixator (Group B). Selection of cases was arbitrary, only keeping into consideration, the amount of tissue contamination, how much wound could be debrided within 6 hours and whether debridement was satisfactory to the surgeon.

Table 6: Radiological fracture union

Fracture union (weeks)	Number of patients	
	Tibia Interlocking (50)	External fixator (50)
6-8	2	0
8-12	7	0
12-16	11	3
16-20	17	19
24-28	10	17
>36	3	5
Total	50	44 (6 pts lost to F.U)

4.1. Complications

Hence, comparing the 2 groups, it was evident that, group A patients (Tibia interlocking nail) had an infection rate of 12%. O complications like non-union, delayed union and Malunion were 10, 14 and 4 percent, respectively.

In group B patients (External fixator) had an infection rate of 26%. Non-union, delayed union and Malunion were 21, 10 and 10 percent, respectively.

Table 9: Functional outcome

Functional outcome	Number of patients	
	Group A	Group B
Excellent	29	17
Good	13	9
Fair	5	7
Poor	3	11
Total	50	44

5. Functional Results

Functional outcome of the patient was done on the basis of Johner and Wruh criteria.

6. Discussion

1. Hundred patients, who suffered from type 3b open fractures of the tibia, were managed with interlocking intramedullary nailing and external fixator during time period from September 2017 at Goa Medical College, Bambolim. Cases included in the study, were fresh injuries and traumatic fractures.
2. For a period of 8-10 months, cases were followed-up at opd level.
3. Goal was to operate the tibia fractures either by closed interlocking intramedullary nailing or by external

Table 7: Weight bearing

Weeks	Partial wt. bearing No of patients		Full wt. bearing No of patients	
	Group A (50)	Group B (44)	Group A (50)	Group B (44)
4 – 8	4	0	0	0
8-12	18	6	4	2
12-16	21	11	13	9
16-20	5	16	26	10
20-24	2	9	7	13
>24	0	2	0	10

Table 8: Complications: Comparing complications of Group A against Group B

Complications	Number of patients		Percentage	
	Group A	Group B	Group A	Group B
Wound infection	6	13	12	26
Screw breakage/Pin Site infection	3	15	6	30
Nonunion	5	21	10	42
Delayed union	7	10	14	20
Anterior knee pain	1	–	2	–
Malunion	2	5	4	10
Joint stiffness	9	14	18	28
Shortening	0	2	0	4

Table 10: Johner and Wruh's criteria for evaluation of final results

S, No.	Criteria	Excellent (Left=Right)	Good	Fair	Poor
1.	Non-unions, ostetitis, amputation	None	None	None	Yes
2.	Neurovascular disturbances	None	Minimal	Moderate	Severe
3.	Deformity				
	Varus/Vargas	None	2-5º	6-10º	>10º
	Anteversion/ Recurvation	0-5º	6-10º	11-20º	>20º
	Rotation	0-5º	6-10º	11-20º	>20º
4.	Shortening	0-5mm	6-10mm	11-20mm	>20 mm
5.	Mobility				
	Knee	Normal	>80%	>75%	<75%
	Ankle	Normal	>75%	>50%	<50%
	Subtalar	>75%	>50%	<50%	–
6.	Pain	None	Occasional	Moderate	Severe
7.	Gait	Normal	Normal	Insignificant limp	Significant limp
8.	Strenuous activities	Possible	Limited	Severely limited	Impossible
9.	Radiological union	Consolidated	Consolidated	Union	Not consolidated

fixator, followed by early mobilization and to compare and determine the best modality of treatment for Type 3b open fractures of tibia.

4. 50% of patients were operated by tibia interlocking (reamed) and rest 50% by external fixator.
5. Thorough wound irrigation and debridement was performed.
6. 46 fractures which were operated with tibia interlocking united within 8-10 months of injury, while 16 patients operated with external fixator united within 10-12 months of injury. 10 patients with communited fracture failed to unite (non-union) 10 months after the injury.
7. Despite the advantage that the use of external fixator involved a shorter duration of operating time and being more suitable in polytrauma patients, it was not well tolerated by the patients. Also the incidence of complications such as non-union, delayed union, pin site infection and re-fracture were higher, compared to group a patients.
8. The use of intramedullary interlocking nail involved a shorter duration of fracture healing, early weight-bearing and early ambulation to pre injury state. The rates of complications were lower too, compared to

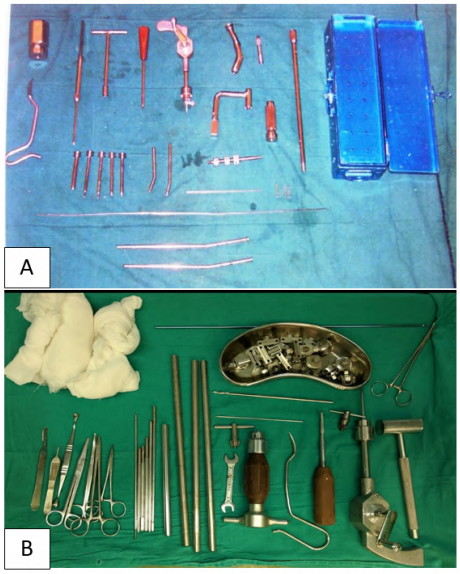

Fig. 1: A): Indian tubular nails interlocking instruments; **B**): External fixator instruments

Fig. 2: Pre-op x-ray

Fig. 3: Operative procedure

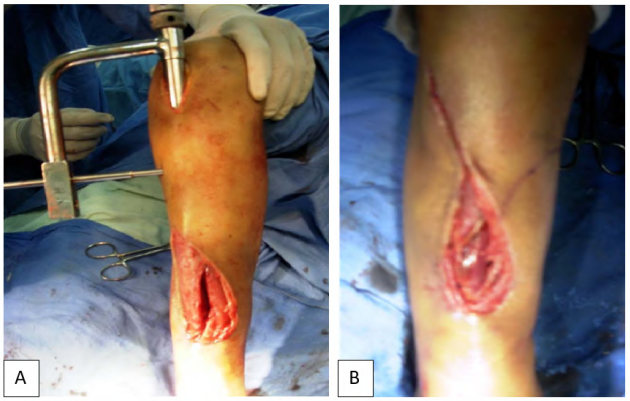

Fig. 4: A): Proximal locking; **B)**: Wound phot

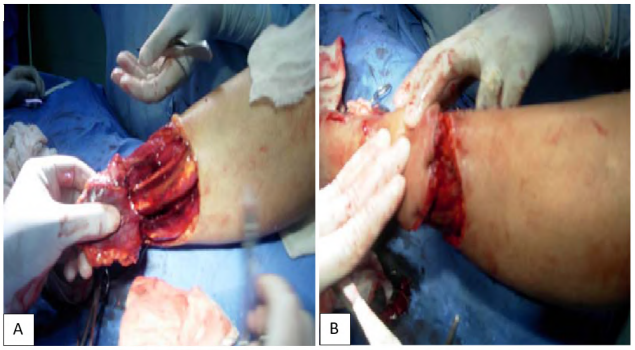

Fig. 5: A): Soleus flap taken; **B)**: Rotation of flap

Fig. 6: Wound covered with flap

Fig. 7: Post-op x-ray

Fig. 8: Pre-op x-ray

Fig. 9: Pre-op wound picture

external fixator. Isolated tibial fractures are ideal, to be treated with intramedullary nail, considering the longer duration of surgery.

7. Conclusion

1. In this comparative study, role of external fixation and intramedullary interlocking nail was compared, to determine the ideal line of treatment of compound fractures of tibia (Gustillo IIIB). The results obtained

Fig. 10: Post-op x-ray

Fig. 11: 6 months follow-up

Fig. 12: 6 months follow-up x-ray

Table 11: Comparison of functional outcome

Study	Excellent	Good	Fair	Poor
Arne Ekeland et al[2]	64.4	28.8	4.4	–
Klemm et al[3]	62.40	31.8	4.5	1.2
Present study	58	26	10	6
Group A				
Group B	38.6	20.4	16	25

Table 12: Time for fracture union

Lawrence B. Bone et al[4]	19 weeks
'Court Brown et al[5]	16.7 weeks
Anglen J. O. et al[6]	22.5 weeks
Arne Ekeland et al[2]	16 weeks
Present study	20.13weeks
Group A	
Group B	28.4 weeks

Table 13: Rate of complications

Lawrence B. Bone et al[4]	6.25%.
Arne Ekeland et al[2]	4.4%.
Blachut PA et al[7]	1%
Present study	13%
Group A	
Group B	26%

Fig. 13: Type 3B compound fracture tibia

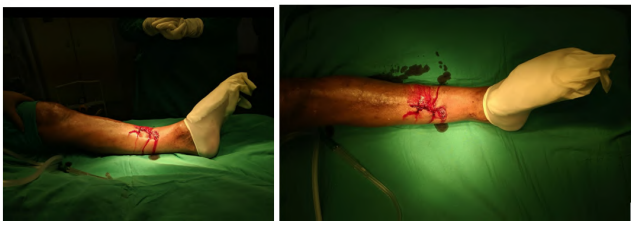

Fig. 15: Intra-op photos

Fig. 14: Pre-op x-ray

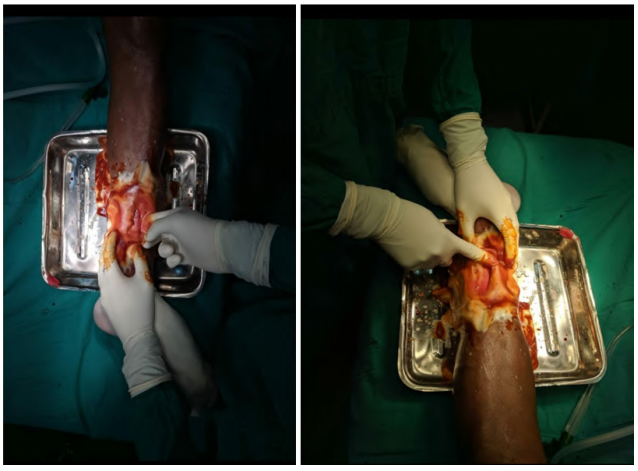

Fig. 16: Intra-op irrigation

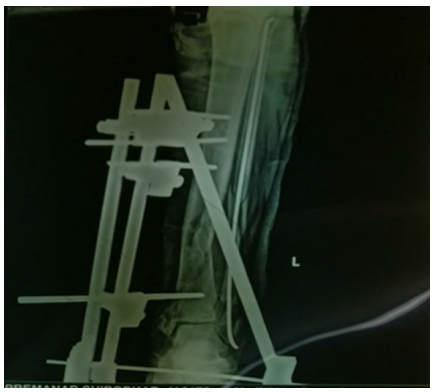

Fig. 17: Post-op x-ray

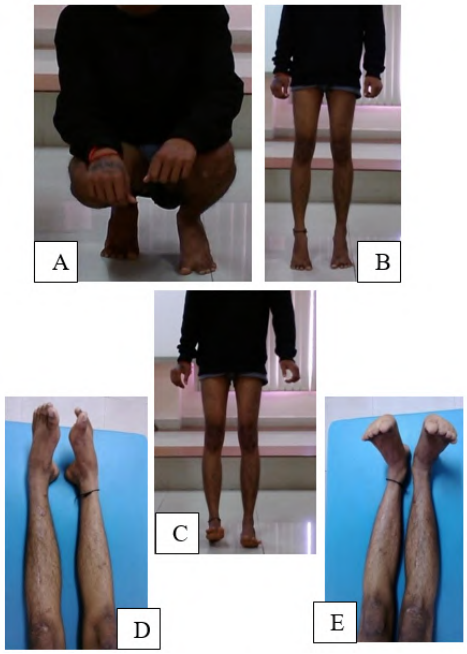

Fig. 18: 6 months follow up; **A**): Knee-flexion squatting; **B**): Knee extension; **C**): Ankle dorsiflexion; **D**): Inversion; **E**): Eversion

where then compared, in terms of union of fractures, complications and functional outcome.

2. The results of closed interlocking intramedullary nailing and external fixator in the treatment of open fractures of the Tibial shaft. (Gustillo type IIIB) were compared

   The outcomes of open fractures tibia were compared in terms of

   (a) Time required for the union of fracture.
   (b) Range of motion of ankle and knee joint.
   (c) Rate of Malunion and mal rotation
   (d) Rate of infection.
   (e) Failure of the implant.

Fig. 19: Pre op

Fig. 20: Post op

Fig. 21: 6 months follow-up; **A**): Knee-flexion and squatting; **B**): Knee–extension ankle-plantar flexion; **C**): Ankle-dorsiflexion; **D**): Inversion

3. Three goals were attempted, for successful treatment of open fractures of tibia. The prevention of infection, the achievement of bony union and the restoration of function.
4. These goals are interdependent and usually are achieved in the chronologic order given. For example failure to prevent infection promotes delayed union or non-union and delays functional recovery of the limb.
5. The 100 odd patients were arbitrarily divided into 2 groups. 50 patients were operated with tibia interlocking nail (group a) and remaining 50 with external fixator, (Group b)
6. Hence this study, it was reported that cases of Type3b open fractures tibia, which were operated by tibia interlocking nail had the following advantages
   (a) Early mobilization and decreased morbidity
   (b) Better patient compliance
   (c) Lesser incidence of infection
   (d) Less rate of deformities
   (e) Faster return to pre-injury status
7. Hence, it was concluded that tibia interlocking nailing (reamed) is a better choice of implant in Type 3 b cases, provided surgical debridement and lavage is done adequately within 24 hours of trauma to prevent complications.
8. We concluded that in Type 3b tibial shaft fracture, intramedullary interlocked nailing is an excellent modality, with advantage of early, accepted union with a mild delay but permissible early mobilization and weight bearing and low patient morbidity.

8. Source of Funding

None.

9. Conflict of Interest

None.

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Author biography

Anish Vernekar, Senior Resident

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