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Functional outcome of primary unreamed interlocking intramedullary nailing in open tibial fractures

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Abstract
Background & Objectives: Open tibial fracture management is a major challenge to orthopedic surgeons globally. Successful treatment of open tibial fractures aims at bony union' soft tissue healing and functional improvement to premorbid state. The management protocol for open tibial fracture still remains to be controversial as there is difference in opinion regarding type of implant and method of surgery (reamed or unreamed). Soft tissue injury because of high energy injury and infection makes treatment more challenging.
The aim of our study was to evaluate the functional outcome of primary undreamed interlocking intramedullary nailing in open tibial fractures.
Materials & Methods: 50 patients presenting to casualty, Govt. Medical College, Kozhikode between Januvary2015-March 2016 with open tibial fractures in the age group 18- 60 amenable to ILN was selected. All patients were treated with thorough wound debridement and skeletal stabilization with undreamed interlocking nail in first 24 hours. In all cases, proper soft tissue coverage was attained. Post operatively functionally assessed with modified Johner-Wruhs criteria.
Results & Discussion: Majority of the patients was less than 40 years and 94% were males. In 84% of cases mode of injury was Road Traffic Accidents.98% involved middle and distal third fractures.68% of cases were AO group A type and had good outcome.86% cases were type 1&2 open and had good outcome. Average time for bony union was 21.4weeks.There was no case of knee stiffness and ankle stiffness was 4%.46% of cases was associated with anterior knee pain.76% had good outcome and only 6% was associated with poor outcome. There was three case of deep infection, 2 cases of nonunion, 1 case of malunion, 8cases of delayed union, 3cases of shortening and cases of distal screw breakage.
Conclusion: Primary undreamed interlocking intramedullary nailing as an ideal method for treatment of open tibial fractures type 1, 2 and 3A. Unreamed nails provide a stable fixation preserving the soft tissues sleeve around the fracture site and maintaining the cortical blood flow. Other potential advantages include shorter operative time, less blood loss, early mobilization, shorter hospital and early weight bearing. Complications like infections malunion, nonunion and implant failure is also less. Intial wound management and soft tissue coverage is of paramount importance in the management of open tibial fractures. The nailing procedure is simple and fast and is easily reproducible by an average surgeon with a short learning curve.

Keywords: Open fractures, tibia, interlocking intramedullary nail, primary, unreamed

Introduction
Fractures of the tibial diaphysis constitute the most common open long bone fracture, occurring in approximately two per 10,000 persons per year in the developed world [1]. The blood supply to the tibia is more precarious than that of bones enclosed by heavy muscles. Tibial fractures may be associated with compartment syndrome or neural or vascular injury. The presence of hinge joints at the knee and the ankle allows no adjustment for rotatory deformity after fracture and special attention is needed during reduction to correct such deformity in the management of tibial shaft fractures problems faced are infection, malunion, nonunion, mal alignment and joint stiffness
Because of these problems, identifying optimal treatment for fractures of the tibial diaphysis is a global surgical priority. Basic concepts of the current strategy for open tibial fractures for reducing these complications are

1. Immediate intravenous antibiotics.
2. Urgent and repeated surgical debridement.
3. Immediate rigid skeletal stabilization.
4. Early and appropriate soft tissue coverage.

The skeletal stabilization options for tibial fractures are
A. Intramedullary nail fixation.
B. External fixation.
C. Plate fixation

Although there is no dispute that soft-tissue management is the most important factor in determining the outcome of open tibial fractures, the optimal method of fixation is a matter of debate.
Plate fixation has been associated with an unacceptably high incidence of infection. Sufficient stability of the fracture fragments and soft tissue can be obtained by locked intramedullary nails or external fixation. Compared to external fixator, intramedullary nailing has a lower incidence of infection and non-union. Mean time for bony union is also less in case of intramedullary nailing [13]. Intramedullary nailing approach allows stable fixation with minimal additional violation of the soft tissues in the region of the fracture. Its advantages compared to external fixator include early mobilization, decreased blood loss during surgery, less time for surgery, increased blood supply to fracture bone ends and soft tissues preservation with easier patient care.
The locking of intramedullary nails to the proximal and distal fragments decreases the prevalence of malunion of comminuted fractures. The rate of infection after treatment of open tibial fractures with intramedullary nailing with reaming has been relatively high for Grade III open tibial fractures.
The optimal management of open tibial fractures is of utmost priority because these fractures are occurring mostly in young and active people, which adds to the burden of the society

Aims & Objectives
To assess the functional outcomes of primary unreamed interlocking intramedullary nailing in open tibial fractures as follows

- To study the period of bony union and union rate based on radiological and clinical evidence.
- To study the range of movements at knee and ankle joints.
- To study the complications of unreamed interlocking intramedullary nailing in open fractures of tibia.

Materials and Methods
Study design
A prospective study (analytical study).

Study group
This study includes 50 patients between ages 18-60 years with open tibial fractures who were treated with primary unreamed interlocking intramedullary nailing at Government medical college hospital, Kozhikode from January 2015 to March 2016.

Inclusion criteria
All patients between 18 to 60 years.
Compound fracture tibia-Gustilo-Anderson type I-IIIB.
Both bone fracture leg
Presented within 24hrs.
Provision of informed consent.

Exclusion criteria
Fractures which were not amenable to intramedullary nailing.
Pathological fractures.
Intraarticular extension of fracture.
Open tibial fractures associated with neurological deficit.
Patients requiring a nail of less than 8 mm diameter.
Associated fractures of the foot, ankle, or knee

Procedure
All patients were primarily resuscitated with IV fluids. Vitals were monitored frequently. All patients were given anti Tetanus prophylaxis and Triple Antibiotics Distal neuro vascular status is assessed. All external injuries are documented. Relevant pre-op investigations and X-rays were taken.
Initial wound wash given. Primarily stabilized in long leg slab or Thomas splint.
Patient was taken for surgery after anesthetic checkup and getting detailed informed consent
All surgeries were done under spinal anesthesia.

Initial Wound Debridement
The wound was debrided and irrigated copiously with about 3 to 9 liters of normal saline. Dead muscles, devitalized soft tissues, foreign bodies and small bony fragments without muscle attachments were removed and irrigation was continued until the wound looked relatively clean. High pressure irrigation was avoided and care was taken to avoid soft tissue stripping of fracture fragments.

Positioning and Draping
Patient in supine position. Patient's leg is positioned such that knee is flexed to 90degrees after painting and draping.

Nail Entry Point
A central longitudinal incision is applied over the knee joint from lower border of patella to just above tibial tuberosity. We used patellar tendon splitting approach. The patellar tendon was palpated with knee in flexion and incision is applied. A curved awl directed anteriorly was used to mark and create the entry point of nail anterior to the articular surface.

Nail Insertion
After proper reduction, a guide wire was passed through the medullary canal until it reached the subchondral bone near the ankle joint. Manual reamers were passed over the guide wire through the medullary canal of gradually increasing diameter without reaming until it snugly fitted in the medullary canal at isthmus of tibia. This was checked by fluoroscopy. This was done to determine the length and diameter of the planned nail to be introduced. This was cross checked with the preoperative assessment of the nail length and diameter which was done from preoperative radiographs. The nail length can also be measured anthropometrically from tibial tuberosity to medial malleolus base of the healthy limb. The knee joint to ankle joint line length minus 20 mm, is the most reliable and has shown best correlation with ideal nail length.
We used interlocking nails ranging from 280 mm to 380 mm in length and diameter 8 mm to 10 mm (mainly 8 mm and 9 mm).
The chosen nail was then attached to the target arm and L-handle by locking bolts and the target arm was adjusted and checked for distal locking slots. The nail was gradually introduced in the medullary canal by pressure from the

surgeon or light taps using the mallet with the limb flexed. Fracture was reduced to pass the guide wire. The surgeon's tactile senses guided the placement of the nail across the fracture site in absence of fluoroscopy. The ring on the stem tube of L-handle decided the depth of nail insertion in absence of fluoroscopy. When fluoroscopy was available, the accuracy of reduction and entry and placement of nail was checked fluoroscopically.

Distal Interlocking

Guide wire is made flush with subchondral bone of ankle is marked with Kocher's forceps. Guide wire was withdrawn up-to 10 cm. Outer sleeve was used to mark the location of skin incision. Incision was made and soft tissues dissected up to bone. Outer and inner sleeve were inserted through the target arm to rest on the bone. Drilling was stopped when the step drill got engaged in the slot of the nail. Position of the screw inside nail was confirmed by passing the guide wire. Further outer cortex was drilled. Screw length measured by depth gauge. 2nd distal locking screw was placed in the same manner.

Compression of Fracture

After placing the distal interlocking screws, fracture was checked under fluoroscope and in cases, where compression was necessary it was achieved by attaching the extractor/compressor rod containing the weight and back strapping the fracture. In comminuted cases, back strapping was not done.

Proximal Interlocking

The target arm was replaced, and the same procedure was followed as for distal interlocking to lock the nail proximally. The placement of 2 screws in proximal tibia was done.

Wound Closure

The incision through the patellar tendon was closed first. Next the skin over the screw placement sites was closed. Lastly, wound over the fracture site was closed. Primary wound closure was done in 27 cases and delayed primary closure in 16 cases. Primary SSG in 1 case. Delayed SSG was done in 6 cases. Some of the delayed closure and delayed SSG were initially given VAC dressing.

The operating time was 60 minutes to 90 minutes.

Post-operative regimen

After operation, below knee slab was given for 3 days. Limb was kept elevated and patients were instructed for active toe movements. Parenteral antibiotics were continued for 5 days followed by oral antibiotics until stitch removal or wound healing. Knee and ankle range of movement exercises were started after subsidence of pain (2-3 days). Active knee bending and quadriceps exercises started after 3 days. Staples were removed between 10th and 14thday. Patient was advised quadriceps strengthening exercises and ROM exercises for 6 weeks. Partial weight bearing was started after 6weeks. Full weight bearing was allowed only after evidence of clinical and radiological union.

Post op follow up

Post operatively patient was followed up clinically, functionally & radio logically during immediate post op, post op day 10-14 days, 6weeks and monthly till 6 months using modified Johner-Wruh's criteria. Check x-ray was taken during each visit. The range of movements of the knee and ankle were measured and compared bilaterally. Pain intensity was measured by visual analogue scale (vas) and the outcome was categorized as excellent, good, fair or poor with vas values scoring 0, 1-3, 4-6, and 7-10 respectively. A grade of -Excellent‖ meant no pain,-Good‖ meant occasional pain, -Fair‖ meant that pain had caused some sleep disturbance and -Poor‖ described pain beyond the patient's tolerance. All transverse A3 fractures were dynamised at 2 months.

Bony union was determined with clinical and radiological criteria. Clinical union was defined as the ability to bear full weight with no pain at the site of the fracture and radiographic union was defined as evidence of bridging of three of the four cortices on standard antero posterior and lateral radiograph

Complications

Early complications

1. Infection-Superficial or deep infections.
2. Compartment syndrome.
3. Neurovascular deficits.
4. Fat embolism.

Late complications

1. Malunion.
2. Nonunion.
3. Delayed union.
4. Shortening.
5. Instability.
6. Knee stiffness.
7. Ankle stiffness.
8. Anterior knee pain.
9. Nail bent or break.
10. Screw breakage.

Statistical Analysis

The data was entered in Microsoft excel and further analysis done using the software PASW Statistics 18. The statistical tests performed were the Pearson chi-square test and student t-test. The level of significance was set at 5% (p value <0.05).

Results and Observations

1. Age

In this study 18 patients were between 18-24 yrs, 18 were between25-40yrs, 6 were between 41-50 yrs and 8were between 51-60

2. Sex

In our study 94% were males and 4% females

Table 1: Correlation between Age and Outcome

			Outcome			
		Excellent	**Good**	**Fair**	**Poor**	**Total**
Age	18-24	13	3	1	1	18
		72.2%	16.7%	5.6%	5.6%	100.0%
	25-40	8	6	2	2	18
		44.4%	33.3%	11.1%	11.1%	100.0%
	41-50	3	2	1	0	6
		50.0%	33.3%	16.7%	.0%	100.0%
	51-60	0	3	5	0	8
		.0%	37.5%	62.5%	.0%	100.0%

P value 0.019 in our study, younger age group is having better outcome

3. Side

Right side was involved in 26 patients and left side in 24

4. Level of Fracture
34 cases of middle third, 15 cases of distal third and one case of proximal third shaft of tibia were there in our study there was no statistically significant correlation between level of fracture and outcome or bony union time.

5. Level of Fibula Fracture
We studied the level of fibula fracture with respect to tibial fracture. In around 50% of patient's fracture was above tibial level. There was no significant association between level fibula fracture with respect to final outcome or bony union.

6. Duration of Hospital Stay
In the study majority of patients was discharged within 1 week. Those with infections or other complications were retained. Average duration of hospital stay was 5.82 days.

7. Time of Injury and Arrival at Hospital
We studied the relation between time of injury and arrival at our hospital. 66% of patients presented to casualty within 2 hours and the outcome were good in those. Rest of the patients presented after 2 hours.

8. Duration between Times of Injury to Surgery
Of 50 patients, 28 patients were operated within 7-10 hours 18 patients after 10 hours and 4 within 6hrsThere was no statistically significant correlation between time of injury to surgery and post op infection, this may be due to quality of initial wound care and early administration of antibiotics. Post-operative infection depends more on the soft tissue status and contamination of the wound.

9. Mode of Injury
42 cases were RTA and 8 were fall from height

10. Fracture Pattern According To Ao Classification

Table 2: Fracture Pattern According To Ao Classification

		No Of Patients	Percentage
1.	A1	2	4.0
2.	A2	14	28.0
3.	A3	18	36.0
4.	B1	5	10.0
5.	B2	5	10.0
6.	B3	3	6.0
7.	C1	2	4.0
8.	C3	1	2.0

Table 3: Correlation between Ao Classification and Bony Union

	Bony Union					
Ao						
Classification	0-4 M	5-6 M	7-8 M	9-12 M	Nonunion	Total
1.A1	0	2	0	0	0	2
	0%	100.0%	0%	0%	0%	100.0%
2.A2	4	10	0	0	0	14
	28.6%	71.4%	0%	0%	0%	100.0%
3.A3	1	14	2	1	0	18
	5.6%	77.8%	11.1%	5.6%	0%	100.0%
4.B1	1	4	0	0	0	5
	20.0%	80.0%	0%	0%	0%	100.0%
5.B2	1	2	1	0	1	5
	20.0%	40.0%	20.0%	0%	20.0%	100.0%
6.B3	0	1	2	0	0	3
	0%	33.3%	66.7%	0%	0%	100.0%
7.C1	0	0	2	0	0	2
	0%	0%	100.0%	0%	0%	100.0%
8.C3	0	0	0	0	1	1
	0%	0%	0%	0%	100.0%	100.0%
	7	33	7	1	2	50
	14.0%	66.0%	14.0%	2.0%	4.0%	100.0%

P value 0.01

In our study, we divided the patients according to AO fracture pattern. Majority of patients comes under group A, in which 36 % was A3.Analysis, shows that outcome is poor in group C compared to A&B.

11 Gustilo-Anderson Grade of Open Fracture
In our study of the total 50, 43 patients come under type 1 & 2. Type 1 and 2 had better results compared to type 3. Difference was statistically significant. In Type 3 open only 43% had good results. Bony union time was also better in type 1&2.

12 Co Morbidities
9 patients had diabetes mellitus and one had hypertension
Those with Diabetes mellitus was associated with lower outcome compared with others (p value 0.03). This is due to higher susceptibility to infection.

13. Post Op Infection
There were no infection in 33 patients (66%) superficial infection in 14 cases (28%).Only 3 cases had deep infection

14. Time of Bony Union
From our study, average bony union time is 5 months.40 cases united within 6 months. 8 cases were delayed union. Within 1 year out of which 5 cases united with bone grafting. 2 cases went for nonunion in which re-surgeries were needed.

15. Ankle Rom
ROM more affected in ankle than knee. 16 patients had ROM <75% among them 7 had <50%. This may be due to more incidences of distal 3rd fractures. Outcome was also better in those patients with good ROM ankle.

16. Knee Rom
All patients had knee range of movements more than 80%.

17. Anterior Knee Pain
Anterior knee pain was present for 23 patients (46%). Functional outcome was better in those with no knee pain.

18 Functinal Outcome
By modified Johner Wruhs criteria 24 cases had excellent, 14 patients had good and 9 had fair results. Only 3 had poor outcome

Pre op x-ray **Post op x-ray**

Knee ROM **Ankle ROM**

19. Complications

Table 4: Showing Complications

Early	
Infection-	14
Superficial	
-Deep	3
Compartment Syndrome	0
Neuro Vascular Deficits	0
Fat Embolism	0
Late	
Delayed Union	8
Nonunion	2
Malunion	1
Shortening >1 Cm	3
Instability	0
Nail Bent/ Break	0
Screw Break	1
Stiff Ankle	2
Stiff Knee	0
Ankle Rom <50	10
Knee Rom<50	0
Ant Knee Pain	23

Discussion
The aim of our study was to evaluate the functional outcome of primary unreamed interlocking intramedullary nailing in open tibial fractures. In our study 50 patients were studied. All patients had a minimum follow up of 6 months and maximum up to 1 year.
Management of open tibial fractures continues to be a major problem and challenge to orthopedic surgeons all over the world. Targets for the successful treatment of open fractures of tibia are the prevention of infection, the achievement of union and the restoration of function. The management protocol for open tibial fracture still remains to be controversial as there is uncertainty in type of implant and method of surgery (reamed or unreamed). Complexity of fracture, soft tissue damage due to high energy injury and infection make management more difficult.
Some earlier studies compared cast with nailing for type 1 open fracture. Cast causes joint stiffness, muscle atrophy, osteoporosis, prolonged recumbency and loss of working days. The popularly applied patellar tendon bearing cast (Sarmiento tibial plaster) and early weight bearing may not control alignment in all cases. Besides, there is a danger of slipping of the fracture after weight-bearing. Further, not all cases can be reduced to an acceptable position by closed methods. Sarmiento type patellar tendon bearing functional brace result an average shortening of 6.4mm, an average angulations of 8mm and an average union time of 5.7 months. Plate fixation is not preferred due to chance of infection, soft tissue problems and precarious blood supply.
Other methods are external fixation LRS or Ilizarov. In comparison to all other methods with respect to infection, malunion and nonunion intramedullary nailing is a promising solution to the problem.
Nonunion was also high in Ex-fix treated patients compared to ILN.
Rigid nailing with reaming leads to a higher incidence of infection as dead bone produced due to reaming (debris/endosteal necrosis) acts as a good culture medium for bacteria (Bintcliffe *et al*. [2]).
Interlocking intramedullary nailing solves the problem of malunion because it provides the ability to control length, angulation and rotation. Reaming, however, destroys the endosteal blood supply further devascularizing the already compromised bone. The unreamed tibial nailing is reported to have definite advantages over the reamed nailing. Unreamed nailing in experimental studies has been found to cause less reduction in cortical circulation as compared to reaming of the medullary canal. Klein *et al*. [3] reported 31 percent reduction of cortical circulation using unreamed nail as compared to 71 percent reduction after reaming. Reaming of open fractures has been found to spread the contamination from open wound along the medullary cavity and to strip small fragments of bone from their soft tissue attachments. Reaming has also been reported to slow the revascularization and delay osseous union. The surface area of a hollow nail is 2 times that of a solid nail and so it contains more dead space and therefore more susceptible to infection. Cortical necrosis is less likely to occur with a loosely fitted
Intramedullary nail than a snugly fitted reamed nail. In addition, smooth surface of solid nail may decrease the susceptibility of infection by decreasing the adherence of bacteria. Interlocking nailing without reaming combines the most desirable features of interlocking nailing with reaming and of non-locking nailing without reaming. Length, alignment and rotation are controlled, the soft tissues are

easily accessible, and some endosteal blood supply is preserved. These factors should lower the rates of infection and malunion and expand the use of intramedullary nails to fractures near the metaphysis and to those with more severe comminution and soft-tissue injury.

Many studies recommend primary unreamed intramedullary nailing after proper wound debridement and better soft tissue coverage. It has got many advantages as less time for surgery, less cost implant, single procedure, better maintenance of length angulation and rotation, less infection and good functional outcome.

In our study, most patients affected were younger age male patients. This shows magnitude of the problem in society as most patients will be the only earning member in the family. Most common mode of injury is RTA. In our study 72% patients were less than 40 years and 94% were males.

Most of the fractures were involving middle and distal 3rd, i. e. 98%. This was comparable with other studies. All cases were associated with fibula fracture. The outcome with respect to level of fibular fracture was found to be not significant with outcome. There was one study of Brelusconi *et al*. [4] studied whether to fix fibula or not. None of the parameters considered in that study (open injury, AO classification, device used and level of the fibular fracture relative to the tibial) were shown to have an influence on the development of a nonunion Another paper by Balaji *et al*. [5] to study the effect of intact fibula on open and closed tibial fracture treated with interlocking nail found that outcome was good and comparable to those with fibula fracture.

In our study, we studied the time duration between time of injury to arrival at our emergency department and also time duration between injury and surgery. There was no statistically significant correlation between time between injury and surgery with post op infection. There is no consensus in the orthopedic literature regarding the correlation between time and infection. Spencer *et al*. [6] and Kamat *et al*. [7] did not find an association between infection and time to first debridement. In our study, there was 1 case of infection in cases where surgery was done within 6hours, compared to 16 cases of infection that was done after 6hours.However; there was no statistically significant correlation. The golden period of 6hours may not hold significant. Final outcome may be determined by quality of wound care given at primary centre. More over early administration of antibiotics and initial soft tissue status, co morbidities of patient like Diabetes mellitus and contamination of the wound will determine the outcome along with time duration.

In our study majority 68% were OTA classification group a (a1 a2 a3), 26% B and 6% C. Outcome was better in non-comminuted group A. This was consistent with similar studies by Bone *et al*. [8] showing comminuted fractures group B&C had more delayed union and secondary procedures.

Similar results were obtained in Johner-Wruhs [9] study also.

In our study 46% was type 1 open, 40% type 2 and 7% type 3 open. This was also similar to other studies Johner-Wruhs 58% type 1, 34% type 2 and 8% type 3 and in prospective study by Bone *et al*. 8study which was 60%, 30% and 10% in type 1, 2 & 3 respectively. Type 1 and 2 is associated with good outcome compared to type 3. This signifies the importance of soft tissue management in open tibial fractures. Early wound debridement and soft tissue coverage is as important as skeletal stabilization.

Final outcome was also better with lesser soft tissue injury which was statistically significant. Bony union time was compared with prospective study by Keating *et al*. [10] study which showed comparable results.

In our study those patients having diabetes were associated more chance of post op infection and poor outcome.

In our study, bone union time average was 21.4 weeks. 80% of cases united without any secondary procedures. In similar study using Ex-fix by Beltsios [11] was 25 weeks

In our study 46% cases had knee pain. Most of them had occasional pain only not subsiding even after bony union.

In a prospective study by Keating *et al*. [10] in reamed group there was 49% knee pain whereas in unreamed group it was 41% and in Larsen *et al*. [12] it was 42%.

Toivannen *et al*. [13] showed paratendinous approach for nail insertion does not reduce the prevalence of chronic anterior knee pain in intramedullary nailing of tibial shaft fracture. At the same time Oarfley *et al*. [14] showed that paratendinous approach is related with less knee pain and nail. Position in relation to the anterior cortex and tibial plateau had no influence on knee pain. Only 45% had improvement in symptoms following nail removal in their series. From other studies, it is evident that cause of anterior knee pain is multifactorial and does not depend on the approach alone.

Complications

1. Infection

Most common and worried complication of open tibial fractures is infection. We had 34% infection rate in which 82% is superficial infection in comparison with Johner-wruhs series where it was 7.4% Three patients (6%) had deep infection, for which wound debridement was done under anesthesia, regular dressing, IV antibiotics and guarded weight bearing was continued till the fracture got united. Superficial infection was more in type 1 open where as deep infection was more in type 3.

2. Malunion.

In our series, there was only 1 case of malunion (2%). In another studies Larsen *et al*. [12] (reamed) 8% and (unreamed) 12%, Puno *et al*. [15] reamed ILN it was 0%. One of the most important advantages of nailing is reduction in malunion.

3. Nonunion

There were 2 cases of non-union. First case was young patient with type 3B open and AO group B. Even though younger age group and AO less comminuted group has better prognosis patient went for nonunion. This signifies the importance of soft tissue management and patients should be warned of poor prognosis in type 3 open fractures.

Second was also a young patient with type 1 open and AO group B. Here all the factors were favorable, still patient went for nonunion. This also signifies the importance of soft tissue care. Most probably small wound might have misled the surgeon from meticulous debridement.

4. Delayed Union

80% of cases united within 6 months at an average of 21.4 weeks. There were 8 cases of delayed union (16%). This was comparable to prospective study by Tornetta *et al*. [16] where it was 13%.

All case united by 12 months. Average union time was 37 weeks. Out of 8, 6 needed bone grafting.

5. Shortening

3 cases had shortening more than 1cm, which is 6%. In Johner-wruhs study it was 1.4%.

6. Other Complications

In our study screw breakage was 2% (1 case). There was no incidence of nail breakage or compartment syndrome.

Screw breakage in Larsen *et al*. [12] was 3%, Joshi *et al*. [1] it was 14% and Keating *et al*. [10] 29%. Nail breakage was 0% in Larsen *et al*. and 3% in Joshi *et al*. [1] study. Compartment syndrome was 3.6% in Joshi *et al*. [1] study.

There were no cases of knee stiffness similar to studies of Larsen *et al*. [20] and Tornetta *et al*. [16]. There was ankle stiffness in 2 cases. This may be due to early mobilization of knee from post op day 2 and slight increase in ankle stiffness may be because majority of cases was distal 3rd fractures.

The average nail diameter in our series was 8.7cm.

In our study, 76% had excellent-good outcome which was comparable to other prospective studies by Wani *et al*. and Joshi *et al.*

In our study, there were 7 cases of Type 3 open fractures among which 1 was Type 3B. In Type 3 open only 43% had good results. In 57% result was fair to poor. 1 case of Type 3B also had poor outcome. In similar prospective study by Joshi *et al*. results were fair to poor in 75% cases among Type 3 open.

Conclusion

The present study was undertaken to investigate the outcome of primary unreamed interlocking intramedullary nailing in open tibial fractures. Fifty patients with open tibial fractures were treated with primary unreamed interlocking intramedullary nailing between January 2015 and March 2016 in government medical college, Kozhikode. All cases were followed up minimum for a period of six months and maximum of 12 months

Based on our experience and results, we conclude that primary unreamed interlocking intramedullary nailing as an ideal method for treatment on open tibial fractures type 1, 2 and 3A, when treated within 24 hours. Unreamed nails provide a stable fixation preserving the soft tissue sleeve around the fracture site and maintaining the cortical blood flow.

Other potential advantages include shorter operative time less blood loss, early mobilization, shorter hospital stay and early weight bearing. Complications like infection, malunion, nonunion and implant failure is also less

Initial wound management, early skeletal stabilization within 24 hours and appropriate soft tissue coverage is of paramount importance in the management of open tibial fractures. Type 3A fractures should undergo frequent follow up as there is more incidences of complications like infection and delayed union. Its effectiveness in type 3B open fractures cannot be commented as we had only 1 case and further studies are required. The nailing procedure is simple and fast and is easily reproducible by an average surgeon with a short learning curve. Another advantage as far procedure is concerned is that it can be done without fluoroscopic guidance.

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