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Comparative Study of Reamed Versusunreamed Intramedullary Interlocking nailing for Open Tibia Fractures.

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ABSTRACT:
OBJECTIVES: To compare the clinical and functional outcomes (infections, non-union, malunion, time taken for union,implant failure, need for secondary operations,and range of motion of knee and ankle) between reamed and unreamed nailingin patients with open tibial shaft fractures.
METHODS: This was a single-center prospective randomized trial of 50 patients with open tibial shaft fractures who were treated with either reamed or undreamed nailing and functional and radiological outcome was evaluated with Johner-Wruh's criteria.[1]
RESULTS:Fifty patients completed one year of follow-up. Of these25patients these were reamed nailing and 25 patients were unreamed nailing. Among all
reamed patients, one (4%) required implant exchange because of an infected implant, and one (4%) patient required dynamization for non-union. Among all patients, in the Reamedgroup- 13cases (52%) had excellent results, 10 cases (40%) had good results, and 2cases (8%) had poor results. Unreamed group- 10 cases (40%) had excellent results,10 cases (40%) had good results, 2 cases (8%) had a fair result and 3 cases (12%) hadpoor results. Differences in the rate of radiological union, clinical outcome, time forweight bearing and complications in both groups were not statistically significant.
CONCLUSIONS:In the present study, there is no clear indication orcontraindications to favour either reamed or undreamed nailing over the other technique. Fracture union, functional outcome, and complications are similar in both groups. Considering the ease of technique application and the decreased operative time, unreamed nailing has an edge over reamed interlocking nailing. Our analysis results recommend that reamed intramedullary nailing is safer with lowernon-union rates than unreamed nailing.
KEYWORDS: Reamed, unreamed, interlocking nailing, fracture shaft of the tibia.

I. INTRODUCTION:

With an increasing number of vehicles on the roads in India, complex trauma cases caused by traffic accidents have increased progressively. Tibia is one of the most common bones to sustain open injury because of its subcutaneous position. Indirect injuries are usually low energy and direct injury is usually high energy. The treatment of open fractures requires simultaneous skeletal and soft tissue injury management. After stable fixation, damage to the surrounding tissue is decreased and soft tissue care is facilitated.[2]The option of a skeletal stabilization method for open fractures of the tibial shaft continues to be debatable. Treatment options include castimmobilization, open reduction and internal fixation with plates, external fixator, and intramedullary nailing.[3] The goals for the successful outcome of treatment of open fracture of the tibia include prevention of infection, the achievement of bony union,and the restoration of function. These goals are interdependent and usually are achieved in chronological order.[3] Immobilization in a plaster cast, and fixation with plates and screws have yielded unacceptably high rates of infection. External fixation considered to be the treatment of choice by many traumatologists has the disadvantages of bulky frames and frequent pin tract infections having non-unions and malunions.[4] Intramedullary nails such as Ender's nails, without reaming and having low rates of postoperative infectionare however, unsuitable for comminuted fractures as there is a tendency for shortening or displacement of such fractures around these small nails.[4] The locking of intramedullary nails of the major proximal and distal fragments decreases the risk of malunion. Intramedullary nailing with reaming of the medullary canal is generally considered to cause damage to the endosteal blood supply, which may thereby increase the risks of deep infection and non-union. It has, therefore, been suggested that the insertion of nails without reaming is safer. Recent studies have indicated, however, that nailing either with or

without reaming can be used for open tibial fractures with equal results of the union in either method.

II. OBJECTIVES:

To compare the clinical and functional outcomes (infections, non-union, malunion, time taken for union, implant failure, need for secondary operations, and range of motion of knee and ankle) between reamed and unreamed nailing in patients with open tibial shaft fractures.

III. MATERIALS AND METHODS:

This is prospective interventional study was carried out between July 2021 to December 2022. Fifty patients with open fractures of the tibia who were admitted under the Department of Orthopaedics in ACSR Government Medical College, Nellore, Andhra Pradesh, and who fulfilled the inclusion and exclusion criteria were included in the study and alternatively treated with Reamed and Unreamed intramedullary interlocking nailing.

Inclusion criteria:

1. Grade I and grade II open tibia fractures.
2. Open comminuted and segmental fractures.

Exclusion criteria:

1. Type IIIC open tibia fractures
2. All pathological fractures.
3. Patients medically unfit for surgery.

The patients are followed up for a period of 12 months at regular intervals.The clinical data werecollected and evaluated according to Johner-Wruh's criteria,[1] whichtake functional, clinical, radiological, and subjective outcomes into account. The study was approved by the ethical committee of the hospital, and informed consent was obtained from each patient. There were no patients lost to follow-up.A thorough clinicalexamination was performed including detailed history relating to age, sex, occupation,mode of injury, and past and associated medical illness.Patients were taken to the operating room for emergency irrigation anddebridement of the open fracture.Theseverity of the open fractures determined the subsequent wound care and antibiotictreatment.Wounds were examined and primary closure was done for the woundspresenting within 6 hours of trauma and which were clean. A sterile dressing was puton the wounds and the limb was immobilized. All study patients were put on above knee slabto maintain the length of the lower limb and facilitate the subsequent operative procedure. Alternate patients who met the inclusion and exclusion criteria were respectively treated with Reamed and Unreamed intramedullary interlocking nailing. After relevant investigations, radiography, anaesthetic evaluation, and physician clearance, patients were rushed into surgery as soon as feasible.Preoperatively the length of the nail was calculated by measuring from the tibialtuberosity to the base of the medial malleolus on the unaffected side clinically andthe medullary canal was measured at the isthmus from the radiographs. Accordingly, astock of interlocking nails 2 cm more or less the measured length and 1mm moreor less the measured diameter was always kept.All cases were done through the patella tendon splitting approach and entry point made with a curved bone awl exactly in the line of the medullary canal and slightly distal to the tibial plateau.In cases of proximal one-third tibia shaft fractures entry point is made just medial to the lateral spine of the tibia to prevent angulation or translation. After passing a guide wire fracture is kept in reduction and thetip of the guide wire is adjusted to pass in the distal fragment up to0.5-1cm above the ankle joint under an image intensifier, confirming its containment withinthe tibia by anteroposterior and lateral views.In cases of reamed nailing reaming is started with a small-diameter reamer (8mm) andincreased in half-millimetre increments until cortical contact is reached. The fracturemust be reduced as the reamer passe. In unreamed cases, only the proximal entry point is reamed for easy insertion of the nail. Then appropriate diameter and length of the nail are passed in both groups.Confirm the placement of the nail in situ under the image intensifier in both AP and lateral planes.Routinely we prefer distal locking carried out first, followed by proximallocking. 2 proximal locking screws and 3 distal locking screws (2 anteroposterior and1 mediolateral) were inserted.The position of the screw is again confirmed under the image intensifier.The patellar tendon issutured with delayed absorbable sutures and the skin is sutured with non-absorbable sutures. Sterile dressings were applied over the wound. A compression bandage was given, and Capillary filling and peripheral arterial pulsations were checked.Postoperatively elastocrepe bandage was applied and limb elevation was done overpillows. I.V. antibiotics were given for 5 days postoperatively. Whenever infection ofthe wound was suspected culture from the wound was sent. Switch over to oralantibiotics done on the 6th postoperative day. Skin sutures were removed between the 10th to15th postoperative days. Depending upon the culture report and wound conditionantibiotics were stopped /continued. Efforts were made to obtain definitive coverageof the wound within 7 days.Unrestricted weight

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bearing is permitted in an axial stable pattern (transverse fracture). Weight-bearing is restricted until early callus (4 to 6 weeks) andthen is progressed as tolerated in fractures without axial stability and those at theproximal or distal metaphyseal junction. Further follow-up was done at 4 weeklyintervals and each patient was individually assessed clinically and radiographicallyaccording to the proforma.

IV. RESULTS:

The present study included 50 cases of open tibia fracture in both sexes which were treated by interlocking nailing tibia. 25 cases each with reamed and unreamed respectively. Our aim was to treat these fractures by rigid internal fixation, and early mobilizationand to know the outcome of reamed versus unreamed nailing of the tibia. The mean age group in our study was 36.3 years(reamed) and 36.6 years (unreamed). Males were predominating in our study. Road traffic accidentswerethe main cause of fractures, whereas only in 5 patientscause was self-fall. Associated injuries were present in 7 patients.Right tibial fractures constituted a majority of the patients 31 patients (62%) were havingright tibial fractures and 19 patients (38%) were having left tibial fractures.The majority of the open fractures of the tibia were Gustilo type II[4] in both groups.

	TYPEI	TYPEII	TYPEIIIB
REAMED	2	21	2
UNREAMED	4	19	2

Table 1: DistributionofpatientsaccordingtoGustilo-Anderson[4]openfractureclassification

The mean operation time in Reamed group was 115 min and the unreamed group was 75 min. 2 patients in reamed group and 1 patient in the unreamed group underwent additional soft tissue repair (Split skin graftor Fascio cutaneous flap).Reamed group-10 patients (40%) commenced to protective full weight bearing at 6 weeks postoperatively, in our study most of the patients commenced to protective full weight bearing at 8-12 weeks postoperatively 15 patients (60%).

Unreamed group- 7 patients (28%) were commenced to protective full weight bearing at 6 weeks postoperatively; most of the patients were commenced to protective full weight bearing at 8-12 weeks postoperatively 18 patients (72%).

Table 2:Distribution of patients according to partial weight bearing

REAMED/UNREAMED		Fullweightbearing			
		6week	8week	12week	Total
Reamed	n	10	7	8	25
	%	40.0%	28.0%	32.0%	100.0%
Unreamed	n	7	11	7	25
	%	28.0%	44.0%	28.0%	100.0%
Total	n	17	18	15	50
	%	34.0%	36.0%	30.0%	100.0%
P=0.476					

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REAMED/UNREAMED		Fullweightbearing			
		6week	8week	12week	Total
Reamed	n	10	7	8	25
	%	40.0%	28.0%	32.0%	100.0%
Unreamed	n	7	11	7	25
	%	28.0%	44.0%	28.0%	100.0%
Total	n	17	18	15	50
	%	34.0%	36.0%	30.0%	100.0%
P=0.476					

Table 3:Distribution of patients according to full weight bearing

Dynamization of the nail was done in 1 case in reamed group and exchange tibia nailing was done in 1 case in reamed group. None of the patientsunderwent dynamization or exchange nailing in the unreamed group.Union was defined as the presence of a bridging callus on two radiographic views and the ability of the patient to bear full weight on the injured extremity.

Reamed group- 23 of the 25 fractures united (92%). The time for union ranged from 12-20 weeks with an average of 4 months (16 weeks). 13 (56.5%) fractures healed at 12 weeks, and 8 (34.8%) fractures healed at 16 weeks. Two (8.7%) fractures healed at 20 weeks. Two fractures failed to unite 12 months after the injury.Unreamed group- 22 of the 25 fractures united (88%). The time for union ranged from 12-20 weeks with an average of 16 weeks. 9 (40.9%) fractures healed at 12 weeks, and 8(36.4%) fractures healed at 16 weeks. 5(22.7%) fractures healed at 20 weeks. Three fractures failed to unite 12 months after the injury.

REAMED/UNREAMED		Durationofunion			
		12weeks	16weeks	20weeks	Total
Reamed	n	13	8	2	23
	%	56.5%	34.8%	8.7%	100.0%
Unreamed	n	9	8	5	22
	%	40.9%	36.4%	22.7%	100.0%
Total	n	22	16	7	45
	%	48.9%	35.6%	15.6%	100.0%
P=0.529					

Table 4 :Distribution of patients according to duration of union

The radiological union was seen at an average time of 14 weeks in reamed and 15.2 weeks in unreamed nailing of the tibia.Knee pain was complained of in 2 cases of reamed nailing compared to unreamed.One case reamed got a deep infection which resulted in an infected implant which was later underwent exchange nailing with antibiotic-impregnated tibia IMIL.Overall results were excellent in 23 cases(13 in reamed and 10 unreamed), good in 20 cases(10 in each of reamed and unreamed), fair in 2 cases(none in reamed and two in unreamed), and poor in 5 cases(2 in reamed and 3 in unreamed).

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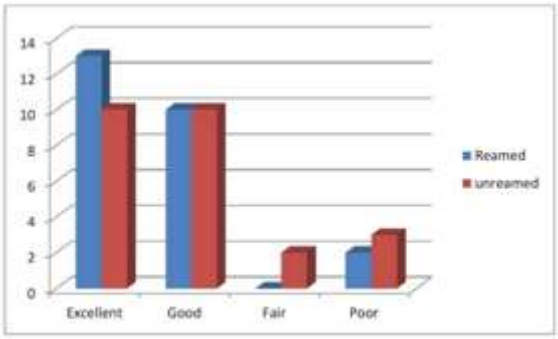
REAMED/UNREAMED		NoComplications	Infected	Intra optibiaplateau fracture	kneepain	Superficialinfection	Total
Reamed	n	21	1	1	2	0	25
	%	84.0%	4.0%	4.0%	8.0%	0.0%	100.0%
Unreamed	n	23	0	0	1	1	25
	%	92.0%	0.0%	0.0%	4.0%	4.0%	100.0%
Total	n	44	1	1	3	1	50
	%	88.0%	2.0%	2.0%	6.0%	2.0%	100.0%

Table 5:Distribution of patients according to complications

V. FUNCTIONAL RESULTS:

Detailed analysis of the function of the patient was done on the basis of the following criteria by Johner and Wruh[1],The results of this series were as follows; Reamed group- 13 cases (52%) had excellent results, 10 cases (40%) had good results, and 2 cases (8%) had poor results.Unreamed group- - 10 cases (40%) had excellent results, 10 cases (40%) had good results, 2 cases (8%) hadfair results, and 3 cases (12%) a poor results.



Graph1:Distribution of patients according to final result of study

Clinical photos of a case in the reamed group:

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Clinical photos of a case in the unreamed group:

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VI. DISCUSSION:

The tibia is one of the most commonly fractured bones in the body and intramedullary fixation of tibial shaft fractures has gained popularity in recent years with the development of interlocking nails. This technique is currently used to stabilize unstable diaphyseal tibial fractures. However, differing surgeons advocate two different methods of nail insertion, i.e., with and without reaming of the medullary canal. Each method has its own advantages and disadvantages and controversy still continues regarding which method is warranted for specific clinical situations.

While reaming can cause devascularization of the cortex and thermal necrosis of the inner 50-70% of the cortex [4,5] thus delaying healing, it can also help to fix the fracture with a larger size nail thus achieving better stability.[6,7,8] The effects of reaming on fat embolism should also be considered.In unreamed nailing, there is a low risk of fat embolism and several studies suggest better preservation and more-rapid recovery of the intraosseous blood supply after insertion of a small-diameter nail without reaming.[9,10]

STUDY	NO.OFPATIENTS		UNIONRATE		NONUNION RATE.		MALUNION RATE		INFECTIONRATE		SCREWBREAKAGE		IMPLANT FAILURE	
	R	UR	R	UR	R	UR	R	UR	R	UR	R	UR	R	UR
BLACH UTPAET AL[11]	73	63	95.9%	88%	4.1%	11.11%	4.10%	3.2%	0%	1.6%	2.7%	16%	0%	1.4%
KEATING	50	44	92%	88.64%	8%	11.36%	4%	2%	4%	2.27%	9%	29%	4.3%	2.4%

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J FETAL[12]														
LARSEN LBET AL 13	22	23	100%	87%	0%	13.04%	9%	17.39%	0%	0%	-	-	-	-
DINESH CHOUD HARYE TAL[14]	20	18	95%	100%	5%	0%	0%	0%	5%	0%	5%	0%	-	-
VISWA NATHN AIKETA L[15]	60	40	95%	85%	5%	15%	1.6%	2.5%	0%	2.5%	10%	27.5%	0%	5%
PRESEN TSTUDY	25	25	92%	88%	8%	12%	0%	0%	4%	4%	0%	0%	0%	0%-

Table 6: Comparison of our study with others.

The comparison of our study with other studies is shown in the table.

The nonunion rate observed in our study was noted to be more in the unreamed group which was 12%, compared to the non-union rate in the reamed group which was 8%. These results were comparable to those obtained by Blachut PA et al.[11] who noted a non-union rate of 11.11% in the unreamed group and 4.1% in the reamed group. Keating JF et a[12]. in their study of 94 patients observed that the non-union rate in the unreamed group was 11.36% and in the reamed group was 8% which was comparable to our study.Although reamed intramedullary nailing might cause damage to the nutrient artery, which is the important source of blood for 70% of the tibial cortex, the rates of non-union have been more with the unreamed group. This could probably be attributed to the increased contact between the implant and the bone surface with reamed intramedullary nailing and thus increase the stability, permitting early weight bearing and eventually facilitating early fracture union.

Reaming also induces a 6-fold increase in periosteal blood flow to overcome the lack of endosteal blood flow and improve fracture healing.Interlocking IM nailing with reaming solves the problem of malunions because it provides the ability to control length, angulation, and rotation but is associated with a high risk of infection in open tibial fractures. However, reaming results in the destruction of all vessels in the medullary canal and increases in medullary pressure which leads to the infiltration of medullary fat, blood clots, and bone debris into the vascular channels. This damage of endosteal blood vessels along with already weakened vascular supply due to periosteal stripping and soft tissue damage causes substantial bone necrosis and accounts for the high rate of infection and non-union in open tibial shaft fractures65

In the current series, there was one superficial infection (4%) in type II open fracture in the unreamed group. The incidence of superficial infection (4%) compares favorably with other series reporting rates of 2.4% to 11.6%. The infection rate using non-reamed locked nails is favorable compared with other studies (6-14% deep infection rates). There was one case (4%) of deep infections in our current series in the reamed group and this is comparable to other studies.

Although theoretically reaming increases the risk of fat embolism, no such reports are obvious in the clinical setting. Though some studies reported that nonunion occurs more commonly in unreamed nailing, that did not seem to be the case in this study.Our analysis results recommend that reamed intramedullary nailing is the safer procedure with lower non-union rates than unreamed nailing. However, this study has not found any statistical difference between reamed and unreamed intramedullary nailing for open tibial fractures.

VII. CONCLUSION:

IM nailing is one of the methods of treatment for open tibial shaft fractures in adults, in spite of the fact that controversy exists regarding the choice of reamed or unreamed intramedullary nailing.The overall functional outcome of reamed and unreamed tibia nailing evaluated using the Johner and Wruhs criteria was comparable between the two groups, with no evidence that reaming delays the process of union.Operative care of the soft tissue wound is critical in the treatment of open fractures.

Adequate debridement of the wound followed by adequate soft tissue coverage is the

key to minimizing infections after these injuries, irrespective of whether the bone is reamed or not- and is the outcome of the present study.Considering the ease of doing the technique and the decreased operative time, unreamed interlocking nailing may have an edge over reamed interlocking nailing.The mechanism of injury has a significant influence on fracture union and patient outcome. High-energy fractures had a significantly longer time to union and a higher rate of delayed union, non-union, and malunion.Early mobilization of the patients in both reamed and unreamed cases help in the healing of the fracture and prevents joint stiffness.Dynamization potentially increases the fatigue life of the implant. It also increases the compression forces at the fracture site.Thus, the overall functional outcome according to Johner and Wruhs' criteria is equal in both reamed and unreamed nailing in open tibial shaft fractures in adults.

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