

Original Research Article

Study of management of diaphyseal fracture shaft femur by intramedullary interlocking nail

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ABSTRACT

Background: Aim of this study was to analyze the effectiveness of interlocking nail in management of femoral diaphyseal fractures with special reference to fracture anatomy, pattern and status of stability.

Methods: This hospital based prospective study was done in the department of Orthopedics, MGM Medical College Navi Mumbai. A total of 41 patients who were admitted in our institute was included to evaluate management of diaphyseal fracture shaft femur by intramedullary interlocking nail from July 2015 to July 2017. They were asked to follow up at 6 weeks, 3 months and 6 months.

Results: Most of the fractures (70.7%) were united in 16-20 weeks while 10 (24.4%) fractures were united in 10-15 weeks and 2 (4.9%) fractures were united in 21-25 weeks. The mean time to union was 16.87 ± 3.09 weeks. In the present study, 26 out of 41 patients had excellent results (63.4%) with full, pain free, function of the extremity. 13 patients with good result (31.8%), 9 patients had flexion deformity 1200, 3 patients had shortening 2 cm, 2 patients had shortening 1 cm. Two patients with fair result (4.8%), both had flexion deformity and none had with poor result. So overall, we had 95.2% excellent to good and 4.8% fair results.

Conclusions: Interlocking intramedullary nailing is the most effective and successful method of definitive primary treatment, in most types of fractures of femur shaft. It provides strong fixation, rotational stability and earliest return to functional status, as rate of healing is good with nailing.

Keywords: Diaphyseal femur fractures, Interlocking intramedullary nail

INTRODUCTION

Orthopedic surgeons often encounter diaphyseal femur fractures.¹⁻³ because these fractures most often result from high-energy trauma, one must have a high index of suspicion for complications or other injuries. Fracture femur is a result of the drawbacks of faster lifestyle, leading to mortality and morbidity in patients with such injury. A diaphyseal femur fracture may lead to significant blood loss because of its larger size, rich vascularity and muscular attachments. Fractures can cause prolonged

morbidity and extensive disability unless adequately treated, as femur is one of the principal load-bearing bones of the body.

Comminuted and segmental femoral diaphyseal fractures are often difficult to treat. When the intermediate fragment is split or comminution is seen of either level of segmental fracture, the only best implant is the interlocking nail, as the conventional Intramedullary nailing fails to provide adequate fixation and length maintenance.

Morbidity in femoral shaft fractures arises from limb shortening, malalignment, knee contractures and other complications of fractures. Mortality is not very common but can result from open fractures and complications like fat embolism, adult respiratory distress or multi organ failure especially in polytrauma patients. Both morbidity and mortality can be reduced by prompt reduction and internal fixation of fracture.⁴ The ultimate goal of fracture care is restoration of alignment, rotation and length, preservation of blood supply to aid union, prevention of infection and early rehabilitation of the patient. The torsional loads are better than plates and the locking mechanism provides less tension and shear than plates. Being load sharing devices Intramedullary nails cause less cortical osteopenia. Currently interlocked intramedullary nailing is considered to be the choice of treatment for femoral diaphyseal fractures.⁵ Fracture management has tremendously advanced over the years. From the use of external splints in the age of Hippocrates to recent sophisticated instrumentation. Closed nailing causes no damage to extraperiosteal soft tissues and the biological environment round the fracture is least disturbed. Another important feature of the closed intramedullary nail is the chance for early ambulation of the patient which reduces complications due to prolonged bed ridden stay. Therefore, we conducted this study in order to analyze the effectiveness of interlocking nail in management of femoral diaphyseal fractures with special reference to fracture anatomy, pattern and status of stability.

METHODS

This hospital based prospective study was done in the department of Orthopedics, MGM Medical College Navi Mumbai. A total of 41 patients who were admitted in our institute was included to evaluate management of diaphyseal fracture shaft femur by intramedullary interlocking nail from July 2015 to July 2017. Patients who had meet specific inclusion and exclusion criteria were enrolled in our study. Institutional ethics committee permission was taken. All patients with femur fracture between inferior margin of lesser trochanter and upper border of the distal end of the femur, closed and Grade I and II open fracture (Gustillo Anderson classification), segmental fracture comminuted fracture (Winquest Hansen classification) were included in the study.⁶ Grade-III Gustillo Anderson compound fracture, age <18 yrs, pathological fractures, metaphyseal fractures, infection at site of incision were excluded. All patients were included after proper informed consent. Follow up of the case was done for a period of at least 6 months with 3 visits (6 weeks, 3 months, and 6 months). In this series of 41 cases we had used the femur interlocking nail which is locally available and is based on AO design due to financial constraints. Its 1.2 mm thick wall, its diameter and the longitudinal slot gives the nail a certain flexibility under bending and torsion. Nail diameter was roughly calculated by measuring the diameter at the narrowest portion of the femoral medullary cavity (isthmus). Nail of

diameters from 9 mm to 12 mm and of lengths 36 cm to 44 cm were kept ready. All surgeries were done in supine position on the fracture traction table under regional anesthesia. The limb rotation was adjusted by comparing it with the uninjured leg and by imaging the reveal of the lesser trochanter in the involved leg and matching that reveal of the lesser trochanter in the uninjured leg. After palpating the greater trochanter, an incision was made of about 5 cm, approximately 5 cm proximal to the greater trochanter. The fascia overlying the gluteus maximus was incised along the line of its fibers. Underlying muscle fibers were split along the lines of its direction and the subfascial plane of gluteus maximus was identified and the piriformis fossa was palpated. With a pointed bony awl, the point of entry was created in the piriformis fossa. Care was taken to make the opening directly in the midplane of the femur, which was verified on the antero-posterior and lateral views using the C arm image intensifier. Once the medullary cavity was entered, a long 3.2 mm ball tipped guide wire was introduced using the guide wire holder (T handle). The ball tipped wire was used initially for reaming. Containment within the femur was confirmed by anteroposterior and lateral views. The fracture was then reduced manually using the same maneuver as was determined prior to painting and draping. The guide wire was then advanced from the proximal to the distal fragment under C arm control and the position was confirmed on both antero-posterior as well as lateral views. The guide wire was advanced into the center to the distal fragment until the tip reached the epiphyseal scar. The straight guide wire was used for standard fractures with minimal comminution whereas for the more severely displaced fractures, the curved tip guide wire was used which was helpful in reduction. Reaming was carried out using cannulated flexible power reamers from 8 mm to 12 mm in 0.5 mm increments i.e. until the desired diameter was achieved. When the desired diameter was reached the exchange tube was passed over the ball tipped guide wire. The ball tipped guide wire was then removed and was replaced with a non ball tipped guide wire. The exchange tube was then removed and placement of the guide wire was again confirmed on anteroposterior and lateral views using C arm control.

Two small size guide wires were used and using the guide wire method, with the distal end of the wire between the proximal pole of the patella and the femoral epiphyseal scar, a second guide wire was overlapped on the first one extending proximally from the femoral entry portal.

The selected nail was then assembled over the jig, orientation of the jig was checked as relative to the nail. The nail was inserted manually over the guide wire as far as possible in the medullary canal. Controlled blows with the ram were used to drive the rail into the medullary canal until the tip of the nail reached the distal metaphysis i.e. tip of the nail reached in between the proximal pole of patella and the epiphyseal scar and the proximal end is

flush with the surface of the cortex at the point of insertion.

After the nail insertion was completed and was found to be satisfactory the guide wire was then removed. We used the freehand technique. The C arm image intensifier was placed in the lateral position and the distal femur was scanned. The C arm was adjusted until a true lateral image was obtained and the screw holes appeared circular. A longitudinal incision approximately 1cm long was made along the midline axis of the leg, overlying the locking hole, carrying the incision down to bone. The 2.5mm K-wire was inserted through the skin incision and down to the bone near the locking holes. The k-wire was tilted and moved under C arm control until the tip of k-wire is centered exactly over the locking hole. The tip of the k-wire was pressed to the surface of the bone and was raised to right angled position with its axis exactly centered on the locking hole. The hole was drilled in the bone directly through both the cortices along the locking hole. K-wire removed and drilling with 4mm drill bit was done. When drilling was completed, the length of the first locking bolt was determined using a depth gauge and the self-tapping 4.9mm locking bolt is inserted.

Correct placement is confirmed in the anteroposterior and lateral views using the C arm. Another technique, which

was used in addition to the C arm was the sounding technique used to determine correct placement of the locking bolt. After inserting the distal most screw, the guide wire was reintroduced and sounded upon the locking bolt to confirm the position was correct. The same technique was followed for the second locking bolt.

Proximal locking was carried out using the insertion handle JIG. A stab incision was made over the appropriate locking hole. The 8mm protection sleeve with the trochar was inserted, through the appropriate hole in the insertion handle, until there was cortical contact. The metal trochar was removed, a 4.0 mm diameter drill sleeve was inserted and accordingly, using a 4.0 mm drill bit a hole was drilled across both the cortices through the proximal locking hole. The depth gauge used to determine the length of the proximal locking bolt. The 4.9 mm bolt was inserted using a screwdriver through the 8mm protection sleeve after removing the drill sleeve. The same procedure was repeated for the second locking bolt, if required. Sutures were removed on the 10th-12th postoperative day and patients were discharged. They were asked to follow up at 6 weeks, 3 months and 6 months and were advised to partial or complete weight bearing according to their fracture pattern and sign of union on follow up radiographs. For evaluation of results Thoresen et al classification system was used.⁷

Table 1: Classification system for the results of treatment (Thoresen et al).

	Excellent	Good	Fair	Poor
Malignant of femur (degrees)				
Varus or valgus	5 ⁰	5 ⁰	10 ⁰	>10 ⁰
Antecurvatum or recurvatum	5 ⁰	10 ⁰	15 ⁰	>15 ⁰
Internal rotation	5 ⁰	10 ⁰	15 ⁰	>15 ⁰
External rotation	10 ⁰	15 ⁰	20 ⁰	>20 ⁰
Shortening of femur (cm)	1 cm	2 cm	3 cm	>3 cm
Range of motion of knee (degrees)				
Flexion	>120 ⁰	120 ⁰	90 ⁰	>90 ⁰
Extension deficit	5 ⁰	10 ⁰	>15 ⁰	>15 ⁰
Pain or swelling	None	Sporadic, minor	Significant	Severe

Statistical analysis

Quantitative data is presented with the help of mean and standard deviation. Qualitative data is presented with the help of frequency and percentage table. Statistical analyses were performed using SPSS 20.0.

RESULTS

According to Winquist and Hansen classification, 34 (82.9%) patients had Grade I fracture while 2 (4.9%) and 3 (7.3%) patients had Grade II and Grade III fractures respectively.

Most of the fractures (70.7%) were united in 16-20 weeks while 10 (24.4%) fractures were united in 10-15 weeks

and 2 (4.9%) fractures were united in 21-25 weeks. The mean time to union was 16.87±3.09 weeks.

There were complications in 17 patients. 8 (19.5%) and 2 (4.8%) patients had knee flexion <120° and <90° respectively while 2 (4.8%) and 1 (2.4%) patient had limb length shortening by 2 cm and 1 cm respectively. 3 (7.2%) patients had infection while 1 (2.4%) patient had knee flexion <120° and shortening 1 cm.

In the present study, according to Thoresen et al classification system, 26 out of 41 patients had excellent results (63.4%) with full, pain free, function of the extremity.⁷ 13 patients with good result (31.8%), 9 patients had flexion deformity 1200, 3 patients had shortening 2 cm, 2 patients had shortening 1 cm. 2 patients with fair result (4.8%), both had flexion

deformity and none had with poor result. So overall, we had 95.2% excellent to good and 4.8% fair results.

Table 1: Demographic profile (n=41).

Characteristics	N	%
Age (in years)		
18-20	6	14.70
21-30	22	53.50
31-40	7	17.10
41-50	4	9.80
>50	2	4.90
Mean±SD	29.7±11.21	
Gender		
Male	35	85.30
Female	6	14.70
Mode of injury		
RTA	21	51.30
Fall	19	46.30
Assault	1	2.40
Site of fracture		
Upper Third	12	29.20
Middle Third	13	31.70
Lower Third	16	39.10
Geometry of fracture		
Transverse	21	51.20
Comminuted	7	17.10
Oblique	6	14.60
Spiral	7	17.10

Table 2: Winquist and Hansen classification.

Winquist and Hansen classification	N	%
Grade I	34	82.9%
Grade II	2	4.9%
Grade III	3	7.3%
Grade IV	2	4.9%
Total	41	100%

Table 3: Final outcome.

Outcome	Frequency	Percent
Excellent	26	63.40%
Good	13	31.80%
Fair	2	4.8
Total	41	100

DISCUSSION

The treatment of fractures of the shaft femur has been revolutionized by advent of Kuntscher’s nail in 1940. The scope of femoral shaft nailing has been broadened with reaming and interlocking of intramedullary nails. Since then, the unacceptable rates of malunion and non-union shown by various methods of conservative treatment have fallen dramatically.

Majority of the patients (53.5%) were in the second decade of life, followed by 17.1% and 14.7% in the third decade and fourth decade respectively. 9.8% patients were in the age group of 41-50 years while 4.9% patients were in the age group of >50 years. The mean age of the patients was 29.7±11.21 years. Winquist et al in his series reported 3rd, 4th and 5th decade as a common age group i.e. 70% middle age group population, with mean age 29 years age group population, with mean age 29 years age group.⁸ White et al observed mean age of 28 years but same age distribution in 68 % of his patients.⁹



Figure 1: Radiographs of one case (AP and lateral view). A) Pre-op: AP and lateral view. B) Post-op 6 weeks: AP and lateral. C) Post-op 3 months, D) Post op 6 months.

There was male preponderance (85.3%) in the study while female patients constituted 14.7% of the study group. Alho et al reported 55% male predominance in 120 patients.¹⁰

In the study, there is right sided predominance compared to the left side (61.1% vs. 39.01%). Metsemakers et al reported 18% with bilateral femoral shaft fractures and 12% patients with either left or right.¹¹

Road traffic accident was observed to be the main cause of fracture (51.3%) whereas 46.3% and 2.4% of fractures were due to fall and assault respectively. Winquist et al had 77% of cases because of road traffic accidents.⁸ Metsemakers et al reported road traffic accidents were the most common cause of injuries involving 172 patients

(74.8%).¹¹ This observation by various authors implies that fracture shaft femur is usually a result of high energy trauma so it is commonly associated with other injuries.

In our series, associated injury was present in 17 (41.5%) patients while it was absent in 24 (58.5%) patients. Winquist et al in his study observed a much lower percentage of associated injuries.⁸ White et al observed 76% of his cases were associated with other injuries.⁹ Nidharshan et al reported associated injuries more in the middle age group (40-64 years) more comparable to the younger group 18-39 years than the older age group (65+).¹²

In our study, 34 (82.9%) patients had Grade I fracture while 2 (4.9%) and 3 (7.3%) patients had Grade II and Grade III fractures respectively. 2 (4.9%) patients had Grade IV fracture. Lhowe reported type III 36%, type I 29%, type II 21, type IV 14% in 67 cases.¹³ Brumback et al showed Winquist type III as commonest 52%, type II 20%, type IV 18% and type I 10% in 81 cases.¹⁴ Metsemaker et al reported type I in 29 cases (11.7%), type II in 15 cases (6.05%) and type III in 8 cases (3.23%).¹¹

Majority of the fractures (51.2%) were transverse fracture followed by spiral and comminuted fractures (17.1%) and oblique (14.6%). Klemm-Borner showed comminution in 40.6%, butterfly 21.1%, transverse 16.4% in 293 patients.¹⁵ Most of the fractures requiring fixation were in the lower third (39.1%) followed by middle third (31.7%) and upper third (29.2%). Thoresen et al in his study of 48 cases reported 50% of fractures of M/3.⁷ Wiss et al reported 50% cases of M/3 fracture patients.¹⁶ Alho et al, reported 56.9% of M/3 in 120 cases.¹⁰

In the present study, 11 (26.8%) patients had open fractures while 30 (73.2%) patients had closed fractures. Christie et al had 16.6% open fractures in 117 cases.¹⁷ Alho et al had 12.2% open, of which 6.5% were grade I, 4% were grade II and 1.6% were in grade III in 120 cases.¹⁰

The injury to surgery interval for 7 (17.1%) patients was less than 24 hours, 1-3 days for 16 (39.1%) patients, 4-6 days for 16 (39.1%) patients and 2 (4.9%) patients had to wait for more than 6 days before getting operated. The average injury-surgery interval was 3.7 days. Lhowe treated 67 open fractures with average injury-surgery interval of 7 hours.¹³ Blumberg et al had 3.5 days in his 73 patients.¹⁸

The hospital stay of all patients ranged between 8 to 24 days. 19 (46.3%) patients were admitted in the hospital for 7-14 days while 51.3% and 2.4% patients were admitted in the hospital for 15-21 and 21-28 days respectively. The mean hospital stay was 15.4±3.71 days. Metsemakers et al found mean duration for hospitalization period was 15 days.¹¹

In the present study, 21 (51.3%) and 2 (4.9%) patients had operative time of 150-200 and >250 minutes respectively while 9 (21.9%) patients each had operative time of 100-150 and 200-250 minutes. The mean operative time was 180.3±38.25 mins. Lhowe in his series reported mean operative time of 182 min in 67 patients.¹³ Wiss et al, had average operative time of 3 hour 15 min in his cases.¹⁶

There were complications in 17 patients. 8 (19.5%) and 2 (4.8%) patients had knee flexion <120° and <90° respectively while 2 (4.8%) and 1 (2.4%) patient had limb length shortening by 2 cm and 1 cm respectively. 3 (7.2%) patients had infection while 1 (2.4%) patient had knee flexion <120° and shortening 1 cm.

In the present study, 8 (19.5%) and 2 (4.8%) patients had knee flexion <120° and <90° respectively. Wiss et al reported average knee flexion 125 degree with only 3 patients had less than 90 degree flexion.¹⁶

In the present study, 2 (4.8%) and 1 (2.4%) patient had limb length shortening by 2 cm and 1 cm respectively. For the patients with 2cm of shortening, shoe raise was given and now these patients are managing well without any difficulty in daily activity. Christie et al reported 2 patients (1.7%) with more than 2 cm shortening, both had spiral fractures in a study of 117 patients.¹⁷ Brumback in his study of 133 patients treated with Russel Taylor or Brooker Willis nail had 1 cm shortening in 2 patients and 1 patient had 2 cm shortening.¹⁴ All were due to intraoperative fixation, in a shortened position and not due to postoperative loss of fixation. Wiss et al, reported 2.5% cases showing shortening in 117 patients.¹⁶ Johnson et al, reported shortening of 1-2 cm in 13% of cases.¹⁹ Lhowe, reported 7 % cases with 1-2 cm shortening.¹³

In the present study, 2 (7.2%) patients had infection. In all cases the wound was debrided and antibiotics were given, wound healed completely and none of the patient showed evidence of deep infection. Christie et al had 1 superficial infection and 14 patient had prolonged wound discharge with no osteomyelitis.¹⁷

Lhowe et al, reported 67 open fractures treated by immediate nailing with 5% wound seroma and 5 % wound infection.¹³ Klemm et al, reported study of 293 patients with deep infection in 7 patients, 3 of which were closed fracture.¹⁵ Wiss et al reported only 1 superficial infection in 112 patients at the trochanteric incision with no deep infection and no osteomyelitis.¹⁶ Metsemakers et al reported 3 superficial wound infections, but no deep infection which were treated with short term and antibiotic treatment.¹¹

In the present study, 26 out of 41 patients had excellent results (63.4%) with full, pain free, function of the extremity. 13 patients with good result (31.8%), 9 patients had flexion deformity 120°, 3 patients had shortening 2 cm, 2 patients had shortening 1 cm. 2

patients with fair result (4.8%), both had flexion deformity and none had with poor result. So overall, we had 95.2% excellent to good and 4.8% fair results. Alho et al reported 63% excellent results, 19.5% good results, 15.4% fair results and 1.6% poor result in 120 patients.¹⁰ Thoresen et al reported 63.8% excellent results, 17% good results, 15% fair results and 4.25% poor results in his study of 48 cases.⁷

CONCLUSION

Interlocking intramedullary nailing is the most effective and successful method of definitive primary treatment, in most types of fractures of femur shaft. Intramedullary nail controls rotational and longitudinal forces that act across the fracture site. It provides strong fixation, rotational stability and earliest return to functional status, as rate of healing is good with nailing. Supine position on traction table, with the affected limb adducted, provides sufficient access for entry point. Allows resumption of knee range of movement exercises at early stage, reducing mortality and morbidity. Closed nailing is preferred over open nailing due to its faster rate of healing. Preferably nails with diameter of more than 10mm should be used to avoid chances of nail breakage. Rotational alignment should be confirmed before fixing the interlocking bolts to avoid malrotation.

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Ethical approval: The study was approved by the institutional ethics committee

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