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"Results of Early Fixation of Open Fracture Shaft of Tibia by Closed Reamed Static Interlocking intramedullary Nail: A study in National Institute of Traumatology and Rehabilitation (NITOR), Dhaka, Bangladesh"

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Abstract **Original Research Article**

Background: The tibia by its location is exposed to frequent injuries as one third of its surface is subcutaneous. Treatment of tibial fracture in adult is a challenge to orthopaedic surgeons due to poor soft tissue coverage and blood supply. Moreover, compartment syndrome, neurovascular injury and infection might add to this burden. The nail provides good stability against bending forces, while the interlocking screws control axial compression and rotational instability. Closed insertion techniques reduced operating time, causes minimal surgical trauma and consequently fewer postoperative complications like infection. ***Objectives:*** The main focus of this current study was to evaluate union and complications like infection, knee pain. ***Materials and Methods:*** This prospective study was carried out in the National Institute of Traumatology and Rehabilitation (NITOR), Dhaka, during the period of July 2014 – June 2016. This was an observation study, which included 18 patients aged between 18 to 60 years, all irrespective of sex having open tibial fracture (G-II) treated by closed reamed static interlocking intramedullary nailing within 48 hours of injury. ***Results:*** Maximum tibial fracture cases were found in 26-35 years and male was predominant. Motor vehicle accident (MVA) accounted for 72.22%; right side involvement was in 61.11% cases. All cases had mid shaft transverse fracture of tibia and it been stabilized by static nailing. Mean time interval between injury and fixation was 33±7.7 hours. Functional outcomes of patients were based on "Tucker's criteria". The duration of hospital stays varied from 5 to 7 days and union time required 14 -27 weeks with mean 19.9 weeks. Post-operative complication was superficial infection in 05.55% cases. After full weight bearing mild pain was found in 05.55%, anterior knee pain was observed in 33.33% cases. There were satisfactory results in 16 cases (88.88%) and unsatisfactory in 2 cases (11.11%). ***Conclusion:*** The treatment of open tibial diaphyseal (Gustilo-II) fractures with early closed reamed interlocking intramedullary nailing is effective and safe technique; it combines a satisfactory rate of union with low complication rate and patients can return to work earlier.

Keywords: Tibia, Orthopaedic Surgeons, Intramedullary Nail, Infection, Neurovascular Injury.

INTRODUCTION

Tibia is one of the long bones situated subcutaneously, more vulnerable for traumatic fracture and more commonly result in an open fracture than any other long bone. Open fractures are classified by the Gustilo and Anderson classification. Approximately 63% open fractures are involving tibia. Treatment of the open fractures of the tibial shaft remains Challenging. The precarious blood supply and the lack of soft tissue over the shaft of the tibia make these fractures vulnerable to non-union and infection. Basic concepts of the current strategy for open tibial fractures reducing these complications are as follows: a) immediate intravenous antibiotics; b) urgent and regular surgical debridement; c) immediate rigid skeletal stabilization; d) early appropriate soft-tissue coverage. Such fractures are more commonly associated with neurovascular compromise and infection. All patients were treated with appropriate antibiotics, irrigation of the wound and debridement. There are several techniques for the stabilization of these fractures includes immobilization

by a cast, external fixators and internal fixation with plates and screws or intramedullary (IM) nailing. Among the stabilization techniques Locked intramedullary nailing procedure is better for prevention of soft tissue infection as well as bone healing. Nail is a load shearing device and is stiff to both axial and torsion forces. Closed nailing involves least disturbance of soft tissue, fracture hematoma and natural process of bone healing as compared to other forms of internal fixation [1]. Most of the open fracture shaft tibia managed by external fixators immediate after injury. The use of external fixators is not without some problems. Infection about the pin site is not uncommon. Pin site infection is associated with thermal necrosis of the bone at the time of insertion. In addition to infection, it is uncomfortable for the patient to bear external fixators for long term management. In economical point of view, locked intramedullary nailing is less costly in comparison to external fixators for the long-term management of open fracture shaft of tibia. The treatment of open fractures requires the simultaneous management of both skeletal and soft tissue injury. Controlling the instability of the bone provides a number of benefits. The continued damage to the surrounding tissue by displaced bone fragments is decreased, care of the soft tissue injuries is facilitated, and the patient's comfort is increased. Options include immobilization in a cast, external fixators and by internal fixation with plates and screws or intramedullary (IM) nailing. Such treatment prevents access to the wound and therefore prevents wound care in fractures with more extensive soft tissue injury. Intramedullary nailing without reaming has been advocated in the treatment of open tibial fractures. The prevalence of both deep infection and non-union in association with type I, II and IIIA open fractures treated with IM nailing without reaming has been lower than that associated with similar fractures treated with other fixation devices. Sie *et al*.[2] compared treatment of open tibial fractures with unreamed nail and external fixators. It was found that the use of intramedullary nail is better than external fixation for treatment of open tibial fracture. Patil *et al*.[3] compared type III fracture treated with un-reamed nailing and external fixation and found similar rates of deep infection in each group. The primary goal of treatment is to obtain a functional extremity, which usually necessitates removal of devitalized tissue, stabilization of the bone, and reconstruction of the soft-tissue envelope. A healed, noninfected soft-tissue envelope is required to provide the optimal environment for vascular ingrowth and subsequent bone healing. At the time of injury, both the endosteal and the periosteal blood supply are damaged. The endosteal vessels supply the inner two thirds of the cortex, and the periosteal vessels supply the outer third. The extent of damage and the length of the vascular recovery phase determine the time to bone union and the resistance to infection. Accordingly, further disruption of the blood supply should be avoided during fracture management. Nonreamed intramedullary nailing of open tibial fractures has received a great deal of interest recently because it appears to meet the objectives required to optimize treatment. Many clinical studies have compared the results of reamed and unreamed nailing in the tibia. Most surgical interest has focused on the open fractures associated with significant soft-tissue damage, despite the fact that a beneficial effect would be expected for reaming in low-energy closed fractures with associated minor soft-tissue damage. A meta-analysis [4] of the literature concerning reaming of the femur and tibia concluded that reaming is beneficial and that it reduces the rates of non-union and implant failure in comparison with non-reamed nailing. There is no significant difference in the reamed and unreamed IM nailing for the treatment of tibial fracture, but result recommends reamed nail for the treatment of closed tibial fractures for their lower fixation failure rate [5]. Another study by Tabatabaei1 *et al*.[6] recommends unreamed and reamed interlocking nailing can be used in open tibial fractures type I, II, and IIIA with quite similar rates of success. Reaming of the tibia during IM nailing does not add a significant amount of time to tibial nailing procedures. 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 debated. Sufficient stability of the fracture fragments and soft tissues management usually can be obtained by interlocking intramedullary nails or external fixation. Plate fixation has been associated with an unacceptably high incidence of infection. For Gustilo type-I, type-II, and type-IIIA open fractures, most orthopaedic traumatologists prefer intramedullary nailing.

OBJECTIVES

a) General objective

- To assess the functional outcome of open tibial diaphyseal fracture (G-II) treated by early closed reamed static interlocking intramedullary nailing of tibia.

b) Specific Objectives

- To assess fracture healing.
- To evaluate post-operative infection (superficial or deep).
- To observe final range of motion of both knee and ankle joints.

METHODOLOGY AND MATERIALS

This was a prospective type of study, was conducted at the National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka. During the period from July-2014 to June-2016. A total of 18 patients were included for study. This randomized study was carried out to evaluate the results of treatment of open (Gustilo-II) tibial fracture (AO-4.2. A3) by early closed static reamed interlocking intramedullary nailing. Among the patients who attended at emergency

of NITOR, only 18 patients were selected having open (Gustilo-II) diaphyseal fracture (AO-4.2. A3) of tibia. Mean time interval between injury and closed interlocking intramedullary nailing was 33±7.9hours for an open tibial shaft fracture. In all of the cases, standard one proximal and two distal locking screws were used. All of the nails were countersunk below the cortical bone of the proximal tibia. After the insertion of the nail, the incision was closed with interrupted sutures. All of the patients routinely received an intravenous ceftriaxone antibiotic at the induction of the spinal anaesthesia. A questionnaire was prepared by the researcher, key variables like age, sex, presenting complaints, clinical findings, associated medical condition, investigations, per-operative findings and outcome of surgery which was verified by the guide and the data were collected by the researcher himself. Statistical analyses were carried out by using the Statistical Package for Social Sciences version 16.0 for Windows (SPSS Inc., Chicago, Illinois, USA). The mean values were calculated for continuous variables. The qualitative observations were presented by frequencies and percentages.

Inclusion Criteria

- Open fracture shaft tibia-fibula (G-II) without neurovascular deficit.
- Age 18 years to 60 years.
- Patient presented within 48 hours of injury.
- Transverse fracture of mid shaft of tibia-fibula.

Exclusion Criteria

- Open fracture shaft of tibia (G-I and G-III)
- Patient with osteoporotic bone.
- Patient presented after 48 hours of injury.
- Age below 18 years and above 60 years.
- Debilitated and diabetic patient.

RESULTS

During the period extending from July 2014 to June 2016, a total of 18 patients were included for study. (Table I) shows the age range was from 18 to 60 years. 18-25 years age was 6 (33.33%), 26-35 years age was 9 (50.00%), 36-45 years age was 1 (05.55%) and 46-55 years age was 2 (11.11%). Maximum cases were in 26-35 years. In this study, 16 cases (88.88%) were males and 2 cases (11.11%) were females. People from various occupations of tibial fracture were: day laborer was 5 (27.77%), businessman was 2 (11.11%), farmer was 3 (16.16%), student was 3 (16.16%), housewife was 2 (11.11%), driver was 1 (05.55%), government service holder was found 2 (11.11%). (Table II) In this study motor vehicle accident (MVA) accounted for 13 cases (72.22%), fall from height for 02 cases (11.11%) and 03 cases (16.66%) were due to assault. (Table III) In this study right side involvement was in 11 cases (61.11%) and left side in 07 cases (38.88%). (Table IV) Among the type of nailing, static was in 18 cases (100.00%). (Table V) Duration of hospital stay, patients stayed in hospital 5 days to 7 days, with mean 6.8±1.3 days. (Table VI) Union time of the study patients was 14 weeks to 27 weeks, with mean 19.9 weeks. (Table VII) Infection (Deep) was 00 (00.00%), (Superficial) 01 (05.55%), restriction of knee movement 00 (00.00%) and anterior knee pain was 06 (33.33%). (Table VIII) Pain at full weight bearing, after 6 months, no pain was found in 17 (94.44%), mild pain was in 01 (05.55%), moderate pain was in 00 (00.00%) but severe pain was found in none. (Table IX) It this study excellent result was found in 12 (66.66), good in 04 (22.22%), fair in 02 (11.11%) and poor result was not found.

Table-I: Distribution of study population according to age, sex and occupation (n = 18)

						Occupation	N	%
Age (Years)	**Number of patients**	**Percentage**	**Sex**	**Number of patients**	**Percentage**	**Day Labour**	**5**	**27.77**
18-25	6	33.33	Male	16	88.88	Farmer	3	16.16
26-35	9	50.00	Female	2	11.11	Student	3	16.16
36-45	1	05.55				Housewife	2	11.11
46-55	2	11.11				Driver	1	05.55
56-60	00	00				Government service holder	2	11.11
						Businessman	2	11.11

Table-II: Distribution of the study population by cause of injury (n=18)

Cause of injury	N	%
Motor vehicle accident	13	72.22
Fall from height	2	11.11
Assault/ violence	3	16.66

Table-III: Distribution of the study population by side of injury (n=18).

side	N	%
Right	11	61.11
left	07	38.88

Table-IV: Distribution of the study population by type of nailing (n=18)

Type of nailing	No. of patients	Percentage
Static	18	100.00
Dynamic	0	0.00

Table-V: Duration of hospital stay of study population (n=18).

	Minimum (In days)	Maximum (In days)	Mean (In days)
Duration of hospital stay	5	07	6.8±1.3

Table-VI: Duration of union time of fracture of the study population (n=18).

Union time (in weeks)		Mean (in weeks)
Minimum	Maximum	
14	27	19.9

Table-VII: Distribution of the complications of the study population (n=18).

Complication	Number of patients	Overall percent
Infection (Deep)	00	00
Restriction of knee movement	00	00.00
Infection (Superficial)	01	05.55
Anterior knee pain (AKP)	06	33.33

Table-VIII: Distribution of the study population by pain at full weight bearing, after 6 months (18)

Pain at full weight bearing	No. of cases	Percentage
No pain	17	94.44
Mild	1	05.55
Moderate	00	00.00
Sever	00	00.00

Table-IX: Distribution of the study population by grading of results (According to Tucker criteria) (n=18)

Grading of results	No. of patients	Percentage
Excellent	12	66.66
Good	4	22.22
Fair	2	11.11
Poor	0	0.00

Satisfactory result 12+4 = 16 (Excellent + good) = 88.88%,
Unsatisfactory result 2+0 = 2 (fair+ poor) = 11.11%

DISCUSSION

Over the last 50 years the management of tibial fracture has oscillated like a pendulum of a clock from non-surgical treatment to surgical treatment. In the past, tibial shaft fractures were managed by immobilization in a plaster cast [7]. Thereafter functional brace has been used commonly. Open tibial fractures have been associated with high rates of malunion, nonunion, and deep infection. The use of plaster casts to treat open tibial fractures has been associated with an infection rate in excess of 1.4% and malalignment rates as high as 4.3% [8]. In a prospective study comparing plating with external fixation of open tibial fractures, Bach and Hansen [9] reported a 19% deep infection rate in the plated group compared with 13% in the external fixation group [10]. The plating resulted in higher incidence of non-Union, infection and fixation failure. And the external fixation resulted in pin site infection and sometimes osteomyelitis of bone [9]. Kuntscher Nail fixation does not provide rotational stability and axial length [11]. Dissatisfaction with these limitations stimulated surgeons to use intramedullary nailing that minimize the chances of post-operative infection, prevent rotation, collapses, angulations and shorting, promotes early union, regain early activity and reduce exposure and operative trauma[12]. Several recent reports have suggested reamed locking nails may be used safely, Kaltenecker *et al*.[13] reported on the use of locking nails to treat types I, and II open tibial fractures and reported a 1.2% infection rate. Court-Brown, *et al*.[12] gave details of the use of the reamed grosse kempf nail for 41 grade II and grade III open tibial fractures, reporting an infection in 1 of 14 grade II and 3 of 13 grade IIIB fractures. This prospective study was carried out with an aim to assess the functional outcome of open tibial diaphyseal fracture treated by closed interlocking intramedullary nailing. To assess the progress of treatment, immediate weight-bearing, usefulness in term of functional outcome and effectiveness, pain status on weight bearing, incidence of infection, delayed union and non-union, fracture healing time was observed by follow up both clinically & radiologically, post-operative complications, final range of motion of both knee and ankle joints also were observed. Among the patients who attended at emergency in the NITOR, a total number of 18 patients with type-II open fracture of tibia (AO-4.2. A3) during the period of July 2014 to June 2016 were included in this study. The present study findings were discussed and compared with previously published relevant studies. In this study it was observed that people from various occupation of life were victims of tibial fracture (laborers, farmer, businessman, student and housewife). It was observed in this study that the patients' ages with tibial fractures varied from 18 to 60 years and maximum incidence occurred between 26–35 years age group. Kamruzzaman & Islam [14] showed the average age of patient was 35 years and age ranged between 20 to 62 years. The high incidence of young adult age group points to the higher rate of mobility as well as social violence in this age group. In this study it was observed that 88.88% tibial shaft fractures involved in men and 11.11% occurred amongst women. Kamruzzaman & Islam [14] observed 70.59% male and 29.41% female in their study. The above findings are close to the current study. In the present study it was observed that motor vehicle accidents (MVA) accounted for 72.22% cases, fall from height 11.11% and 16.66% due to assault. Similarly, Kamruzzaman & Islam [14] reported that 82.76% fractures were due to motor vehicle accidents and 17.24% were due to fall. The above findings are consistent with the current study. Motor vehicle accidents were major cause of fracture as our population and drivers do not properly follow the traffic law. It was observed that right sided injury was more common, which was found 61.11% and left sided injury was found in 38.88% cases. Similarly, Kamruzzaman & Islam [14] found 72.41% patients had right sided fracture and 27.59% had left sided fracture, which are similar with the current study.

Right sided fracture was more may be due to right sided dominance of people. The observation of this study showed that mean duration of hospital stay was 6.8±1.3 days varying from 5 - 07 days. Janssen *et al*. [15] reported that patients stayed in the hospital for an average of 10 days with a range from 4 to 15 days. In this study it was observed that fracture union time was 14 weeks to 27 weeks with an average union time 19.9 weeks. Shetty *et al*. [16] mentioned that the mean time-to union was 21.4 weeks. Gupta *et al*. [17] found union between 11 weeks to 28 weeks with interlocking nails, which is comparable with the current study. Out of 18 cases 1 (05.55%) case had superficial infection at the wound site. Wound swab yielded the growth of Pseudomonas which was sensitive to Levofloxacin. Skin infection was managed by flashing with normal saline followed by povidone iodine solution dressing. In the study of Shetty *et al.*[16] superficial infection rate was 4%. In this study it was observed that pain at full weight bearing, after 6 months, 94.44% patients had no pain, mild pain was in 05.55% but severe pain was not observed in this current study. There was no restriction of ankle and knee movements. But in our study 33.33% patients complain of anterior knee pain which was comparable with Court –Brown *et al*. [12] reported 36% incidence of anterior knee pain. Anterior knee pain is due to prominent of anterior end inserting nail. There was no incidence of screw failure or nail breakage. There was no incidence of any neurovascular injury or compartmental syndrome. Neither any Varus nor valgus deformity was seen. The final result of the study was analyzed by observing the outcome of treatment of 18 patients, which was included in this study. For evaluation of results, Tucker's criteria were considered. A single grading system of the fractures was used to have uniformity while evaluating the outcome of treatment in open fractures. Moreover, this system included infection as one of the parameters for assessment of outcome. Excellent and good results were accepted as satisfactory, while fair and poor results were regarded as being unsatisfactory. In this series, there were satisfactory results in 16 cases (88.88%) and unsatisfactory in 2 cases (11.11%). In this study it was observed that satisfactory result 88.88% (excellent result 66.66%, good 22.22%) and fair 11.11%. Kaushik *et al*.[18] obtained that 61.7% of patients showed excellent and 23.5% showed good result of the patients having open tibial diaphyseal fracture treated by intramedullary interlocking nail. Srinivas *et al*.[19] showed 54.17% excellent, 25.00% good, 16.67% fair and 4.16% patients have poor result which is comparable to our study.

LIMITATIONS OF THE STUDY

The study dealt with a small number of patients whose surgical management was done during a long period (July 2014 to June 2016). So, it is very difficult for the researcher to obtain necessary data from the patient by follow up. Because sometimes patients showed disinterest in follow up at a fixed interval.

CONCLUSION

This study was performed to assess the functional outcome of open (Gustilo-II) tibia-fibular diaphyseal fracture (AO-4.2. A3) treated by early closed interlocking intramedullary nailing. The treatment of tibial diaphyseal fractures with closed interlocking intramedullary nailing is effective; patients can return to work earlier than other treatment. Soft tissue infection can be controlled by this method as well as fracture union rate is significant. Almost all patients can return to their previous work and peritraumatic level of activity. In general, fear of postoperative chronic anterior knee pain (AKP) should not restrict the use of intramedullary (IM) nails in the treatment of tibial shaft fractures.

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