Comparative Study

A Comparative Study of Management of Fracture Shaft of Femur by Open Versus Closed Intramedullary Interlocking Nailing

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Abstract

Background: Orthopaedic surgeons often encounter diaphyseal femur fractures, which most often result from high-energy trauma, one must have high index of suspicion for complications. Currently surgery is indicated for most femur fractures because of high rate of union, low rate of complications and advantage of early rehabilitation which decreases the morbidity and mortality rate in patients. While the main stay of the treatment has been reamed interlocking intramedullary nailing. *Objectives:* To compare the time taken for bone union and the functional outcome in patients with fracture shaft of femur treated with interlocking intramedullary nail. Open versus closed method. *Methods:* Patients who were admitted with fracture shaft of femur to the department of Orthopaedics in R.L .Jalappa Hospital & Research Centre, attached to Sri Devraj Urs Medical College, Tamaka, Kolar. Duration of study 2 years. The time taken for bone union, range of movements and the complications encountered during the procedure and later were compared between open versus closed method of intramedullary nailing for fracture shaft of femur. *Results:* In our series age was between 16-70 years, the mean age was 43 years and the incidence was high in the age group of 21-30 years. 57 fractures were in men and 3 fractures were in females. 52 fractures were as a result of road traffic accident, 4 cases were due to direct trauma to the femur and 4 cases were due to fall from height . 40 patients had fracture on the right side and 20 patients had fracture on the left side. Based on Razaq MNU *et al*[16] modification of Thoresen *et al*[12] criteria results were graded as excellent in 47 cases (78.3%), good in 12 cases (20%) and poor in 1 case (1.7%). *Conclusion:* From our study we conclude both closed and open methods of nailing do not differ much with respect to the post operative complication, time of fracture union and the functional outcome. Closed nailing requires more surgical expertise, sophisticated instruments and more time consuming and increased exposure to radiation to patient and surgeon. . Open method of nailing on other hand is less time consuming and less radiation to patient and surgeon with an advantage of accurate anatomical reduction and primary bone grafting

Introduction

Orthopaedic surgeons often encounter femoral shaft fractures. These fractures most often results from high energy trauma[1], so one must have a high index of suspicion for complications and associated injuries. In developing countries, femoral shaft fractures are commonly due to increasing incidence of road traffic accident (RTA)[1].

Open method of nailing of the femur involves inserting the nail after exposing the fracture. The advantages of this method include less expensive equipment is required than is needed for closed nailing. No special fracture or operating table is required, no period of preliminary traction is required to distract the fracture. Absolute anatomical reduction is easier to obtain than with closed techniques, direct observation of the bone may identify undisplaced and

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undetected comminution not noted roentgenographically. Precise interdigitation of the fracture fragments improves rotational stability. In segmental fractures the middle segment can be stabilized, preventing the torquing and twisting associated with closed reduction and medullary reaming. In nonunions opening of the medullary canals of the sclerotic bone is easier and rotational mal alignment is rare after open reduction[2].

The present study is to compare the functional outcome of open versus closed intramedullary interlocking nailing of fracture shaft of femur as we see many road traffic accidents victims with femoral shaft fractures both open and closed type in R L Jalappa Hospital because it is situated on the national highway. We prospectively analysed 30 cases of closed nailing and 30 cases of open nailing from time of admission to a minimum of 6 months of post-operative period.

Materials and Methods

Aims are to compare the functional outcome of closed intramedullary nailing versus open intramedullary nailing of fracture shaft of femur and to asses the intra-operative difficulties and complications , operative time ,c-arm exposure, post-op complications., time to fracture union, time of ambulation and range of motion.

Patient admitted with fracture shaft of femur were recruited and the alternative cases were allotted to each group in the study as per surgeons choice. In Group A Closed intramedullary interlocking nailing of fracture was done. In Group B Open method of intramedullary interlocking nailing was done. The sample size was 30 each (**Table 2**).

The time taken for bone union, range of movement and complications encountered during the procedure and later were compared between open versus closed method of intramedullary interlocking nailing for shaft of femur.

Inclusion Criteria are age group more than 15 years, 5cm distal to lesser trochanter and 9 cm from the distal articular cartilage, closed fractures and open type I , II, III A and B Gustilo Andersons. Exclusion criteria are Type III C – Gustilo Andersons, old age not fit for surgery, fracture shaft with supracondylar extension and pathological fracture.

Pre Operative Treatment

All patients were stabilized starting from the vital parameters of airway, breathing, circulation and care of affected part. Initially Thomas Splint was used in all the patients to immobilize the fracture site, followed by X-ray of the affected site.

X-ray pelvis with both hips and X-ray of affected femur with knee joint was taken as standard protocol. Depending on the type of fracture (open or closed fracture), associated injuries, head injury, treatment was planned.

Table 1
Late complications in two groups of patients studied

Late complications	Group A (n=30)		Group B (n=30)	
	No	%	No	%
1.Deep infections	1	3.3	0	0.0
2.Implant removal	1	3.3	0	0.0
3.Non-union	0	0.0	0	0.0
4.Malalignment	3	10.0	1	3.3
5.Shortening	2	6.7	1	3.3
6.Implant breakage	0	0.0	0	0.0
7.Screw breakage	0	0.0	0	0.0
Total	7	23.3	2	6.7
Incidence of late complications are positively more associated with Group A with p value 0.145.				

Upper tibial traction was put in 56 patients (close 25, open 21), calcaneal traction in 4 patients (close 1, open 3). 8 cases no traction was applied as they were operated within 6 hours of injury. Once patient was fit for surgery, group A closed nailing was done and in group B open nailing.

The length of nail was measured from tips of greater trochanter to the upper pole of patella. The diameter of nail was assessed at the narrowest portion of the isthmus on A-P view.

Operative Procedure

Group - A (Closed Nailing)

Patient in supine position on a fracture table. Initially fracture site was visualized under image intensifier. The piriformis fossa was exposed through gluteal approach and curved bone awl positioned over the piriformis fossa, in line with the medullary cavity and position confirmed on both AP and lateral views passed till level of lesser trochanter . Ball tipped guide wire passed through the entry point, into the proximal fragment and then into distal segment after reduction of fracture. Position of guide wire was confirmed on AP and lateral imaging. Reaming was done over the guide wire to appropriate size with 1 mm increments. Exchange tube passed and ball tipped guide wire removed and plain guide wire was passed across the fracture site.

The nail length was confirmed under C-arm vision or measuring the length of guide wire jetting out in comparison with the same size guide wire. Proximal jig mounted interlocking nail of appropriate size and length passed over the guide wire. Guide wire was removed and proximal locking was done. Rotational alignment was confirmed and distal locking was done with free hand technique. For stable fractures dynamic locking was done. Wound was closed in layers after heamostasis under aseptic recautions.

Group - B (Open Nailing)

Patient on operating table in lateral decubitus position. Femur was exposed through postero-lateral approach. Fracture site identified and fracture hematoma evacuated. 6mm manual reamer passed across the proximal fragment and then guide wire was passed and extracted through the gluteal region. Reaming of the proximal fragment was done over the guide wire with 1 mm increments. Followed by the reaming of the distal fragment. The nail length was confirmed under C-arm vision or measuring the length of guide wire jetting out in comparison with the same size

Table 2
Functional grading in two groups of patients studied

Grading	Group A		Group B	
	No	%	No	%
Excellent	24	80.0	23	76.7
Good	5	16.7	7	23.3
Poor	1	3.3	0	0.0
Total	30	100.0	30	100.0

Distribution of results are statistically similar in two groups with p value 0.872.

Table 3
Complication's Encountered During Surgery

Series	Complications	% of Cases
Harper MC *et al*[11] 1985	Intra-operative shattering of cortices	8%
	Difficult in closed reduction	5%
Thoresen BO *et al*[12] 1985	Comminution at entry point	6.2%
	Poor reduction	6.2%
Meena RC *et al*[4] 2006	Upper cortex shattered	4.34%
Present study 2012	Difficulty in entry point	10%
	Difficulty in fracture reduction	17%
	Difficulty in guide wire insertion	10%

Table 4

Series	Complications	Open %	Closed %
Leighton RK *et al*[13] 1986	Malunion	-	4.7%
	Shortening	1.5%	-
	Infection	l.5%	3%
Meena R C *et al*[4] 2006	Delayed/ Nonunion	19.35%	7.%
	Infection- deep/superficial	3.2%; 16%	4.3%;8.6%
	Shortening	6.4%	30%
	Broken nail	3.2%	-
	Failed distal locking	19.4%	-
Gharehdaghi M *et al*[14] 2007	External rotation deformity	-	6%
	Nonunion	3%	1.5%
	Shortening	7 .2%	2.5%
	Deep infection	1.8%	l.3%
	Implant failure	3.6%	1.3%
Present study 2012	Nonunion	-	-
	External rotation deformity	3%	10%
	Infection- deep/superficial	0%; 10%	3%;7%
	Shortening	3%	7%
	Screw brekage	0%	0%

guide wire. Nail with proximal jig mounted and pass through the proximal fragment in antegrade fashion after reduction of fracture. The nail was passed across the distal fragment. Proximal locking was done followed by distal locking by free hand technique after confirming rotational alignment. Wound closed in layers after maintaining hemostasis under aseptic precautions.

Post Op Management

Post operative intravenous antibiotics were used in all the patients for minimum of 48 hours. Post operative check X-ray were taken to analyse fracture site reduction and alignment.

Static quadriceps exercises started within 24 hours of surgery followed by knee flextion extension exercises within 48 hours of surgery.Patients were mobilized on 2nd post operative day with toe touch weight bearing in lst post operative week depending on stability of fracture and patients compliance. Suture removal was done 10th post operative day.

The follow up in both group of patients was done at l month, 2, 3 and 6 months and were assessed clinically and radiologically.

Criteria for valuation

Evaluation of fuctional outcome was done according to criteria laid by Razaq MNU *et al* [16] modification of Thoresen *et al*[12] criteria - 2009.

Results and Analysis

The average age in Group A was 29 (18-50 years) and average age in Group B was 33 (18-57 years) .In Group A all the patients were male and in Group B 24 were male patients and 1 female patient. In group A there were

Table 5				
Series	**Year**	**Union rate**		**Duration**
		Open %	**Closed %**	
Meena RC *et al*[4]	2006	87.87%	93%	12 months
Gharehdaghi M *et al*[14]	2007	93.2%	95.4%	6 months
Present study	2012	100%	100%	8 months

20 (80%) cases of RTA, 3(12%) cases of direct trauma and 2(8%) cases fall from height. In group A there were 21 (84%) cases of RT A, 1 (4%) cases of direct trauma and 3(12%) cases fall from height.

In both the groups 14 (56%) cases were right side and 11 (44%) were left side.In group A 7 (28%) cases were proximal third, 12 (48%) cases were middle third and 6(24%) cases were distal third. In group B 6 (24%) cases were proximal third, 12 (48%) cases were middle third and 7(28%) cases were distal third.

In both the groups static locking was done in 22 (88%) cases and dynamic locking was done in 3 (12%) cases at the time of the surgery. In Group A the fracture patterns were transverse 13 (44%), short oblique 1(3%), long oblique 1 (3%), spiral 0(0%), comminuted 13 (43%) and segmental 2 (7%).

In Group B the fracture patterns were transverse 16 (54%), short oblique 1(3%), long oblique 0 (0%), spiral 0(0%), comminuted 12 (40%) and segmental 1 (3%).In group A 17 (57%) cases were grade 0, 5(17%) case was grade l, 4(13%) cases were grade 2, 3 (10%) case was grade 3 and 1(3%) case was grade 4.

In group B 18(60%) cases were grade 0, 5(17%) cases were grade l, 5(17%) case was grade 2, 2 (6%) case was grade 3 and no case was grade 4.

Number of C arm shots <10 were 0 (0%) and 2(8%) cases in group A and group B respectively. Number of C arm shots between 10-20 were 0 (0%) and 5(20%) cases in group A and group B respectively. Number of C arm shots between 21-30 were 3 (12%) and 7(28%) cases in group A and group B respectively. Number of C arm shots between 31-40 were 5 (20%) and 11(44%) cases in group A and group B respectively. Number of C arm shots between 41-50were 8(32%) and 0(0%) cases in group A and group B respectively .Number of C arm shots >50 were 9 (36%) and 0(0%) cases in group A and group B respectively .

Contralateral Femoral fracture were present in 2(7%) in each group Patellae fracture were present in 2 (7%) and 4(13%) cases in group A and group B respectively. Type of anaesthesia in group A were general anaesthesia in 5 (20%) cases, spinal anaesthesia in 12(48%) and epidural anaesthesia in 8(32%).

Type of anesthesia in group B were general anesthesia in 4 (16%) cases, spinal anesthesia in 14(56%) and epidural anesthesia in 7(28%). Number of cases with operative time < 1 hour - 0 (0%) case and 4 (16%) in group A and Group B respectively. Number of cases with operative time 1 - 2hours - 7 (28%) case and 12 (48%) in group A and Group B respectively. Number of cases with operative time 2-3 hours - 14 (56%) case and 9 (36%) in group A and Group B respectively. Number of cases with operative time >3 hours - 4 (16%) case and 0 (0%) in group A and Group B respectively.

Ipsilateral lower extremity fracture were present in 10 (33%) cases and 5 (17%) in group A and group B respectively. Head injury was present in 1(3%) case and 2(7%) in group A and group B respectively. Pelvic fracture was present in 1 (3%) in each group. Upper extremity fracture were present in 3 (10%) cases and 3 (10%) in group A and group B respectively.

Table 6 Duration for full weight bearing			
Series	**Year**	**Duration (Range in weeks)**	
		Open	**Closed**
Leighton RK *et al* [13]	1986	12- 14	12-14
Gharehdaghi M *et al*[14]	2007	10-20	5-16
Present study	2012	8-12	8-12

Table 7
Functional Grading

Series	Year		Open %				Closed %		
		E	G	F	P	E	G	F	P
Rokkanen P *et a1*[15]	1969	-	79%	21%	-	-	86%	14%	-
Leighton RK *et al*[13]	1986	-	97%	3%	-	-	92%	8%	-
Meena RC *et al*[4]	2006	56%	-	42%	2%	65%	-	35%	-
Present study	2012	77%	23%	-	-	80%	17%	-	3%

Number of cases operated within 7 days were 21 (70%) and 20(67%) in group A and group B respectively. Number of cases operated between 7-14 days were 8 (27%) and 6(20%) in group A and group B respectively. Number of cases operated after 14 days were 1 (3%) and 4(13%) in group A and group B respectively.

Difficulty in entry point was encountered in 3 (10%) cases in group A and no cases in group B (**Table 3**). Difficulty in reduction of fracture was encountered in 5 (17%) cases in group A and no cases in group B. Difficulty in guide wire insertion was encountered in 3 (10%) cases in group A and no cases in group B. Difficulty in distal locking was encountered in 5 (17 %) cases in group A and 2(7%)cases in group B.

Superficial infection was encountered in 2 (7%) cases in group A and 3(10%)cases in group B. Shortening of 1-2 cms was encountered in 2 (7%) cases in group A and 1(3%)case in group B. External rotation deformity> 5% was encountered in 3 (10%) cases in group A and 1 (3%)case in group B. Deep infection was encountered in 1 (3%) case in group A and none in group B. No post operative cases of neuro vascular deficit was encountered in the study groups (**Table 4**).

Discussion

Femoral shaft fractures are the most challenging fractures to fix for an Orthopaedic Surgeon. Interlockling nailing is the treatment of choice for all femoral fractures from 5 cm below lesser trochanter to 15 cm above the knee joint[109] The invention of Intramedullary Interlocking Nail made a revolution in the management of femur fractures[2].

Closed interlocking nailing technique was introduced after the advent of C- arm. In India there are few centres having facility of C-arm control, at the basic level of health infrastructure particularly at rural centres where no facility of C-arm and high surgical expertise are available. Open interlocking nailing is the modality to treat femur shaft fractures[4].

The open interlocking nailing with a predictable surgical time is less expensive, easy and more convenient for less experienced newly qualified orthopaedic surgeon and only fewer instruments are required. Due to the direct observation of bone anatomic reduction can be done which is not possible with close interlocking procedure particularly in comminuted and segmental fractures. In comparison to the closed method, rotational mal alignment is rare after open reduction. In non unions opening of the medullary canals of the sclerotic bone is easier, and simultaneous bone grafting is possible[4].

Long surgical skin scar, increased blood loss, loss of fracture hematoma (which is more important in fracture healing) increased infection rate, and complication rate particularly in comminuted fracture and decreased rate of union has its own demerits in open IL nailing procedure[4].

Periosteal stripping does not significantly decrease blood flow in middle layer of diaphyseal cortex. Endosteal and periosteal blood vessels are anastamotic and are capable of sustaining adequate circulation to diaphysis[5]. Fracture hematoma has a potential osteogenic factors which is evacuated in open nailing[6,7].

Inspite of evacuation of fracture hematoma and periosteal stripping it is a fact that open nailed fractures unite by callus formation[8,9].

Studies also show that reaming and intramedullary nailing reflexesly increase the blood flow in the facultative extra periosteal circulation. Hence exuburent callus forms in open nailed fractures[10].

In our present study we have 30 cases of fracture shaft of femur treated by closed intramedullary interlocking nail in Group A, 30 cases of open intramedullary interlocking nailing in group B.

The patients were allotted randomly into each group and also based on surgical indication and surgeon compliance.

Operative Time

The range of operative time in our study groups compared to the quoted studies are mentioned below.

The range of operative time in our study groups A and B were 1.30 - 3.30 hours and 45 minutes - 2.30 hours respectively.

OT in hours is significantly less in Group B compared to Group A with p<0.001**.

C-arm exposure's were high in closed nailing as compared with open nailing because of mulitiple exposures starting from fracture reduction, entry point, guide wire placement, and distal locking. It co-related with study reported by Jain RK *et a1*[41].

C-arm exposure is significantly less in Group B with p<0.001**.

Post Operative Complications

The post operative complications encountered in our study co-related with the quoted studies in **Table 4**.

In our study 6 cases of extensor lag, 3 in each group, which improved with quadriceps exercises and knee flexion-extension exercises. The good post-op range of motion was attributed to strict post-op regimen of quadriceps drill and knee flexion extension exercises and continious passive motion in patients non-compliant with the above mentioned regimen.

Post operative complication in our study groups were almost similar and statistically insignificant.

Union Rates Open Versus Closed Nailing

The rate of union achieved in our study groups was superior to the quoted studies below in (**Table 5**).

Overall Union Rates

In our study we got 100 % union rates in both the groups with duration of union by 8 months.The union in our study group A and B were 16 weeks and 20 weeks respectively.

The duration for full weight bearing in our study groups was earlier with respect to the quoted studies (**Table 6**).

Toe touch weight bearing with walker was used in most of our patients in both groups with in 1st post-operative week. By the end of 4weeks partial weight bearing was started based on signs of callus on x-ray and fracture stability. By the end of 12 weeks most of our patients were full weight bearing with walker.

Our study results were evaluated based on criteria laid by Razaq MNU *et al* [16] modification of Thoresen *et al*[12] criteria - 80% excellent, 17% good, 3% poor in group A and 77% excellent, 23% good in group B.

Distribution of results depending on the functional grading are statistically similar in two groups with p value 0.872.

Conclusion

Interlocking intramedullary nailing is a very effective and successful method of definitive primary treatment, in most types of fractures of the shaft of the femur. It is effective in providing strong fixation controlling rotational and longitudinal deforming forces . It allows early weight bearing ,early rehabilitation and early return to normal status.Both closed and open methods of nailing do not differ much with respect to the post operative complication, time of fracture union and the functional outcome. Closed nailing requires more surgical expertise, sophisticated instruments and more time consuming and increased exposure to radiation to patient and surgeon. Open method of nailing on other hand is less time consuming and less radiation to patient and surgeon with an advantage of accurate anatomical reduction and primary bone grafting. Though risk of infection is high in open method in our study the infection rate was similar in both groups.

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