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Outcome of Femoral Shaft Fractures Treated with Intramedullary Interlocking Nail with Primary Dynamization

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Abstract

Introduction: Fractures of the shaft of the femur are among the most common fractures encountered in Orthopaedic practice. Most of the fracture occurs in young adult due to high velocity injury. It can be life threating due to open wound, fatembolism, ARDS or multiple organ failure. Femoral nailing with reaming remains the gold standard for the treatment of isolated femoral fractures.

Objective: To assess the Outcome of Femoral Shaft Fractures Treated with Intramedullary interlocking Nail with Primary Dynamization.

Methods: The study was a prospective observational study with analytical design was conducted in National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Sher-E-Bangla Nagar, Dhaka from July 2017 to June 2019. Patients with closed transverse fracture shaft femur (AO type 32-A3) attending the Emergency and Out Patient Department (OPD) of National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Sher-E-Bangla Nagar, Dhaka, within the defined period were the study population.

Results: The mean age of the patients was 32.50±11.81 years where minimum age was 18 years and maximum age was 60 years. Above figure shows that, most of the patients (92.0%, n=46) were male and the rests (8.0%, n=4) were female. The mean duration of injury of the patients was 13.90±4.68 days where minimum duration of injury was 5 days and maximum duration of injury was 21 days. 88.6% (n=39) patients had no femoral shortness and rests (11.4%, n=5) had femoral shortness. Among the patients, 9 patients (20.4%) had varus malalignment and 7 patients (15.9%) had valgus malalignment. Two patients (4.5%) had good knee flexion and one patient (2.3%) had poor knee flexion. 88.6% (n=39) patients had no or up to 5^0 loss of extension of knee and rests (9.1%, n=4) had 10^0 loss of extension of knee and only one patient had 15^0 loss of extension of knee. Thoresen criteria, majority of the patients (59.1%, n=26) had excellent outcome and near about one fifth of the patients (22.7%, n=10) had good outcome. However, 15.9% (n=7) patients had moderate outcome and only one patient

(2.3%) had poor outcome. Majority of the patients (80.6%) who had open reduction, had union in ≥3 cortices within 24 weeks whereas all of the patients (100.0%) who had close reduction, had union in ≥3 cortices within 24 weeks. Fisher Exact test showed that there was no significant association between **type of reduction and** radio-graphic union within 24 weeksas p=0.157.

Conclusion: Primary dynamization with intramedullary interlocking nail is effective for the management of transverse fracture shaft of femur (AO type 32-A3).

Keywords: Outcome, Femoral Shaft Fractures, Intramedullary interlocking Nail.

Introduction

Fractures of the shaft of the femur are among the most common fractures encountered in orthopaedic practice [1]. Most of the fracture occurs in young adult due to high velocity injury. It can be life threating due to open wound, fatembolism, ARDS or multiple organ failure [2]. Femoral nailing with reaming remains the gold standard for the treatment of isolated femoral fractures [3].Treatment of long bone fractures had changed dramatically after introduction of Intramedullary nails by Kuntscher around 1939 [4].Intramedullary nailing may be antegrade or retrograde and may be static or dynamic locking [5]. Primary dynamization is dynamic locking of axially and rotationally stable fracture at the time of initial fracture fixation whereas secondary dynamization is removing interlocking screw from longer fragment/ moving proximal interlocking screw from static to dynamic slot in nail [6]. Dynamization is done with one locking screw placed in proximal dynamization screw hole and two locking screws placed on distal side of the fracture. This allows early weight bearing and early fracture union. Dynamization is important for early mobilization, allowing both hip and knee motion [7,8]. Rate of union in femoral shaft fractures have been reported more than 90% and the efficacy of nail dynamization has been reported to range from 19% to 82% [9]. Dynamization promote callus remodeling and prevent the fixation device from breaking. It also shorten the mean time of union [10]. Dynamization of a previously interlocked intramedullary nail is a simple method for treating femoral shaft fractures (FSF) in patients with delayed healing after intramedullary nailing and is believed to stimulate an osteogenic response due to increased load across the fracture site [11].Most modern generation nails are cannulated to facilitate insertion - by keeping the cannulation small, the effect of its presence on the strength of the nail is minimised. All modern nails offer multiple locking options proximally and distally [12]. For transverse fracture dynamic locking may be performed. A3 type fractures are generally more stable than other fractures types. After nail insertion verus/valgus malposition, or shortening usually not occur. Therefore compression is the main concern andA3 fractures can be treated dynamic locking (primary dynamization) (AO Foundation, n.d.). The present study was conducted to evaluate the effectiveness of interlocking intramedullary nail with primary dynamization for the treatment of 32-A3 fracture shaft femur.

Materials and methods

Study design: The study was a prospective observational study with analytical design.

Study period: The study was conducted from July 2017 to June 2019.

Study place: The study was conducted in National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Sher-E-Bangla Nagar, Dhaka.

Study population: Patients with closed transverse fracture shaft femur (AO type 32-A3) attending the Emergency and Out Patient Department (OPD) of National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Sher-E-Bangla Nagar, Dhaka, within the defined period were the study population.

Selection criteria

Patients were selected on the basis of following inclusion and exclusion criteria

Inclusion criteria

1. Closed transverse fracture shaft femur (AO type 32-A3)
2. Duration of injury up to 3 weeks
3. Patient's age 18 years to 60 years
4. Patients of both sex

Exclusion criteria

1. Open fracture
2. Pathological fracture
3. Bilateral fracture
4. Fracture at the lower third or neck of the femur
5. Pregnant woman
6. Patients who did not agree to participate in this study

Sample size: Statistically the following formula was used to calculate the sample size:

$n=z^2pq/d^2$

As the study was conducted over a limited period of time, the sample size was adjusted to 50.

Data collection technique: Data from the patients were collected through face-to-face interview until the desire sample size was attained. Postoperative fracture alignment was assessed using the Thoresen scoring system that includes parameters such as valgus/varus, antecurvatum/recurvatum, shortening and rotation (internal and external). The former two parameters were determined by examining the radiographs in both A/P and lateral views. Rotation was determined clinically by the position of the patella relative to the anterior superior iliac spine and the presence of shortening was established by clinical measurement for limb-length discrepancy.

Data analysis: The data collected from the patients were analyzed. After completion of data collection, the data were checked and edited manually and verified before tabulation. Data were coded, entered and analyzed in a computer. The statistical analysis was conducted using SPSS (statistical package for social science) version 25 statistical software. The findings of the study were presented by frequency, percentage in tables and graphs. Means and standard deviations for continuous variables and frequency distributions for categorical variables were used to describe the characteristics of the total sample. Associations of data were assessed using Fisher's Exact test. Here, $p<0.05$ was considered significant. Here, all p-values were two sided.

Results

Above table shows that among the patients, 40.0% (n=20) were from 18-27 years age group, 26.0% (n=13) were from 28-37 years age group, 22.0% (n=11) were from 38-47 years age group and 12.0% (n=6) were from ≥48 years age group. The mean age of the patients was 32.50±11.81 years where minimum age was 18 years and maximum age was 60 years. Above figure shows that, most of the patients (92.0%, n=46) were male and the rests (8.0%, n=4) were female. Above table shows that most of the patients (94.0%, n=47) did not have any co-morbidity. Few had Diabetes mellitus (4.0%, n=2) and Hypertension (2.0%, n=1). Above figure shows that, majority of the patients (64.0%, n=32) had injury on right femur and rests (36.0%,n=18) had on left femur. Above table shows that half of the patients, 50.0% (n=25) had duration of injury of 8-14 days and 46.0% (n=23) had duration of injury of 15-21 days. The mean duration of injury of the patients was 13.90±4.68 days where minimum duration of injury was 5 days and maximum duration of injury was 21 days. Above table shows that 78.0% (n=39) patients had RTA and 22.0% (n=11) had a fall from height. Above table shows that most of the patients (88.0%, n=44) had no associated injury. Others had ipsilateral jones fracture (2.0%, n=1),

contralateral dislocation of elbow (2.0%, n=1), ipsilateral fracture base of 4th metatarsal (2.0%, n=1), ipsilateral fracture patella (2.0%, n=1), contralateral open Fracture of 2nd, 3rd and 4th metatarsal (2.0%, n=1), and ipsilateral open Monteggia fracture dislocation (2.0%, n=1).

Table-1: Distribution of patients by femoral shortness (n=44)

Femoral shortness	Frequency (n)	Percentage (%)
Absent	39	88.6
Present (2 cm)	5	11.4

Above table-1 shows that, 88.6% (n=39) patients had no femoral shortness and rests (11.4%, n=5) had femoral shortness.

Table-2: Distribution of patients by varus and valgus Malalignment (n=44)

Malalignment	Frequency (n)	Percentage (%)
Normal	28	63.6
Varusmalalignment (in degree)		
Excellent (5^0)	6	13.6
Good (5^0)	1	2.3
Fair (10^0)	2	4.5
Poor (>10^0)	0	0.0
Valgus Malalignment (in degree)		
Excellent (5^0)	1	2.3
Good (5^0)	5	11.4
Fair (10^0)	1	2.3
Poor (>10^0)	0	0.0

Above table-2 shows that, majority of the patients (63.6%, n=28) did not have any varus or valgus malalignment. Among the patients, 9 patients (20.4%) had varus malalignment and 7 patients (15.9%) had valgus malalignment

Table-3: Distribution of patients by knee flexion (n=44)

Knee flexion	Frequency (n)	Percentage (%)
Excellent (>120^0)	41	93.2
Good (100^0-120^0)	2	4.5
Moderate (90^0-100^0)	0	0.0
Poor (<90^0)	1	2.3

Above table-3 shows that, most of the patients (93.2%, n=41) patients had excellent knee flexion. Two patients (4.5%) had good knee flexion and one patient (2.3%) had poor knee flexion.

Table-4: Distribution of patients by loss of extension of knee (n=44)

Loss of extension of knee	Frequency (n)	Percentage (%)
Excellent (Up to 5^0)	39	88.6
Good (10^0)	4	9.1
Moderate (15^0)	1	2.3
Poor (>15^0)	0	0.0

Above table-4 shows that, 88.6% (n=39) patients had no or up to 5^0 loss of extension of knee and rests (9.1%, n=4) had 10^0 loss of extension of knee and only one patient had 15^0 loss of extension of knee.

Table-5: Distribution of patients by rotation of knee (n=44)

Rotation Of Knee	Frequency (n)	Percentage (%)
No Rotation	21	47.7
Internal Rotation		
Excellent (0^0 to 5^0)	6	13.6
Good (10^0)	1	2.3
Moderate (15^0)	1	2.3
Poor ($<15^0$)	0	0.0
External Rotation		
Excellent (0^0 to 5^0)	9	20.4
Good (10^0)	3	6.8
Moderate (15^0)	2	4.5
Poor ($>15^0$)	1	2.3

Above table-5 shows that, 47.7% (n=21) patients had no rotation. Eight patients (18.2%) had internal rotation of knee and 15 patients (34.1%) had external rotation of knee.

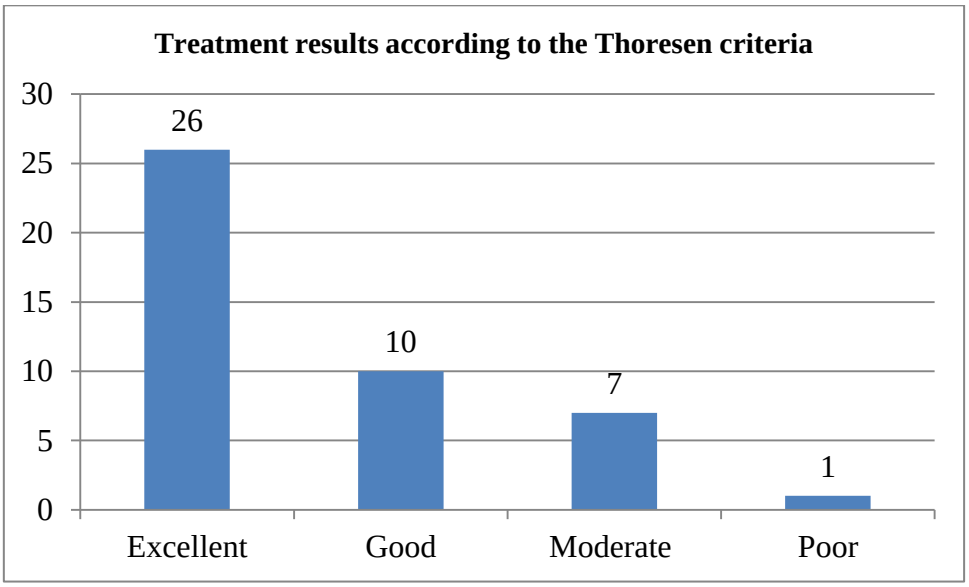

Figure-1: Distribution of patients by treatment results according to the Thoresen criteria (n=44)

Above fig-1 shows that according to the Thoresen criteria, majority of the patients (59.1%, n=26) had excellent outcome and near about one fifth of the patients (22.7%, n=10) had good outcome. However, 15.9% (n=7) patients had moderate outcome and only one patient (2.3%) had poor outcome.

Table-6: Association between treatment result and associated injury (n=44)

Associated Injury	Treatment results according to the Thoresen criteria				P value
	Excellent	Good	Moderate	Poor	
Absent	25(64.1%)	8 (20.5%)	6 (15.4%)	0 (0.0%)	0.036
Present	1(20.0%)	2 (40.0%)	1 (20.0%)	1 (20.0%)	

Above table-6 reveals that majority of the patients (64.1%) who did not have any associated injury had excellent outcome whereas one fifth of the patients (20.0%) who had any associated injury had excellent outcome. Fisher Exact test showed that there was significant association between

treatment result and associated injury as p=0.036.

Table-7: Association between type of reduction and radiographic union within 24 weeks (n=44)

Type Of Reduction	Radiographic union within 24 weeks		P value
	Union in ≥3 cortices	Delayed union	
Open	25(80.6)	6 (19.4%)	0.157
Closed	13 (100.0)	0 (0.0%)	

Above table-7 reveals that majority of the patients (80.6%) who had open reduction, had union in ≥3 cortices within 24 weeks whereas allof the patients (100.0%) who had close reduction, had union in ≥3 cortices within 24 weeks. Fisher Exact test showed that there was no significant association between **type of reduction and** radio-graphic union within 24 weeksas p=0.157.

Discussion

Intramedullary nailing has been established as the standard technique for treatment of femoral-shaft fractures and nonunions [13,14,15]. This prospective observational study had been conducted among 50 patients with femoral fracture to evaluate the effectiveness of dynamic interlocking intramedullary nail for the treatment of 32-A3 fracture shaft femur. Results of the present study showed that 40.0% patients were from 18-27 years age group, 26.0% were from 28-37 years age group, 22.0% were from 38-47 years age group and 12.0% (n=6) were from ≥48 years age group. The mean age of the patients was 32.50±11.81 years and most of the patients (92.0%) were male in the present study. There tends to be an age- and gender-related bimodal distribution of fractures with injuries occurring most frequently in young males after high-energy trauma and in elderly females after falls from standing [16]. Other studies also found that younger patients were more affected than older ones and there were predominance of male patients [17,18,19]. Most of the patients (94.0%) did not have any comorbidity. Few had diabetes mellitus (4.0%) and hypertension (2.0%). Majority of the patients (64.0%) had injury on right femur and the mean duration of injury of the patients was 13.90±4.68days.Majority of the patients (88.0%) had noassociated injury. Others had ipsilateral jones fracture (2.0%, n=1), contralateral dislocation of elbow (2.0%, n=1), ipsilateral fracture base of 4^{th} metatarsal (2.0%, n=1), ipsilateral fracture patella (2.0%, n=1), contralateral open Fracture of 2^{nd}, 3^{rd} and 4^{th} metatarsal (2.0%, n=1), and ipsilateral open Monteggia fracture dislocation (2.0%, n=1).Patients were regularly followed up in outpatient department at week 2, 6, 12, 16 and 24. Within these period, only two patients developed postoperative infection. These patients were treated accordingly. Among these two patients, one had diabetes mellitus and other had pin tract infection at the site of upper tibial skeletal traction which was given preoperatively. Dynamization results in increased contact area at the fracture site, improved osteogenesis, and improved transmission of weight-bearing forces [20]. Within 6 months, most of the patients (86.4%) had radiographic union in ≥ 3 cortices. Six patients (13.6%) failed to progress to union by six months. They were observed for more three months. Within this time period, all patients had radio-graphic union in ≥ 3 cortices. Panti et al [3] reported that 80.0% patients had radiographic union after intramedullary interlock nails. Though, all patients treated with closed reduction, had radio-graphic union in ≥ 3 cortices within 24 weeks, no statistical difference was found between open and closed reduction regarding this issue. On clinico-radiological evaluation at 9 months after surgery excellent results were noted in 16 (53.3%) patients in dynamized group with postoperative intrfragmental gap <3 mm. In patients with postoperative intrfragmental gap = 3 mm, excellent results were seen in 12 (66.7%) in patients, good results in 5 (27.8%) patients, and poor results in 01(5.5%) patients. Roy and Prasad et al [21] compared outcomes of interlocking nailing versus k-nail in femoral shaft fractures at the isthmus and reported that both groups had more than 90% of its scores in excellent range for each of the Thoresen parameters. Demiroglu [19]

evaluated the results of the treatment with unreamed intramedullary nailing in patients with femur shaft fracture, and reported that according to the Thoresen criteria, the rate of excellent-good results was 78%.In the current study, functional outcome was categorized as excellent, good, moderate and poor outcome. Patient was considered as having excellent outcome if patient had no to minimal mal-alignment (0^0-5^0), < 1 cm femoral shortness, no to minimal extension lag (0^0-5^0) and no pain. Majority of the patients (59.1%) had excellent outcome and near about one fifth of the patients (22.7%) had good outcome. However, 15.9% patients had moderate outcome and only one patient (2.3%) had poor outcome (had associated fracture patella). Significant association was found between **treatment result** and associated injury (p=0.036). Majority of the patients (64.1%) who did not have any associated injury had excellent outcome whereas one fifth of the patients (20.0%) who had any associated injury had excellent outcome. In the present study, no significant statistical difference was found between open reduction and closed reduction regarding functional outcome which was consistent with other studies [22,23]. Closed interlocking nailing was an accepted modality of treatment for femoral shaft fractures. Open nailing was given up as high rates of infection and extensive surgery were noticed. But recently with the development of potent antibiotics, surgical asepsis and meticulous dissection, these fallacies could be overcome [22].

Conclusion

Primary dynamization with intramedullary interlocking nail is effective for the management of transverse fracture shaft of femur (AO type 32-A3).

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