Original Article

Management of Fractures Shaft of Tibia in Adult Interlocking Nailing Versus Plating in: A Comparative Study

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Abstract

Background: *Tibial shaft fractures are the commonest long bone fractures in adults, most commonly managed by intramedullary interlocking nailing. However, several meta-analysis show that locking plate osteosynthesis is equally effective in managing tibial diaphyseal fractures and are associated with less number of complications.* ***Aim:*** *To compare the results of fixation of tibial fractures followingplating and nailing in terms of union, patient satisfaction and complications.* ***Materials and Methods:*** *Khwaja Yunus Ali Medical College and Hospital based non randomized clinical trial was performed from September 2014 to August 2017 where closed or open diaphyseal or metaphyseo- diaphyseal fractures of the tibia (closed or open Gustilo Anderson type 1 through 3B) were included. Simple sequential allocation was used for allotting the patients to two groups, one for interlocking nailing and other for plating. The patients were followed up for clinical, radiographic and functional results.* ***Results:*** *Forty patients with 41 involved limbs completed followup for one year. in our study was 19.55±0.69 weeks in case of interlocking nailing and 20.38±1.39 weeks in case of plating and there was no statistically significant difference between the two.* ***Conclusion:*** *There was no difference between the twomodalities in terms of fracture union. Complications were lesser but more serious in case of plating. Patient satisfaction was more with plating.*

Key words: *Bone IM Nails, Bone Plates,Fracture Fixation*

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Introduction

Incidence of tibial diaphyseal fractures (27 per 100,000 persons per year in an average population) is the highest among long bone fractures.[1] Now-a-days closed reduction with intramedullary interlocking nailing is generally accepted by surgeons to be the most popular method for fixation of tibial fractures in adults.[2] The advantages of interlocking nailing are: (a) it provides adequate mechanical stability with better fracture alignment as in open reduction and internal fixation and (b) it maintains proper biological environment including intact soft tissues with blood supply as is found in closed reduction and plaster of paris application.

Locking plate osteosynthesis is generally executed in fractures extending into metaphysis. Though 98% of the cases are successful, complications like infection, wound breakdown, malunion and nonunion are frequently reported. Some recent studies including a meta-analysis of 11 trials report that nailing technique was associated with more complications like prolonged healing time and postoperative pain as compared to minimally invasive technique. Randomised pilot trial by Mauffrey C et al.[3] to determine the functional outcome after locking-plate or intramedullary nailing, demonstrated an adjusted difference of 13 points in the disability rating index in favour of the intramedullary nail but this was not statistically significant.[4]

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Saied A et al, in their randomized control trial of plating versus nailing for closed non-comminuted fracture tibia with intact fibulae, concluded that both nailing and plating were equally suitable for such fractures, but the patients in whom intramedullary nails are used may require additional surgeries to achieve union, and complain of knee pain.[5]

A randomized prospective comparison of 104 skeletally mature patients by Vallier HA et al., with intramedullary nail and medial locking plate showed rates of infection, non-union and malunion were similar but intramedullary nailing was associated with more malalignment (23%) in comparison to plating (8.3%). Till today, it remains inexplicable which is a better option amongst the two, but data show that interlocking nailing is the preferred choice of most surgeons.[6]

So, we conducted a study to compare the results of both bone fractures of the leg in terms of the rate of union, quality of the limb, incidence of complications and patient satisfaction.

Materials and Methods

We performed hospital based non-randomized clinical trial at the Department of Orthopaedics, at Khwaja Yunus Ali Medical College and Hospital, Enayetpur, Sirajganj, Bangladesh, lasting three calendar years (from September 2014 to August 2017) after attaining due permission from the Institutional Research Ethics Board. All the adult patients (>18 years age) with closed or (Gustilo- Anderson Type 1, 2 and 3A) open fractured tibia with or without fibula who presented later than 48 hours or in whom surgery was delayed beyond 48 hours because of comorbidities or haemodynamic instability and were operated by a senior consultant were included in the study. Patients with evidence of osteoporosis, pathological fractures and fractures having intra articular extension or associated compartment syndrome or presenting with Tscherne grade III soft tissue injury or Gustilo Anderson type 3C were excluded from the study. Patients who were known smokers, suffering from comorbidities like chronic renal diseases, diabetes or any other disease or taking medication which could influence fracture healing were excluded as fractures which were operated within 48 hours of the traumatic event or in emergency.

The patients attending casualty with fracture tibia were initially resuscitated and fracture was immobilized with groin to toe Plaster of Paris (POP) slab. The fracture extent, comminution and geometry were assessed by radiographs taken in anteroposterior and lateral views.

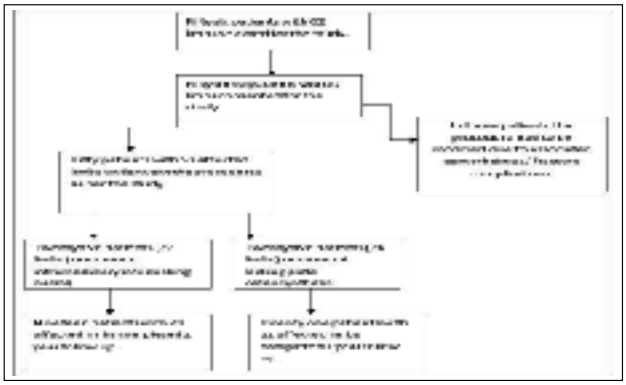
The patients were taken up for surgery after all routine preoperative investigations were found to be within normal limits. Fifty six patients with 62 affected limbs were included in the study. After obtaining due consent, they were distributed into two groups using simple sequential allocation. The patients included in the first group underwent intramedullary interlocking nailing of the tibia and the rest underwent locking plating of the fractures by a senior consultant.

The patients with open fractures were started on intravenous antibiotics consisting of piperacillin and tazobactam combination and amikacin with tetanus immunoglobulin after sensitivity testing as soon as they were received and were continued on the initial antibiotic until five days after definitive surgery. Thorough lavage with normal saline was done in the operating room along with adequate debridement by a senior consultant.

All the closed fractures received a dose of a third generation cephalosporin 12 hours before surgery which was repeated one hour before surgery and continued 12 hourly for 48 hours.

Standard operative techniques were used in both the groups. Closed indirect reduction technique was initially attempted in both the groups. In both the groups, the associated fibular fracture was not fixed unless it involved the lower one third.[7]

In the operating room, strict asepsis was maintained and draping and antiseptic painting was done after positioning the patient under anaesthesia. For nailing, tourniquet was avoided. A 5 cm long incision was marked from the lower pole of patella to the anteromedial aspect of the tibial tuberosity. A patellar tendon splitting approach was used and the periosteum was incised along the line of skin incision. The entry point was made with a diamond awl. Keeping the knee flexed to 900, with the help of a curved awl, the window was tunneled to the medullary canal. The guide wire was inserted up to fracture site. Reduction was achieved by traction and closed manipulation of the limb and guide wire passed to the distal fragment. If reduction was not achieved by closed means, an incision was placed at the fracture site for open reduction. In all the cases (closed or open), sequential reaming was done with flexible reamers passed over the guide wire and minimum 9 mm diameter nail was used. The nail was introduced over guide wire. Further fine reduction under Image Intensifier Television (IITV) was achieved and the nail was negotiated into the distal fragment with the gentle taps of the hammer over the nail head. Use of blocking screws also depended on the surgeon's choice. Locking was done in static or dynamic mode depending on the fracture pattern. Free hand technique was used for distal locking of the nail under image guidance. Impaction was done, by padded gentle strokes over the heel. An appropriate length of 4.5 mm cortical screw was used for locking. The operative steps are summarized in [Table/Fig-1]. Proximal locking was done using aiming device. After suturing the periosteum and soft tissues with vicryl, skin closure was done. Compression bandage was applied and below knee posterior slab was applied.[7]



In case of plating, tourniquet was routinely used unless contraindicated. Minimally invasive techniques {Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO)} were used unless fracture could not be reduced satisfactorily by closed means or it was an open fracture. Fracture reduction was achieved under IITV and two small incisions were placed on either side of the fracture depending on the length of the plate used. The skin and subcutaneous tissue was elevated using a long handled periosteal elevator and the plate introduced below this tunnel. If reduction could not be achieved satisfactorily, a longitudinal incision was made 1 cm lateral to the tibial crest, fracture was exposed and the muscles were laterally retracted. Plate benders were used to contour the plate to the anatomy. Few 4.5 mm implants were used to decrease hardware prominence. The plate was positioned over the fracture site on the medial surface if MIPPO technique was used or else on the lateral surface, as shown in [Table/Fig-2] and temporarily held in place with standard plate-holding forceps. Lag screws were used whenever required in case of type A1, A2, B1, B2 and C fractures before inserting the first locking screw. A 3.2 mm drill bit was used to drill to the desired depth. Locking screws of 4.5 mm were inserted with torque-limiting screw driver under image guidance and securely locked to the plate.[8]

Postoperatively the limb was kept elevated at all times and active toe movements were encouraged. The patient was monitored for excessive swelling, pain and distal circulation. The first dressing was done after three days of the operation when the slab was removed and active knee and ankle mobilization exercises started. Suture removal was done after 10 days unless infected. Partial weight bearing with two axillary crutches started according to the patient's tolerance. Full weight-bearing was allowed depending on the fracture pattern, stability of the fixation and regional pain. Biweekly follow up was undertaken till clinical union was evident with monthly X-rays to note the progress of healing. Whenever signs of clinical union were apparent, it was confirmed radiologically [Table/Fig-3]. Thereafter the patient was followed up monthly until six months and then two monthly till one year.

The outcome variables included duration of surgery, intraoperative blood loss (measured by weighing the mops before and after the surgery and adding this to the amount of collection in the negative suction machine), time for union, incidence and severity of complications, functionality of the limb (Karlstrom and Olerud criteria and lower extremity functional scale).[9]

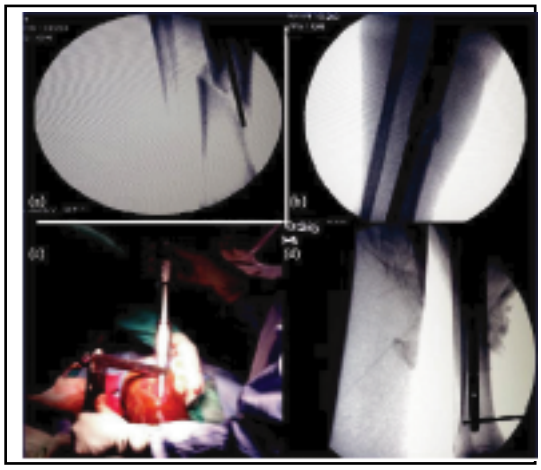
Statistical analysis

Statistical analysis was done using SPSS software (version 21.0). Kolmogorov and Smirnov analysis was used to confirm comparability of the two samples. Mean, standard error of mean and the distribution of each variable was calculated. Statistical significance was calculated using the independent sample t-test for ordinal variables.

Results

Of the 56 patients, 40 patients with 41 involved limbs completed follow up upto one year. The patient's selection and follow up is described in [Table/Fig-4]. The demographic characteristics of the population studied and the two groups are summarized in [Table/ Fig-5].

In the present study two (5%) of the patients were between 18 to 20 years old, 10 (25%) were between 20 to 30 years old and another



Table/Fig-1: Intraoperative photographs of interlocking nailing.
(a) After traction, the guide rod is introduced upto fracture site under image guidance.
(b) Reduction achieved and guide rod introduced to distal fragment under image guidance.
(c) Nail introduced over the guide rod with gentle hammering.
(d) Freehand distal locking done under image guidance.

Table/Fig-2: Intraoperative picture of plating.
Open reduction and internal fixation of a Type 1 open fracture tibia with locking plate and screws.
The tibia is being drilled with a quick coupling drill bit with appropriate sleeve.
[Table/Fig-3]: United fractures.
Radiographs showing the united fractures of tibia and fibula:
a) Shows anteroposterior view of united tibial fracture after nailing in both legs;
b) Shows anteroposterior and lateral views of the united tibial fracture after locking plate.

Table/Fig-4: Flow chart showing selection procedure and follow up of the pa-tients

10 (25%) were between 30 to 40 years old. Of the remaining, 6 (15%) were between 40 to 50 year old, 7 (17.5%) were between 50 to 60 years old and 5 (12.5%) were between 60 to 70 years old.

		Nailing	Plating	Overall
Mean age (years) (mean± standard error) □ □		**40.80±3.35**	**39.81±3.31**	**40.29±2.33**
Gender distribution	Males	13	13	26
	Females	6	8	14
Mode of injury	RTA	11	15	26
	Sports injury	4	4	8
	Assault	1	0	1
	Fall from height	3	2	5
Involved limb	Right	13	16	29
	Left	7	5	12
Soft tissue status	Closed fracture	14	13	27
	Type 1	3	7	10
	Type 2	2	1	3
	Type 3A	1	0	1
AO classification	Type A	8	7	15
	Type B	8	9	17
	Type C	4	5	9
Associated fibular fracture		16 □	17	33
Duration between trauma and surgery (days) (mean± standard error)		7.1± 3.28	7.09±3.53	7.1± 3.37

Complications □	**Interlocking**	**Nailing**	**Plating**
Intraoperative blood loss (ml) (mean± standard error)	165.00 ± 5.31	184.29± 5.33	p=0.014
Duration of surgery (minutes) (mean± standard error)	75.45 ± 3.03	85.05± 2.54	p=0.019
LEFS score at six months (mean± standard error)	80.73± 2.14	88.18± 1.70	p=0.046
Karlstrom and Olerud score at six months (mean± standard error)	30.55± 0.57	30.71± 0.79	p=0.867
Time for union (weeks) (mean±	19.55± 0.69	20.38± 1.39	p=0.602

In our study, 33 (82.5%) of cases (15 of nailing and 18 of plating group respectively) were operated under spinal anaesthesia, 6 (15%) of patients (3 each of nailing and plating) under epidural anaesthesia and one (2.5%) case (of nailing) under general anaesthesia. The outcome variables are summarized in [Table/Fig-6].

Intraoperatively, 6 (14.6%) of limbs (5 of nailing and 1 of plating group) lost 100-150 ml of blood, 27 (65.9%) (12 of nailing and 15 of plating group) lost 150-200 ml of blood and eight (19.5%) limbs (3 of nailing and 5 of plating group) lost 200-250 ml blood during their respective surgeries.

In the present study, duration of surgery was 50-60 minutes in one (2.4%) case (of nailing), 60-70 minutes in 6 (14.6%) cases (5 of nailing and 1 of plating), 70-80 minutes in another 17 (41.5%) cases (9 of nailing and 8 of plating), 80-90 minutes in 7 (17.1%) cases (1 of nailing and 6 of plating), 90-100 minutes in five (12.2%) cases (1 of nailing and 4 of plating), 100-110 minutes in three (7.3%) cases, all of nailing and 110-120 minutes in two (9.5%) cases, both of plating.

Postoperative functional performance of the limb, as calculated by the Karlstorm Olerud Score at six months showed that 40 (97.6%) of the limbs (20 each of nailing and plating groups) had fared well {17 (41.5%) excellent, 14(34.1%) good and 5 (12.2%) satisfactory and four (9.8%) limbs had moderate score} while 1(2.4%) patient had poor results according to Karlstrom Olerud score.

Patient satisfaction was better with plating, as 14 (66.7%) cases of plating reported a LEFS score more than 90 as compared to 10 patients (50%) of nailing.

Union was achieved in less than 20 weeks in 29 (70.8%) of the limbs (14 of nailing and 15 of plating) and 25-30 weeks in 9 (22%) cases (5 of nailing and 4 of plating). Three (7.2%) cases (1 of nailing and 2 of plating), which had gone into non- union united after secondary procedure.

The complications of the surgeries noted in our study are summarized in [Table/Fig-7].

The four cases of superficial wound infection (including 1 stitch abscess was managed by local wound care and intravenous antibiotics (cefoperazone and sulbactam) over five days continued by oral clindamycin (300 mg twice daily) for next five days. Knee stiffness, ankle stiffness and calf muscle atrophy was managed by appropriate physiotherapy supervised by a designated physiotherapist of the hospital. The case with limb shortening was managed by shoes with appropriate heel raise. The patient with valgus malunion was asymptomatic but was instituted physiotherapy. [Table/Fig-8] shows clinically the range of flexion at the knee following nail and plate fixation.

There was no case of implant breakage or exposure of implant outside the skin in the present study.

There was no statistically significant difference between interlocking nailing and locking plate osteosynthesis in terms of time required

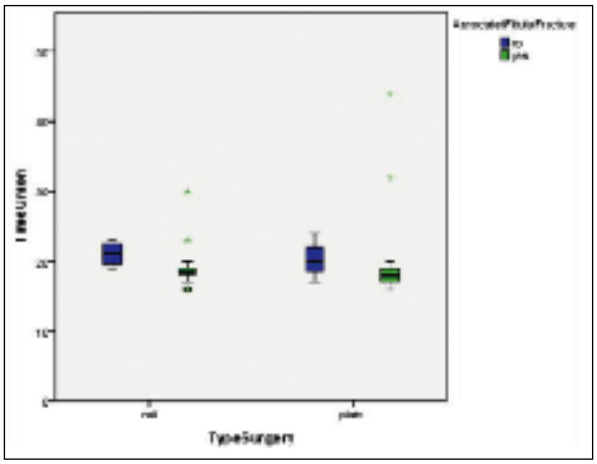
Complications□ □	**Interlocking Nailing**	**Plating**
Anterior Knee Pain □ □	4 □ □	0
Infection		
● Superficial□ □	2	2
● Dep □□ □	0□ □	0
Dropped Hallux Syndrome □	3 □ □	0
Delayed union and non union □	1 □ □	2
Knee stiffness□ □	1□ □	0
Ankle stiffness□ □	1 □ □	2
Limb shortening		
● □ < 2 cm □ □	0 □ □	1
Implant prominence□ □	0 □ □	2
Mal alignment		
□ □ ● Valgus angulation □	1 □ □	0
Wasting of calf muscles □	1□ □	2

Table/Fig-7: Table showing the complications of our study.

Table/Fig-8: Range of motion of knee.
Clinical photograph of the patient showing the range of motion of the knee joint in terms of degree of flexion: a) shows patient has gained full flexion of knee following nailing; b) Shows full flexion of the knee following plating.
for fracture union or functional status of the limb after six months. There was, however, statistically significant difference between the duration of surgery and amount of blood loss during surgery, both favouring interlocking nailing. Major complications too, were lesser in case of nailing compared to plating. On the contrary, anterior knee pain and dropped hallux, which were detrimental to intermediate term patient satisfaction, were unique to nailing.

Discussion

The average time interval between trauma and surgery was (mean± standard deviation) 7.1±3.37 days. This result is similar to that of Cheng W et al.[10] where duration between injury and surgery had been 7.1±4.9 days [10]. This is due to the lack of proper communication facilities in the area where the patients presented late. Eight of the patients (3 of nailing and 5 of plating) had history of manipulation by indigenous bone setters.
In the study by Ji J et al.[11] average blood loss was 122 ml (range 100-350 ml) in case of nailing and was 175±96.9 ml in the study by Cheng et al., while plating, comparable to ours.
Average duration of surgery was 94 minutes (range 60-132 minutes) for nailing by Ji J et al., and for plating by Cheng W et al. was 87±25.7 minutes.
In our study, the mean time for union was 19.55±0.69 weeks for nailing, with 20.38±1.39 weeks for plating and 19.98±0.78 weeks overall. Saied A et al., in their study had reported union in 4.30±1.48 months in plating and 4.34±1.45 months in case of interlocking nailing, with dynamization being required in four (12%) of the patients, while one case of non-union persisted even after that. In the study by Vallier HA et al., the mean time to tibia fracture union for all patients was 4.7 months (range 2.5-14).[12]
Associated ipsilateral fibular fracture delayed the union, as evident from our study. However, this group of patients benefitted more from plating than from nailing as is evident from the [Table/Fig-9] in terms of time required for union, a finding also noted in the study by Saied A et al.
One (5%) case of interlocking nailing and two (9.5%) plating cases required secondary procedures following which union was achieved at 30 weeks in case of nailing (after dynamization) and two Cases where only tibia was fractured.
cases getting united at 32 and 44 weeks (following bone grafting) respectively after plating. In the study by Oh et al. (34.8%) cases required revision surgery for delayed union; where an average of 10.2 months (range: 5-16 months) were required for final union.[13]



Table/Fig-9: Variation of time required for union of tibial fracture depending onthe type of surgical intervention with relation to associated fibular fracture.
Boxplot showing the time of union with respect to type of surgery with or without associated fibular fracture.
1. Time of union: Time in weeks required for the fracture to achieve full clinical and radiological union.
2. Type of Surgery: nailing or plating done for the patient.
3. Associated fibular fracture: Denoted by colour of the plot.
Cases where both tibia and fibula were fractured.
Anterior knee pain had interfered with activities of daily living in four cases (20%) of the limbs among patients undergoing interlocking intramedullary nailing. In the meta-analysis by Katsoulis E et al.[14] incidence of anterior knee pain was found to vary between 10% and 86% in various studies with mean of 47.4%. They were managed with lifestyle modification, regular physiotherapy as advised by designated physiotherapist of the hospital and NSAIDs.
In our study, decreased range of knee motion compared to contralateral knee was found in one (5%) patient with nailing and two (9.6%) with plating and decreased range of ankle motion compared to contralateral ankle was found in one (5%) patient with nailing and two (9.6%) patients with plating. The loss of motion was less than 10° arc in the knee in all patients in both nailing and plating. However, in case of ankle, 10° loss of dorsiflexion was found in case of nailing and 5°each in plating. The study by Lefaivre KA et al., showed decrease in ankle range of motion in 19 (57.6%) patients and in 6.1% there

was decreased knee range of motion.

Calf atrophy was found in one patient with interlocking nailing and two patients with plating. Again nine (27.3%) patients had a smaller calf on the affected limb by a margin of 0.5-1.0 cm in the study by Lefaivre KA et al.[15]

Implant prominence was seen in two (9.5%) patients with locking plate but did not warrant implant removal. Study by Shrestha D et al.[16] showed 30% patients with tibial fractures having implant prominence which required hardware removal.

Dropped hallux syndrome was found in three (15%) of the limbs with nailing. Chalidis B et al., had reported 0.8% incidence in their studies which required surgical exploration. However, all our cases were self limiting and recovered without exploration within six months.[17]

Limitation

This was a non-randomized clinical trial without blinding. Rando-mization and blinding would have lessened the bias. A randomized control study (preferably multi-centre) with larger sample size would have given more authentic conclusions.

Conclusion

Though major complications are more with locking plate osteosynthesis in tibial fractures, the patients who were free of these major complications had lesser incidence of persistent pain or other chronic symptoms and were happier (better LEFS score) than their counterparts with interlocking nail. Locking plate osteosynthesis is a very simple, easy, rapid, reliable and effective method for management of tibial fractures in adults, especially in terms of patient satisfaction and can be considered as an effective alternative to nailing in selected patients.

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