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A comparative study of surgical management of tibial shaft fractures in adults by reamed versus unreamed intramedullary interlocking nail

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Abstract
Tibial shaft fractures being most common type of long-bone fracture encountered, we compared reamed and unreamed IMIL nailing. 50 patients randomly allotted to reamed and unreamed groups treated with IMIL nailing. Patients were followed up regularly for 6 months and evaluated using Johner and Wruh's criteria. We found no significant difference in functional outcome (p value- 0.564) and post-operative infections and complications between two groups. With the convenience of performing and less operative time over reamed nailing, unreamed nailing may have upper hand over reamed nailing.

Keywords: unreamed IMIL nailing, tibial shaft fractures, surgical management

Introduction

Tibia being the common bone fractured in any trauma because of its subcutaneous nature and due to increasing cases of high energy injuries in the present days.

A tibial shaft fracture is a common trauma, especially amongst young and middle-age people. Its prevalence is lower amongst children and older people. The tibial shaft is the commonest site of long bone fractures due to its superficial location. [1]

Treatment of tibia shaft fractures being controversial, due to its lack of soft tissue coverage and precarious blood supply, it is vulnerable for non-unions and mal-unions and infections.

The aims of treatment for tibial shaft fractures are re-establishing pre-injury anatomy and function with lowest complication rates. Several methods have been used for treatment of this fracture. Closed reduction and cast immobilization have previously been regarded as the standard treatment for low-energy tibial shaft fractures. However, during the last few decades, locking intramedullary (IM) nailing has become a popular method for treating tibial shaft fractures [2].

The use of IM (intramedullary) nailing in the treatment of tibial shaft fractures has the following advantages: closed reduction and preservation of the periosteal blood supply, the possibility of early mobilization of the knee and ankle joint, the ease with which the limb can be observed postoperatively, a lower prevalence of wound infections, good biomechanical stability of the cortical bone, good possibility for bone union, and a faster recovery and return to work [3].

However, the choice between two alternative intramedullary nailing approaches, reamed or unreamed, is an ongoing controversy. The use of unreamed intramedullary (IM) nails avoids infection but potentially may compromise stability at the site of the fracture. While reamed nails offer improved stability of the fracture, their use carries a theoretical risk of increasing infection. Fractures of the tibia cannot be treated successfully in all cases with only one approach or a single simple set of rules [4].

The presence of hinge joints at the knee and ankle allows no adjustment for rotatory deformity after a fracture. Delayed union, non-union and infection are relatively frequent complications especially after open fractures of the shaft of tibia.

In this study, two modalities of fixation of shaft of tibia fractures are chosen and compared i.e., reamed interlocking intramedullary nailing and unreamed interlocking intramedullary nailing and any differences in prognosis will be studied.

Objectives

1. To compare the time taken for union of fractures after reamed and unreamed nailing for tibial fractures.
2. To determine the clinical and functional outcome (infections, non-union, mal-union, implant failure, need for secondary operations) between reamed and unreamed nailing in patients with tibial shaft fractures.
3. To compare the range of motion of knee joint after reamed and unreamed nailing for tibial fractures.

Materials and Methods

Patients of both sexes belonging to adult age group presenting with fracture tibia to Orthopaedic Department of Mysore Medical College and Research Institute, Mysore are admitted from November 2019 to June 2021 and evaluated. Those satisfying our inclusion criteria and are surgically fit are included in the study. This includes a prospective study of 50 cases among patients with fracture shaft of tibia admitted in our institution who were randomized and allotted into two groups, one group underwent reaming and other group unreamed intramedullary nailing. Each group containing 25 patients.

Inclusion criteria

1. Patients with closed tibial shaft fractures and open type 1 and type 2 fractures.
2. Patients above the age of 20 years and under 60 years of age.
3. Patients managed surgically by Intramedullary inter locking nailing (reamed/ unreamed).

Exclusion criteria

1. Children with tibial fractures in whom the growth plate is still open.
2. Patients with type III open tibial shaft fractures.
3. Patients lost in follow up.
4. Patients with polytrauma.

Operative Procedure

- All patients are operated under spinal/epidural anesthesia. Midline Longitudinal incision over the patellar ligament at the level of joint, 5 to 6 cm long is used, splitting the tendon longitudinally.
- Entry portal is made 2 cm proximal in the midline or slightly medial and behind the tibial tuberosity.
- A curved awl is used to open the medullary canal and is pushed as far as possible into medullary canal, while the handle should be in line with the axis of the shaft.
- 3.2 mm guide wire with ball tip is pushed into the canal, past the fracture site into the malleolar region (0.5 to 1 cm proximal to ankle joint) assisted by reduction manually.
- Next step is to ream the medullary canal in case of group 1. Reaming is done with the help of flexible reamers. Normally we start from 8 mm and increase by increments of 0.5 mm. The medullary canal is reamed 1 mm more than the diameter of measured at isthmus an X-ray lateral view.
- In case of group 2, nail is passed directly over the guide wire after approximately determining the diameter of the medullary canal with the help of C-arm, specially giving importance at the isthmus while measuring.
- For distal locking by C-arm and free hand technique, the C-arm is placed to show the locking holes of nail as perfect circles on the monitor.

Post-Operative Period

- Postoperatively, the limb is elevated on a pillow. Immediate postoperative complications like fat embolism and compartment syndrome, neurological damage and vascular injury is looked for. Wound infection is watched for in the postoperative period.
- Parenteral antibiotics are given for 3 days, and continued in the form of oral antibiotics till suture removal, which is done on 10-12 days.
- Active quadriceps exercises are restarted on the first postoperative day with active ankle and toe movement with knee mobilization, as far as the patient is comfortable and free of pain.
- Radiograph of the leg is taken to assess the fracture alignment, nail placement and locking screws.
- The patient is made to ambulate from the third postoperative day without bearing weight on the operated leg with crutches or walker. Suture removal is done around 10-12th day if the wound has healed.

Follow UP

- It was done using Johner and Wruh's criteria.[5] Patients were followed up periodically on an outpatient basis at 4th, 6th, 10th, 12th, 16th, 20th weeks and 6th month and in between if required.
- The complaints were noted and the clinical and radiological assessment of the patients were done, for pain, deformity, shortening, range of motion of knee, ankle and radiological union.

Operative Photographs

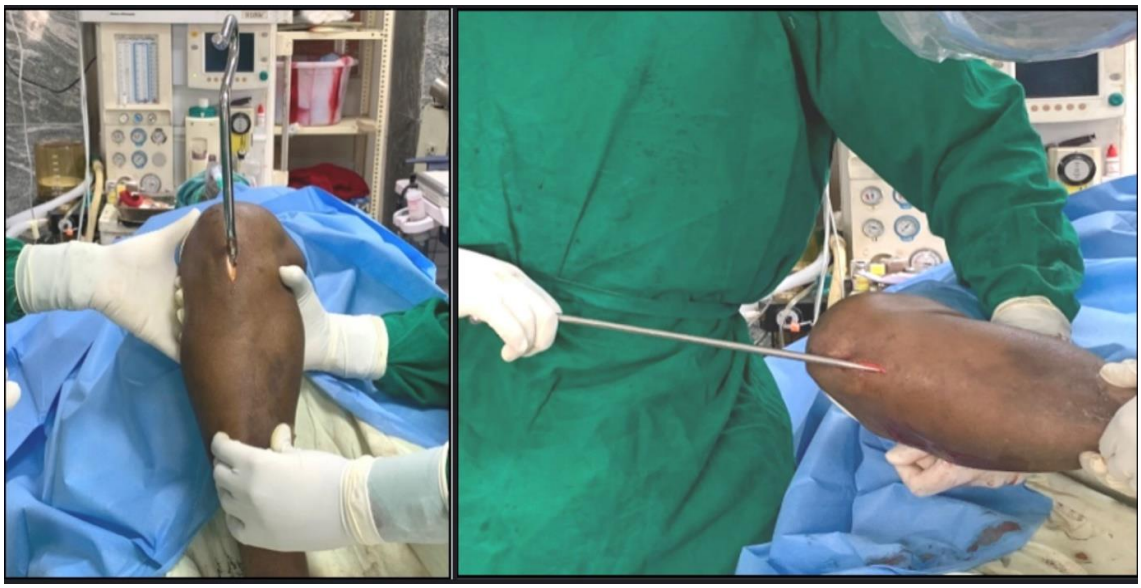

Fig 1: Intra-op procedure images of taking entry point and reaming medullary cavity

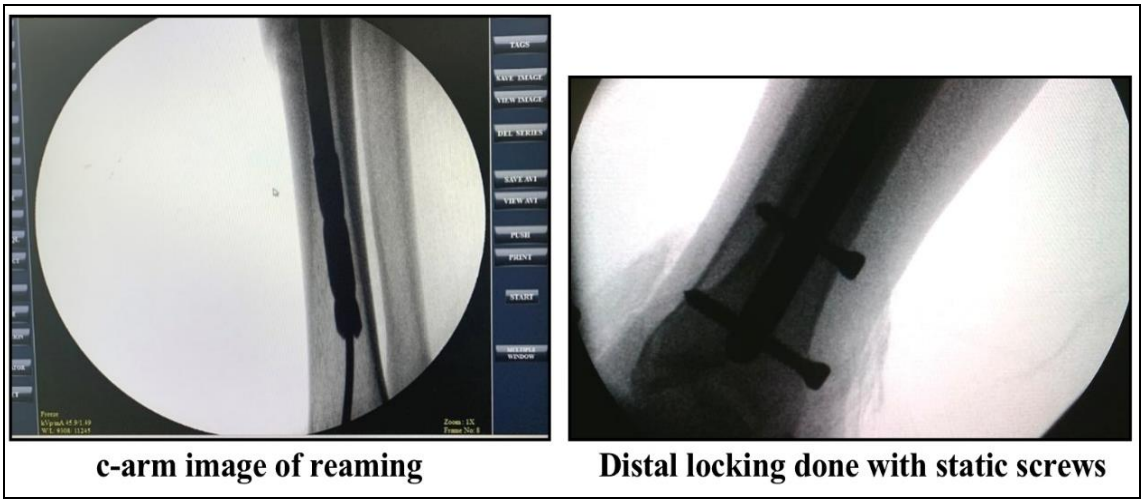

Fig 2: Intra-op C-arm images

Results

Our study was done in Mysore Medical College and Research Institute, Mysore, 50 patients with fracture shaft of tibia were first randomized into two groups and treated with Reamed and Unreamed closed intramedullary interlocking nailing. The results observed are as below.

Table 1: Age-wise distribution

Age group (years)	Reamed	Unreamed
18-29	7	8
30-39	13	11
40-49	4	4
50-59	1	2

Age-wise distribution

In this study average age of the patient in reamed group was 33.92 whereas in unreamed group was 35.32. Majority of the patients were between the age group of 30-39 in both groups.

Sex-wise distribution

In this study, males were more than female sex. The present study has 17 (68%) males and 8 (32%) females and 16 (64%) males and 9 (36%) females in Reamed and unreamed group respectively.

Anatomical location of fracture

The commonest anatomical location of fracture was at the middle-third of the tibia in both the groups. This constituted 52% and 44% of tibial shaft fractures in reamed and unreamed group respectively, Followed by middle-lower junction. The diaphysis is a more rigid bone, so fractures are common in middle third of tibia.

Type of injury

In this study 18 cases (72%) and 17 cases (68%) were closed fractures among reamed and unreamed group respectively. Whereas open fractures accounted for 7 cases (28%) and 8 cases (32%) in reamed and unreamed groups.

Type of fracture

In this study, reamed group had more of transverse fracture constituted for 48% cases, 20% of comminuted fractures, 16% of oblique fractures, 12% wedge fractures, only 1 case of spiral fracture. unreamed group had 44% transverse fractures, 24% of wedge fractures, 16% comminuted fractures, 12% oblique fracture and 1 spiral fracture.

Nail size

In majority of cases, we used 10 mm nail size in reamed group patients, 11mm nail was used for one patient in reamed group. In unreamed group patient's majority we used 8- and 9-mm nail size**.**

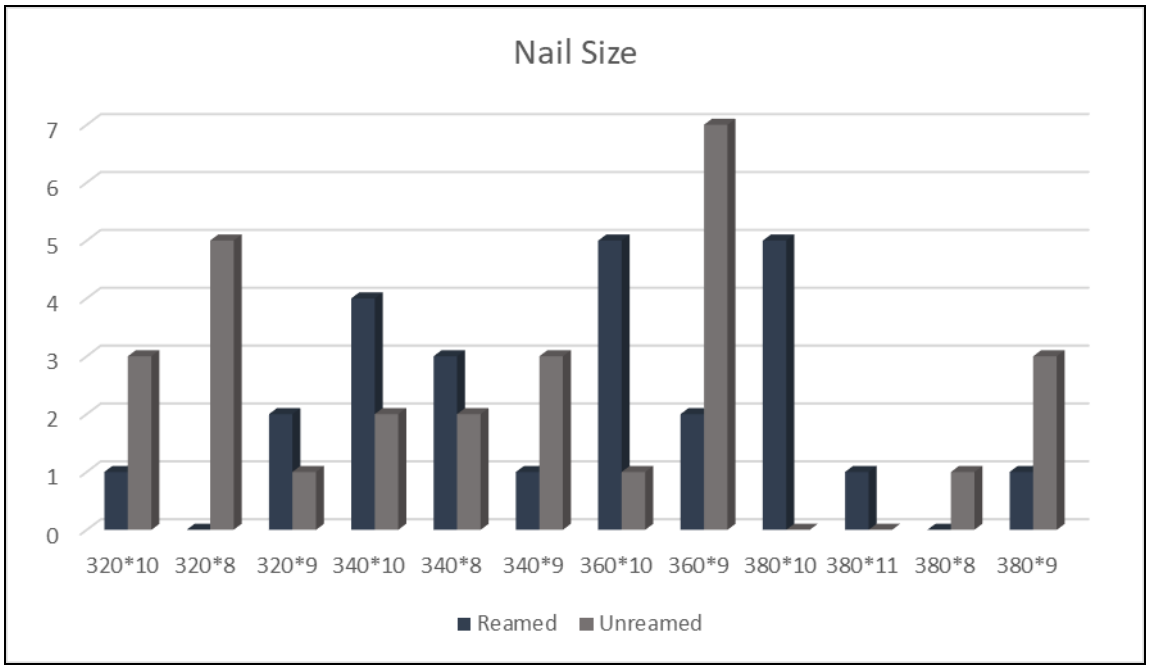

Fig 3: Nail size

Deformity

In this study, in reamed group 22 patients in deformities, 2 patients had valgus deformity, 1 patient had varus deformity. In unreamed group 23 patients with no deformities, 1 patient had valgus and 1 patient had varus deformity.

Table 2: Knee movements

Knee		Groups		Total
		Reamed	Undreamed	
N	Number	21	22	43
	Percentage	84.0%	88.0%	86.0%
>50%	Number	1	0	1
	Percentage	4.0%	0.0%	2.0%
>75%	Number	3	2	5
	Percentage	12.0%	8.0%	10.0%
>80%	Number	0	1	1
	Percentage	0.0%	4.0%	2.0%
Total	Number	25	25	50
	Percentage	100.0%	100.0%	100.0%

Knee movements

In this study, in reamed group 84% cases had normal range of knee movements, 3 cases (12%) had >75% knee ROM, 1 case had >50% knee ROM. In unreamed group 88% cases had normal knee ROM, 1 case had >80% ROM, 2 cases (8%) had >75% knee ROM.

Table 3: Ankle movements

Ankle		Groups		Total
		Reamed	Undreamed	
N	Number	21	22	43
	Percentage	84.0%	88.0%	86.0%
>50%	Number	4	3	7
	Percentage	16.0%	12.0%	14.0%
Total	Number	25	25	50
	Percentage	100.0%	100.0%	100.0%

Ankle movements

In this study, among patients in reamed group 84% had normal ankle ROM, 4 patients had >50% ROM. Whereas in Unreamed group, 88% had normal ankle ROM, 3 patients had >50% ROM

Table 4: Subtalar movements

SL		Groups		Total
		Reamed	Undreamed	
N	Number	21	22	43
	Percentage	84.0%	88.0%	86.0%
>50%	Number	3	2	5
	Percentage	12.0%	8.0%	10.0%
<50%	Number	1	1	2
	Percentage	4.0%	4.0%	4.0%
Total	Number	25	25	50
	Percentage	100.0%	100.0%	100.0%

Subtalar movements

This study observed 84% patients with normal subtalar movements, 12% with >50% ROM, 1 patient with <50% ROM in reamed group. In unreamed group, 88% cases had normal subtalar movements, 2 cases (8%) with >50% ROM, 1 patient with <50% ROM in reamed group.

Table 5: Functional outcome

Functional outcome		Groups		Total
		Reamed	Undreamed	
E	Number	17	21	38
	Percentage	68.0%	84.0%	76.0%
G	Number	5	2	7
	Percentage	20.0%	8.0%	14.0%
F	Number	2	1	3
	Percentage	8.0%	4.0%	6.0%
P	Number	1	1	2
	Percentage	4.0%	4.0%	4.0%
Total	Number	25	25	50
	Percentage	100.0%	100.0%	100.0%

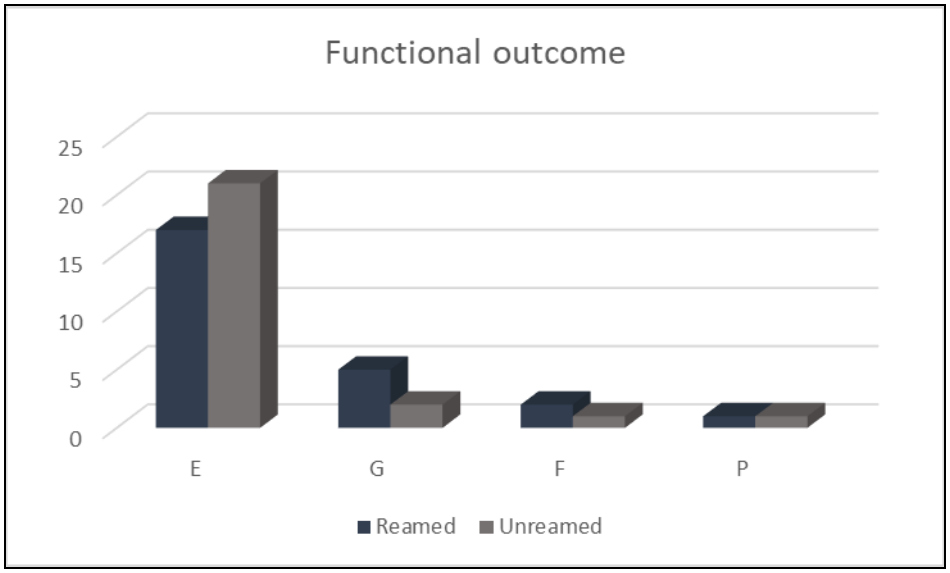

Fig 4: Functional Outcome

Figure 12: Functional outcome

In this study, Reamed group had 68% (17 cases) excellent outcome, 20% (5 cases) good, 8% (2 cases) fair, 1 case with poor outcome. In unreamed group 84% (21 cases) had excellent outcome, 8% (2 cases) good, 4% (1 case) fair, 4% (1 case) had poor outcome.

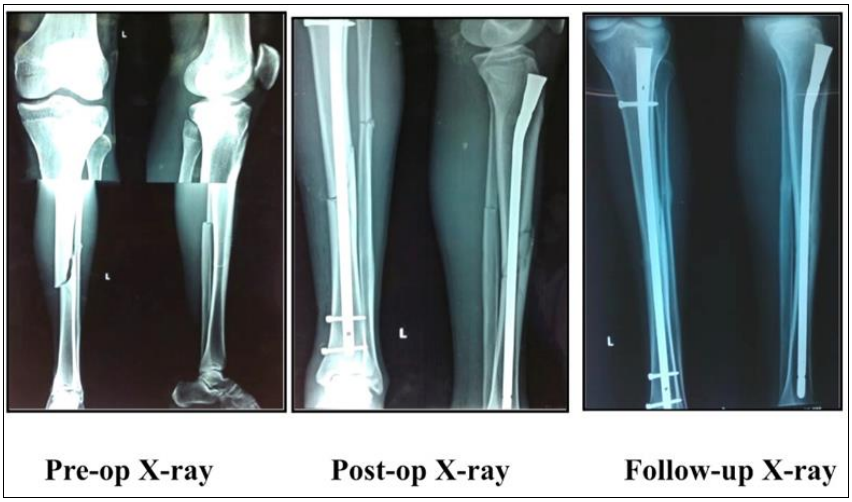

Fig 05: Radiographs of pre-op, post-op and followup of a case

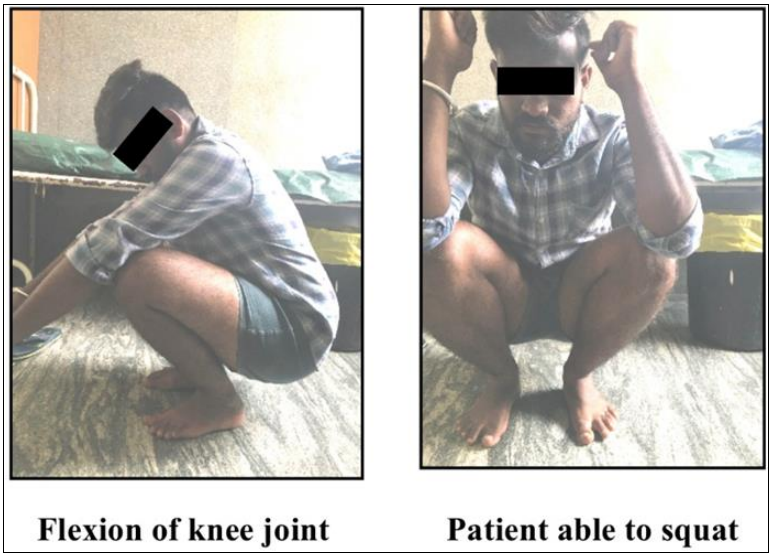

Fig 06: Clinical picture of the patient with excellent functional outcome

Discussion

Tibia fracture being a common injury encountered, its management being studied since the past. The major goal in the treatment of fracture tibia is achieving functionally useful and stable extremity. Closed interlocking intramedullary nailing being the treatment of choice, still controversy exists between reamed and unreamed nailing with their own advantages and disadvantages. Yet the spectrum of injuries to tibia is so great that no single method of treatment is applicable to all fractures.

Most of the patients were middle age between 18-39 years with average age in reamed group was 33.92 years and in unreamed group 35.3 years. Comparable to previous studies done by Arne Ekeland *et al* and Court Brown *et al* where average age was 35 years and 32.4 years respectively. [6, 7]

Male patients were more injured than females, with 68% males and 32% females in reamed group. Whereas 64% males and 36% females in unreamed group. Comparable to previous studies of Court Brown *et al* who noted the male incidence to be around 81.3%, while the female incidence to be around 18.7% [7] and Hooper *et al* noted male incidence at 82% and female incidence at 18%. [8] Female cases have increased in our study because of more active involvement of women in present days and also increased use motor vehicles.

Majority of the cases due to RTA 19 patients (76%) and 18 patients (72%) in reamed and unreamed group respectively. Most of them were the motorists, while the remaining patients tended to be pedestrians or motor vehicle occupants. The incidence of fracture shaft of tibia due to road traffic accidents seemed to be higher in our study compared to Court Brown *et al* in whose study, the incidence was around 37.5% [7] and Hooper *et al* reported a 59% incidence in his study. [8]

Our study had majority with transverse fractures in 48% of cases in reamed group followed by oblique fractures made up 16% cases. In unreamed group majority were transverse fractures 44% followed by wedge fractures made 24% fractures. This is comparable to Court Brown *et al* reported 37.2% of transverse and oblique fractures [7] and Arne Ekeland *et al* reported 42% of transverse and oblique fractures. [6]

The fibula was fractured along with the shaft of tibia in our series in 84% of cases, this is comparable to the study of Court Brown *et al*, where the fibula was also fractured in 77.7% of the cases. The associated fracture of the fibula, in most of the cases reflects on the high-velocity injury pattern in our study, as most of the injuries are due to road traffic accidents. [7]

In our series, we have used intramedullary nails ranging from 8 to 11 mm in diameter and from 320 to 380 mm in length. We were able to use larger diameter nails in reamed group compared to unreamed group but there were no reports of nail failure or broken screws in unreamed group patients.

Fracture union was considered when patient was full weight bearing without pain, fracture site was not tender on palpation and radiograph showed osseous union. In our series, majority of fractures united between 16th to 20th weeks. The average time of union 18 weeks in both reamed and unreamed group, which is comparable to previous studies of Court Brown *et al* who reported average union time at 16.7 weeks. [7] and Arne Ekeland *et al* who noted average union time at 16 weeks. [6]

Table 6: Comparison of fracture union with other studies

Studies	Duration (weeks)
Lawrence B Bone *et al*[9]	19
Court Brown *et al*[10]	16.7
Arne Ekeland *et al*[6]	16
Present study	18

Superficial infection rate was 12% in reamed group and 8% in unreamed group and it healed with dressings and antibiotics. Anterior knee pain was seen in 4 patients 16% in reamed group and 1 patient in unreamed group. In these patients the nail was abutting the patellar tendon and tibial tuberosity and menisci damage causing anterior knee pain and this can be relieved after removal of the nail.

Table 7: Comparison of complications with other studies

Studies		Percentage
Lawrence B.Bone *et al*[9]		6.25%
Arne Ekeland *et al*[6]		4.4%
Blachut PA *et al*[11]		1%
Present study	Reamed group	12%
	Unreamed group	8%

Keating *et al*. reported randomized, prospective study comparing reamed with unreamed locked nailing of tibial fractures. There was no statistically significant difference in the results of treatment of tibial fractures with reamed nailing and with unreamed nailing except for higher incidence of bolt failure in the unreamed nailing. [12]

Court-Brown *et al*., in a randomized, prospective trial, compared reamed and unreamed nail insertion in tibial fractures. They found that reamed nailing resulted in a shorter time to union and reduced the need for additional surgery. They recommended reamed nailing for open tibial shaft fractures. [7]

Klein *et al*. and Schemitsch *et al*. showed that insertion of reamed nails disturbs cortical blood flow to a greater extent than does insertion of unreamed nails, possibly increasing susceptibility to infection. Rarely, reaming may be associated with disastrous complications. These factors led to the development of interlocking intramedullary nails suitable for unreamed insertion [13, 14].

Bhandari *et al*. (2008) found that there was no difference between reamed and unreamed nailing in open tibial fractures [2].

In our study, we got excellent outcome in both groups with no significant difference (p value 0.564) in functional outcome between reamed and unreamed patients. Both groups had only 1 patient (4%) with poor result in each.

Conclusion

- Tibial diaphyseal fractures are commonly seen in physically active young people and are commonly seen as a result of road traffic accidents.
- The interlocking nailing combines control of length, alignment and rotation, preserves periosteal blood supply, some amount of endosteal blood supply and with biological osteosynthesis, lowers the infection and malunion.
- Closed intramedullary interlocking nailing under c arm guidance is a well-established standard procedure for treatment of tibial shaft fractures.
- Patients operated with this technique can be ambulated early without external immobilization in majority of cases, patients are allowed to resume work early as tolerated and this procedure also reduces the hospital stay and boosts up the morale of the patient.
- Even though Intramedullary nailing being choice of treatment for adult tibial shaft fractures, there exist controversy between choice of reamed or unreamed nailing.
- There are no indication or contraindications for choosing either of the options.
- Clinical and radiological outcomes both groups are similar, no statistical significance was found.
- Rate of union, superficial infections and valgus/varus mal-alignments were almost similar in both the groups.
- There was no significant increase in infections in reamed cases as stated in previous literatures though few superficial infections were seen in both groups, there were no medullary infections.
- Mechanism of injury had an influence on rate of fracture union.
- With the convenience of performing the procedure and less operative time over reamed nailing, unreamed nailing may have upper hand over reamed nailing.

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Ethical approval: Considered and taken

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