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Comparative study between interlocking nail and V-nail in management of fracture shaft tibia

Ritesh S. Pathak, M. A. Naser*

Department of Orthopedics, Indian Institute of Medical Science & Research Medical College, Badnapur, Jalna, Maharashtra, India

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***Correspondence:**
Dr. M. A. Naser,
E-mail: amanhospital@gmail.com

ABSTRACT

Background: Tibia is the most commonly fractured long bone in the body. Interlocked nails, either reamed or unreamed, has become the established method of treatment of closed and Grade I, II and III A open fractures of diaphysis of tibia. The cephalo-medullary nail like V-nail, has advantages of less surgical time and cost effectiveness while disadvantage of rotational instability. The present study was undertaken to compare the short-term as well as long-term results of treatment of diaphyseal fractures of tibia with interlocked nail and V-nail.
Methods: Forty patients with fracture of shaft tibia were treated with either interlocked nail or V-nail. Twenty patients were treated with interlocked nail while remaining twenty were treated with V-nail. The follow-up period ranged from 14 weeks to 10 months. The results were assessed according to Ekland grading.
Results: In interlocking series, 85% patients had excellent and good result while 15% patients had fair and poor results. In V-nail series, 30% patients had excellent result, 70% patients had good and fair results while no patient had poor result.
Conclusions: From our study we conclude that closed interlocked nailing is the most ideal method of management of fracture shaft tibia of all types, allowing early mobilization. Closed V-nail is a simple and short procedure with satisfactory results, when used in simple and unifocal fracture types.

Keywords: Diaphyseal fracture tibia, Interlocked nail, V-Nail, Ekland grading, AO classification

INTRODUCTION

Tibia is the most commonly fractured long bone in the body. Severe complications and major disability are common outcomes of this fracture because of its subcutaneous location and precarious blood supply. Various operative and non-operative methods for treatment of fracture tibia have been evolved and are being continuously refined, but which one is better, remains unsolved. Previously, for long duration, fracture tibia was treated by non-operative method, classically closed reduction and immobilization in plaster cast which used to result in fracture union at the cost of joint ROM.[1] The goals of treatment of fracture tibia are to obtain a healed, well aligned fracture, pain-free weight bearing and mobile knee and ankle joints. The intramedullary nailing, locked or unlocked has become an attractive option since image intensifiers have made closed intramedullary nailing possible. The osteosynthesis of a tibial diaphyseal fracture with a interlocked nail is recommended by various authors due to the high union rates, low infection and deformity rates, and good functional results.[2-7] However, up to 79% of patients need complementary procedures for certain complications.[8] Pain in the knee is a frequent complication in 22% to 71% of the cases and breaking of the screws in unreamed locked nails occurs in up to 52% of cases with early weight bearing.[9-12] The presence of hinge joints at the

Knee and the ankle, allows no adjustment for rotatory deformity after fracture. Though there are not many studies comparing the results of interlocked nail and V-nail, the comparison of interlocked nail and Ender's nail (a type of unlocked nail) demonstrates that the latter results in less blood loss, surgery time, and hospitalization time.[13]

The objective of this study was to compare the results of interlocked nail with V-nail, which are less expensive and can be done in short surgical time with less surgical blood loss. We considered these points to be important as, if V-nail is found to be equally effective in simpler types of fractures; it can be widely used in damage control orthopedics.

METHODS

Present study was undertaken at Department of Orthopedics, Indian Institute of Medical Science and Research, Warudi, Jalna, Maharashtra from January 2015 to June 2017. Forty patients with fracture of diaphysis of tibia were divided in two groups- A and B depending upon the registration number patients receive at the time of admission in the hospital.

Group A- Patients with even registration number. These were treated by closed intramedullary interlocking nail followed by immediate hip-knee mobilization on third postoperative day.

Group B- Patients with odd registration number. These were treated by closed intramedullary V-nail followed by continued immobilization in above knee cast for three weeks and then patellar tendon bearing (PTB) brace for next three weeks.

All patients were admitted in orthopedic wards, mode of trauma was classified as low velocity and high velocity as per Donald.[14] Low velocity trauma - fall from height less than 3 meters, bicycle falls, domestic falls. High velocity trauma- automobile, motorcycle accidents and fall from height more than three meters

Patients were evaluated as follows-

a) side of limb affected
b) Type of fracture- closed or compound
c) Extent of soft tissue injury
d) Neurovascular status of the limb
e) Signs and symptoms of compartment syndrome
f) Associated ipsilateral bony injury
g) Associated other bony injury
h) Associated head/chest/abdomen injury.

Compound fractures were classified according to the modified Gustilo and Anderson classification system. All the patients were subjected to radiological evaluation in the form of anteroposterior and lateral views of affected leg including knee and ankle. Fractures of tibia were classified as per OTA-AO classification.

Standard preoperative protocol consisted of AK slab, limb elevation, Inj. TT, Inj. Diclofenac sodium for pain alleviation, and Inj. Cefuroxime 1.5 gm 1 hr before surgery for all patients. All the patients were operated as early as possible.

All the patients were operated using standard operating steps of nailing under C-arm IITV guidance. All the operative procedures were done by a single author (RSP). Postoperatively the patients were kept in above knee slab and limb kept elevated. Inj. Cefuroxime 750 mg IV 12 hourly and Inj. Amikacin 500 mg IV 12 hourly was administered to all patients for 3 days. Inj. Diclofenac sodium was used as analgesic on demand up to 3 days. After 3 days oral Cefuroxime axetil was started and continued till suture removal.

Table 1: Grading system by Ekland.[15]

No.	Criteria	Excellent	Good	Fair	Poor
1	Tibial mal-alignment & shortening				
	a) Varus or valgus	2.5^0	5^0	10^0	$>10^0$
	b) Ante or recurvatum	5^0	10^0	15^0	$>15^0$
	c) Internal rotation	5^0	10^0	15^0	$>15^0$
	d) External rotation	10^0	15^0	20^0	$>20^0$
	e) Shortening	1cm	2cm	3cm	>3cm
2	Range of knee motion				
	a) Flexion	$>120^0$	Up to 120^0	90^0 to120^0	$<90^0$
	b) Extension deficit	5^0	10^0	15^0	$>15^0$
3	Range of ankle motion				
	a) Dorsiflexion	$>20^0$	20^0	10^0	$<10^0$
	b) Plantar flexion	$>30^0$	30^0	20^0	$<20^0$
4	Foot motions as a fraction of normal range of motion	5/6	2/3	1/3	<1/3
5	Pain	None	Sporadic	Significant	Severe
6	Swelling	None	Sporadic	Significant	Severe

For patients treated with interlocking nail (Group A), hip-knee mobilization was started on third postoperative day after discarding the AK slab. Patients treated with V-nail (Group B) were kept immobilized in AK slab till suture removal. After suture removal, AK POP cast was applied at the time of discharge. At first follow-up, at 3 weeks V-nail patients were given a PTB brace and now hip-knee mobilization was started.

All the patients were discharged on 14th or 15th day and regularly followed up every 3 weeks.

All subsequent follow-up evaluation and data preservation was done by a single author (MAN). At follow-up patients were evaluated in terms of-

- Tenderness at fracture site
- Suture line and wound status- evidence of infection
- Range of motion of knee and ankle
- Pain at fracture site/anterior knee pain
- Anteroposterior and lateral radiographs of leg.

RESULTS

Age and gender wise distribution of cases

In interlocking series ages of patients were ranging from 20 to 60 years with maximum number of patients in age group of 20to 40 years. In V-nail series ages of patients were ranging from 20 to 50 years. In interlocking series out of 20 patients, 18 (90%) were male and 2 (10%) were females. In V-nail series 17 (85%) patients were male and 3 (15%) were female (as shown in Table 2).

Type of fracture as per OTA-AO classification

In interlocking series, 5 (25%) cases were Type-C1 fractures while in V-nail series 14 (70%) cases were Type-A3 (as shown in Table 3).

Associated injuries

Out of 40 patients of fracture tibia, 12 (30%) patients were having associated significant injury.

Duration of surgery

Average duration of surgery in interlocking series is 1hour and 30 minutes while in V-nail series it is 45 minutes (as shown in Table 5).

Union time

Criteria for union was 2 to 3 cortices union on radiographs and patient can weight bear on affected extremity without pain. 60% of cases of interlocking showed radiological union at 12-16 weeks. 50% cases of V-nail showed union at 12-16 weeks. One case of interlocking did not show union at 24 weeks and subsequently required bone grafting and one case had nail breakage with non-union which required exchange nailing and bone grafting (as shown in Table 6).

Table 2: Age and gender wise distribution of cases.

	Group -A		Group-B		Total	
	No. of pts.	Percentage (%)	No. of pts.	Percentage (%)	No. of pts	Percentage (%)
Age (in yrs)						
20-30	10	50	11	55	21	52.50
31-40	06	30	06	30	12	30
41-50	03	15	03	15	06	15
51-60	01	05	--	--	01	2.50
Gender						
Male	18	90	17	85	35	87.50
Female	02	10	03	15	05	12.50
Total	20	100	20	100	40	100

Table 3: Distribution of cases as per OTA-AO classification.

OTA-AO Type	Group-A		Group-B		Total	
	No. of pts	Percentage (%)	No. of pts	Percentage (%)	No. of pts	Percentage (%)
Type-A1	3	15	1	5	4	10
Type-A2	1	5	3	15	4	10
Type-A3	4	20	14	70	18	45
Type-B1	1	5	1	5	2	5
Type-B2	1	5	--	--	1	2.5
Type-B3	2	10	--	--	2	5
Type-C1	5	25	--	--	5	12.50
Type-C2	1	5	1	5	2	5
Type-C3	2	10	--	--	2	5
Total	20	100	20	100	40	100

Table 4: Cases with associated significant injuries.

Injuries	Group-A		Group-B		Total	
	No. of pts	Percentage (%)	No. of pts	Percentage (%)	No. of pts	Percentage (%)
Head injury	2	10	1	5	3	7.50
Abdominal injury	1	5	--	--	1	2.50
Hip dislocation	1	5	1	5	2	5
Fracture femur	1	5	1	5	2	5
Fracture distal end radius	1	5	--	--	1	2.50
Fracture patella	1	5	--	--	1	2.50
Fracture humerus	--	--	1	5	1	2.50
Fracture radius/ulna	--	--	1	5	1	2.50

Table 5: Duration of surgery in two groups.

Duration of surgery	Group-A		Group-B		Total	
	No. of pts	Percentage (%)	No. of pts	Percentage (%)	No. of pts	Percentage (%)
30 min to 1 hr	1	5	14	70	15	37.50
1-11/2 hrs	7	35	6	30	13	32.50
11/2-2hrs	10	50	--	--	10	25
2-21/2 hrs	2	10	--	--	2	5
Total	20	100	20	100	40	100

Table 6: Union time.

Union time (in weeks)	Group-A		Group-B		Total	
	No. of pts	Percentage (%)	No. of pts	Percentage (%)	No. of pts	Percentage (%)
8-12	4	20	2	10	6	15
12-16	12	60	10	50	22	55
16-20	1	5	7	35	8	20
>20	1	5	1	5	2	5

Table 7: Results as per Ekland grading.

Grade (Ekland)	Group-A		Group-B	
	No. of pts	Percentage (%)	No. of pts	Percentage (%)
Excellent	12	60	6	30
Good	5	25	10	50
Fair	1	5	4	20
Poor	2	10	--	--

Table 8: Results in different OTA-AO types.

Type	Group-A					Group-B				
	No. of pts	Excellent	Good	Fair	Poor	No. of pts	Excellent	Good	Fair	poor
A1	3	2	1	--	--	1	--	1	--	--
A2	1	1	--	--	--	3	1	2	--	--
A3	4	2	1	--	1	14	5	7	2	--
B1	1	--	1	--	--	1	--	--	1	--
B2	1	1	--	--	--	--	--	--	--	--
B3	2	1	--	--	1	--	--	--	--	--
C1	5	4	1	--	--	--	--	--	--	--
C2	1	--	1	--	--	1	--	--	1	--
C3	2	1	--	1	--	--	--	--	--	--

Table 9: Complications.

Complications	Group-A		Group-B	
	No. of pts	Percentage (%)	No. of pts	Percentage (%)
Superficial infection at insertion site	2	10	1	5
Superficial infection at fracture site	2	10	--	--
Deep infection at fracture site	1	5	--	--
Proximal screw site infection	1	5	--	--
Distal screw site infection	1	5	--	--
Shortening <1 cm	5	25	4	20
Shortening >1 cm	2	10	7	35
Angulations varus/valgus				
$0\text{-}5^0$	1	5	2	10
$6\text{-}10^0$	--	--	1	5
$11\text{-}20^0$	--	--	--	--
Angulations ant/post				
$0\text{-}5^0$	1	5	2	10
$6\text{-}10^0$	--	--	1	5
$11\text{-}20^0$	--	--		
Bending of nail	--	--	1	5
Joint stiffness- ankle	3	15	5	25
Joint stiffness- knee	1	5	5	25
Breaking of drill beat	2	10	--	--
Breaking of proximal bolts	1	5	--	--
Proximal migration of nail	--	--	1	5
Nail breakage	1	5	--	--
Delayed union	3	15	1	5
Non-union	1	5	--	--
Anterior knee pain	8	40	5	25

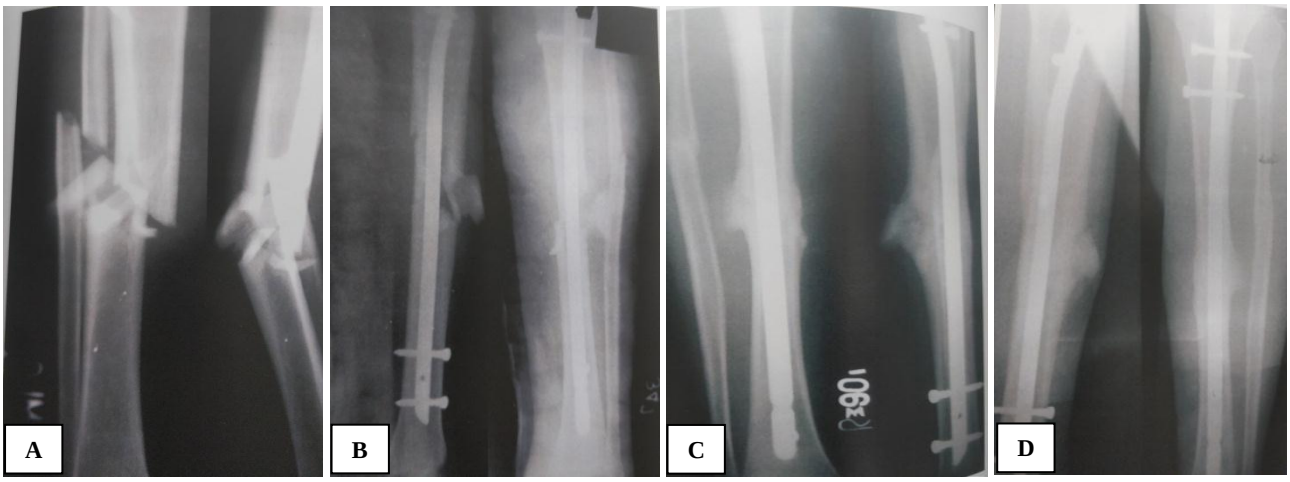

Figure 1: Case of interlocking nail. A=Preoperative radiograph; B=Immediate postop; C=Radiograph at 12 weeks; D=Radiograph showing union at 16 weeks.

Results as per Ekland grading

In interlocking series, results were excellent in 60% of cases, good in 25%, fair in 5% and poor in 10% cases. In V-nail series, results were excellent in 30%, good in 50% fair in 20% cases. No cases with poor results were found in V-nail series (as shown in Table 7).

Results in different OTA-AO types of fracture

It can be seen from Table 13 that results of interlocking are uniformly good in all types of fractures. In simple and unifocal fractures like type A2 and A3 results of V-nail are also excellent (as shown in Table 8).

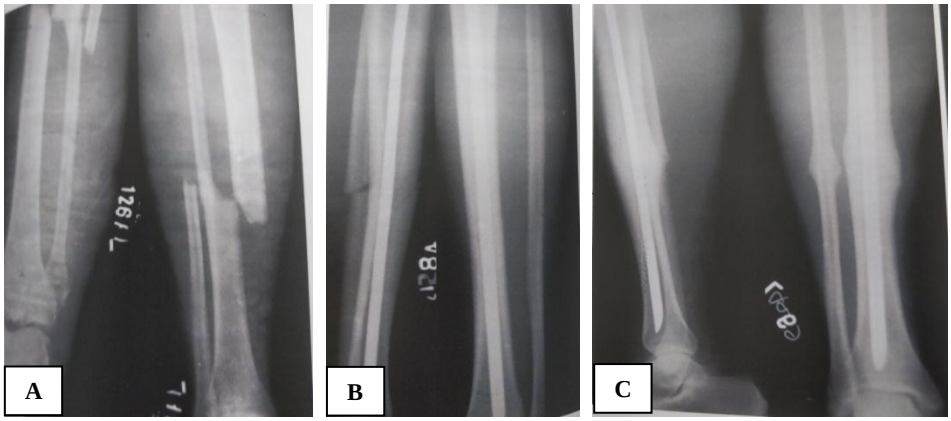

Figure 2: Case of V-nail. A=Preoperative radiograph; B=Immediate postop; C=Radiograph at 14 weeks showing union.

Complications

Anterior knee pain was common complication in both the series but it is higher in interlocking series. Complications of malalignment were more in V-nail series (as shown in Table 9).

DISCUSSION

In the present modern era of speed, there is increased incidence of accidents with increase in number of long bone fractures. Tibia is the commonest long bone to fracture and its subcutaneous location predisposes it for compound injuries. Most of these patients have multisystem involvement other than fractures– case of polytrauma. These patients need different approach in their management. Most of the time, due to involvement of other systems they need to be managed by a team of specialists. In such situations, the philosophy of damage control is usually applied. The objective of this study was to compare the results of interlocked nail with V-nail, which are less expensive and can be done in short surgical time with less surgical blood loss. We considered these points to be important as, if V-nail is found to be equally effective in simpler types of fractures; it can be widely used in damage control orthopedics.

In the present series, 33 patients out of 40 (82.5%) were from the age group of 20-40 years. The average age in a study of 50 fractures of tibia conducted by Whittle et al showed that the average age was 34 years.[16] Of the 40 patients, 35 were males while 5 were females. This was comparable to series of Bonatus et al, Duwelius et al, and Singer and Kellam.[17-19] These findings show that young, active males of working age group are more commonly involved in accidents contributing to man-hour loss.

Majority of the cases in the present study sustained fracture in a road traffic accident. This was similar to Court-Brown study which showed 66.6% of fractures of diaphyseal tibia were due to R.T.A. and 33.4% due to fall.[12]

In the present study, out of 40 patients, 32 were having compound fracture (Gustilo-Anderson Grade I/II) while 8 had closed fracture. Lang et al studied 10 closed and 22 open fractures treated with reamed and unreamed interlocking nail.[20]

In the present study, out of 40 patients 12 (30%) patients were having significant associated injuries. The median operative time in interlocking series was 90 minutes ranging from 60 minutes to 150 minutes? For V-nail, operative time was ranging from 30 minutes to 90 minutes with median of 45 minutes. In the study of Pankovich et al mean operative time was 38 minutes for flexible nailing of tibia.[21] In the Ekland series of interlocking nailing the median operative time was 60 minutes with a range of 30 to 140 minutes.[15]

In the present study, 80% (16) patients in interlocking series showed radiological union at 16 weeks. One patient of interlocking series did not show signs of union at 24 weeks and was subsequently subjected to bone grafting while one case had nail breakage which required exchange nailing and bone grafting. Union time for interlocking series corresponds well with series of Kretteck.[22] In V-nail series, 60% (12) patients showed radiological union at 16 weeks. Out of remaining 40%, 35% united till 20 weeks and 1 patient showed union by 26 weeks. Results in our series were evaluated as per Ekland grading. In interlocking series 12 patients (60%) patients had excellent results, 5 (25%) patients had good results, 1 (5%) patient had fair result and 2 (10%) patients had poor results. In V-nail series, 6 (30%) patients had excellent results, 10 (50%) patients had good results, 4 (20%) patients had fair results and none had poor result.

If we consider the results of interlocking nail and V-nail according to OTA-AO classification of tibial diaphyseal fractures, it can be seen that results of interlocking nail

are uniformly good in all types of tibial fractures. In simple and unifocal fractures like Type-A2 and Type-A3, results of V-nail are also satisfactorily good. Anterior knee pain and complications related with infection are more common with interlocking while joint stiffness and malalignment are more with V-nail.

CONCLUSION

Closed interlocking nail fixation is the most ideal method of management of fracture shaft of tibia of all types. It gives rigid fixation with rotational stability. Early mobilization of knee and ankle is the key advantage with interlocking nailing. Complications like malalignment, joint stiffness are less with interlocking, while complications like infection and knee pain are more with it. Closed V-nail is short and simple procedure with satisfactory results, when used in simple and unifocal fractures. Complications like infection and knee pain are less with V-nail, while malunion and joint stiffness are more with it. From this we conclude that V-nail can also be used in the management of simple, unifocal fractures of shaft tibia especially in patients of polytrauma as part of damage control orthopedics as it can be done in less surgical time with less surgical trauma inflicted upon the patient.

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