

Original Research Article

A study on fracture of femur shaft treatment with intramedullary interlocking nailing

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ABSTRACT

Background: Rigid interlocking nailing for femoral shaft fracture is ideal for use in adolescents in terms of stability of the fracture and convenience for the patient. Closed reduction and intramedullary interlocking nailing is the surgical treatment of choice for the closed shaft fractures of femur. Present study conducted to study the principles of intramedullary interlocking nailing and to assess the outcome of the patient.

Methods: The present study comprises of 28 cases of fracture shaft of the femur admitted in orthopaedics wards of JJM Medical College, Davangere. Total 28 cases considered for closed intramedullary nailing.

Results: In 55% cases closed intramedullary nailing given excellent healing of fracture, in 25% cases healing was good, in 10% cases it was average and 5% cases poor healing was observed.

Conclusions: It is concluded that closed intramedullary interlocking nailing method given good result in treatment of shaft fractures of femur.

Keywords: Intramedullary nailing, Femur, Diaphysis fractures, Interlocking

INTRODUCTION

Advancement in mechanization and acceleration of travel have been accompanied by an increase in the number and severity of fractures. Fracture shaft of the femur results from the drawbacks of fast life and violence which is a major cause of morbidity in lower extremity injuries and continues to pose vexing problems for the orthopaedic surgeons. Even though, the femoral shaft fracture management gained importance way back in 18th century due to its disastrous complications like fat embolism, acute respiratory distress syndrome, prolonged morbidity and mortality, there wasn't much improvement till the turn of the 20th century due to lack of proper instrumentations, knowledge of fracture anatomy, biomechanical principle of fracture healing. There is a gradual transformation in the treatment of fracture shaft femur from skin traction, splints, cast application, open

reduction and internal fixation with plates and screws, external fixators to intramedullary nails. At the beginning of intramedullary nail era, the conventional intramedullary nails by closed methods, gained wide popularity in transverse fracture of the middle 1/3rd of the femur due to no disturbances of periosteal blood supply, fracture hematoma, and rapid healing of fracture with lesser risks of complications like infection, non-union and shortening. But still it had its draw backs in references to comminuted fractures of the femurs as in not providing rotational stability and axial length. Thus making other methods in treatment of comminuted fractures such as skeletal traction, spica cast, functional cast bracing, roler traction, open reduction and plate osteosynthesis more effective even though these methods had their own drawbacks such; prolonged hospitalization, non-union, malunion, shortening, extensive surgical dissection with considerable blood loss, definite risks of infection and

implant failure. Therefore several investigators after trial and error developed and implemented interlocking intramedullary nails. This method provided immediate leg length and rotational stability to the fracture and allowed the patient to be mobilized without risks of shortening. And this being a closed technique the risks of infection, delayed union and non-union and were minimized hence making this to be a far superior technique as compared to the rest and proclaiming it as the best technique in this revolving era of inventions and discoveries. The present study was conducted to study the principles of intramedullary interlocking nailing, to assess the functional outcome of the patient with reference to, early mobilization, rate of fracture union and Complications and to study the follow up and restoration of function of the limb.¹⁻³

METHODS

The present study comprises of 20 cases of fracture shaft of the femur in adults about 20 years old, admitted in orthopaedics wards of JJM Medical College, Davangere during November 2013 – October 2017. All the fractures, which were included in the study were traumatic in origin, most of them are due to road traffic accidents. Out of the 20 cases, all were fresh fractures. Most of the patients were seen within 24 hours (12 cases), some were seen between 24-48 hours (7 cases) and remaining one case after 48 hours. Patients in this study varied from 20 to 70 years of age, of these 18 cases were males and 2 cases were female. As soon as the patients were admitted he/she had undergone standard initial evaluation prior to surgery. A detailed history was taken with special reference to mode of injury, severity of trauma and duration.

Statistical analysis of the result

Mean and standard deviation were calculated for age, subjective assessment, clinical assessment, functional assessment and radiographic assessment, 't' test was used to compare the statistical significance, 'p' value less than 0.05 was considered as statistically significant.

Management

Stabilization of the patient

a. Emergency care

Special attention was given to the cardiopulmonary status. Vital signs were monitored from time to time. The arterial status of the limb was under constant supervision if the fracture of the femur was in the distal 1/3rd. Blood gas levels were monitored for early diagnosis of fat embolism. Blood transfusion was done in few cases preoperatively because fracture shaft of the femur is associated with loss of 1,200 ml of blood into the soft tissue.

b. Immobilization of the affected limb

Immobilization of the affected limb was done in Thomas splint, to prevent soft tissue damage, to decrease pain, to distract the fragments, and for easy mobilization of the patient.

Operative procedure

Patient positioning

Correct patient positioning makes the difference between a successful and unsuccessful nailing. The surgery was done usually under spinal or general anesthesia. Later patient was brought to the edge of the fracture table, perineal support was given to the buttocks either in supine or lithotomy position. The technique of the position of the patient is slightly modified from supine to lithotomy position in our study due its additional advantages like easy access for the image intensifier and enough space for the assistant surgeon.

Reduction of the fracture under C-arm guidance

This is achieved after giving traction to affected limb in line with the body. Skeletal traction was applied in a few cases to the lower end of femur of the affected limb. In few cases we couldn't achieve reduction even after giving traction, in these cases manual reduction was done under C-arm guidance.

Incision and entry point location

Incision

The skin incisions run in line with the femoral shaft. The incision was given from proximal to the tip of the greater trochanter and extends about 5-8 cms proximally. Split the skin, fascia of gluteus maximum in line with the fibers and cut the abductors. Feel the trochanter and put self-retaining retractor to expose the area.

Point of entry

Obtained the correct point of entry is the most important feature of the operative procedure. We often used the entry point as piriform fossa (18 cases) or the junction of anterior 1/3 and posterior 2/3 of greater trochanter. After locating the entry point, it is checked under C-arm in both AP and lateral views.

Opening of the medullary canal

A curved bone awl was used to make the entry point and cannulated cutter was used to enlarge it.

Passing the reaming rod

Then a curved tip reaming guide rod of 3.2 mm diameter × 950 mm length was inserted from the point of entry

into the medullary cavity. The bend in the reaming guide rod is essential for closed reduction and is only 2 centimeters from the end of the bulb to allow passage. The rod was passed up to the Fracture site. Then closed reduction with the help of assistant surgeon was done. The rod was pushed into the distal fragment. Then the guide rod was moved up to the subchondral bone of the distal femur. The tip should be in the center, otherwise it may cause varus or valgus deformity if the reaming rod end is in the lateral or medial aspects respectively.

Reaming

Reaming was done with cannulated flexible medullary reamers for closed nailing. The reaming was started with 9mm end cutting reamer followed by side cutting reamers, which were used to enlarge the medullary cavity. During each passage of reamer across the fracture site careful monitoring is required to prevent eccentric reaming. The size of the reamers was progressively increased by 0.5 mm in diameter. The femur was progressively reamed to more than 1 mm of the selected nail. In our hospital, we used up to 12 mm reamers. Tissue protector was used at the incision area to prevent damage to the skin and soft tissue. The curved tipped guide rod was held during reaming to prevent it from backing out by using holding forceps. Exchange the reaming rod with guide rod by using Teflon sleeve. The present study uses AO nail.

Nail insertion

During nail insertion extra care was taken while crossing the fracture site to prevent comminution. Nail should be placed in the center.

Locking

The present study uses the Locking Bolts. Locking of the nail was done with specially designed interlocking bolts. This has a low profile head, fully threaded with special low profile threads. It has a slightly rounded trocar point with a core diameter of 4.3 mm and outer diameter of 4.9mm. Proximal locking was done with the help of targeting device that attaches firmly to the proximal tip of the nail and distal locking was done with free hand technique with the help of C-arm. In our study 26 cases of the interlocking was in static mode and 4 was in dynamic mode. Only one case of dynamization was done. After thorough wash the incision was closed in layers and patient was shifted to postoperative ward.

Post-operative management

In the post-operative ward constant monitoring of the patient for first 12 hours was done to counter unwanted complications like fat embolism, some patients were given blood transfusion. Quadriceps exercises and Straight leg lifting were started on the morning after the operation. Patient was made to sit up on the second day to prevent pulmonary complications, in multiple injured patients. Supplemental external support was given in the form of Thomas splint and traction in few cases. Gradual knee joint motion started either actively or with the help of C.P.M. machine on the fourth day. Non-weight bearing mobilization with the help of crutches were taught and advised to continue knee exercises. Sutures were removed on the 10th post-operative day and patient was discharge on the following day.

Table 1: Criteria for evaluation of fracture femur.

Excellent	Good	Fair	Poor
<p>Sound bony union radiologically at the end of 4 months.</p> <p>No pain while walking.</p> <p>Knee motion equivalent to opposite die.</p> <p>No infection.</p> <p>Return to work within 4 months.</p> <p>No deformities.</p>	<p>Sound bony union radiologically.</p> <p>No pain while walking.</p> <p>No impairment of function for ordinary purposes but with limitation of knee motion <10°.</p> <p>No infection.</p> <p>Return to work within 5 months.</p> <p>Shortening of the limb <1.5 cm.</p>	<p>Sound bony union with the occasional mild pain at the fracture site.</p> <p>Limitation of knee motions more 10° to less than 40° but with satisfactory function for light duties.</p> <p>Superficial infection</p> <p>Return to work within 6 months.</p> <p>Shortening > 1.5 cm to <2.5 cm.</p> <p>Angular deformities with <10°.</p>	<p>Non-union and malposition.</p> <p>Persistent pain while walking.</p> <p>Limitation of motion in knee >40°.</p> <p>Shortening >2.5 cm.</p> <p>Deep infection</p> <p>Inability to attend his/her work even after 6 months.</p>

Follow-up

Patients were reviewed and radiographs were taken at 6 weeks (1½ months) 12 weeks (3 months) 18 weeks (4 ½ months) 26 weeks (6 ½ months) 1 year after nailing to document fracture healing and to examine clinically for pain, abnormal mobility at the fracture site and to assess the knee, and hip range of movements. If the radiographs

suggested that good callus seen at the fracture site, partial weight bearing was started at the end of six weeks and complete weight bearing by the end of 4 months. In cases where the fracture gap was not closed at the end of 6 weeks or any radiological signs of delayed union noticed at the fracture site, dynamization was done (1 case) to promote early bony union by promoting axial compression. In this study, Fracture Union was

considered when patient was weight-bearing without pain, radiographs showed osseous union in A.P. and lateral views, and time for healing is within 4 months. Delayed union was considered present if radiographs failed to demonstrate progressive consolidation between 16 and 24 weeks after injury. And non-union was considered by the presence of pain and motion at the fracture site and radiographs failed to demonstrate evidence of progressive healing 26 weeks following injury. Rotations (external and internal) and shortening are assessed clinically. Rational malunion was measured by a goniometry with patient prone and the knee flexed to 90 degree. Shortening of the length of the femur was measured from the tip of the greater trochanter to the joint line. Functional assessment was done on the final follow-up considering the following parameters. Type of fracture, radiological bony union, function of knee or range of knee movements, time of return to duty, and complication or residual deformity.

During follow-up

Criteria for evaluation of results

For evaluation of the clinical results of fracture femur, the subjective and objective results were combined and stored (Table 1).

RESULTS

The study consists of 20 cases of fracture shaft of the femur treated by closed intramedullary nailing with interlocking intramedullary nail in the Department of Orthopaedics, JJM Medical College.

Of the 20 fractures we followed up, 16 were closed fractures- 80%, 4 were open fractures- 20%. Kalus W. Klem and Martin Borner criteria for evaluation of final results after femoral shaft fractures (Table 2).

Table 2: The results were assessed by Kalus W. Klem and Martin Borner criteria.

Criteria	Excellent	Good	Fair	Poor
Non-union/delayed union	None	None	None	Yes
Radiographic alignment	Normal	-	-	-
Angular deformities	None	<5°	5-10°	>10°
Muscle atrophy	None	<2cm	2-5cm	>5cm
Hip movements	Full range	Slight loss	>25%	-
Knee movements	Full range	Slight loss	>25%	-
This study results	11 cases (55%)	5 cases (25%)	2 cases (10%)	2 cases (10%)

DISCUSSION

The management of fracture shaft femur continues to pose vexing problems for orthopaedic surgeons even in the 20th century. Fracture shaft femur are at an increase in the present, due to high-speed transportation and rapid industrial development. In the past 25 years, internal fixation of femoral shaft fractures has gained widespread acceptance as the surgical techniques and implants have steadily improved. Several recent large series have shown closed IM nailing as the treatment of choice for closed middle on third fracture of the femur. But unfortunately they could not maintain the length and rotational control in complex fractures. Interlocking nails have greatly expanded the indications for closed IM nailing of femur fractures. The average age in the present series was found to be 35.65 years. The statistic average age range (mode) in our series was found to be 26 years percent in 21-30 years range. In the study, most of the patients were males (90%) and females formed about 10% study group. The male to female ratio was 9:1 the higher percentage of males than females reflects the fact that under Indian circumstances males were more exposed to trauma. In the study, the involvement of the right side was more than the left side in the order of 70 percent, which is in well accordance with Donald Wiss series.⁴

We did not encounter any bilateral fracture shaft of femur. The commonest mode of injury in our series is that by road traffic accident (85%) followed by fall from heights 10% and Trivial fall (5%). This series is well in accordance with Johnson series.⁵ Fractures occurred at all levels of shaft of the femurs. The commonest site was middle third (56.7%) of the femur. Which is well in accordance with Thoresen (56%).⁶ In our series, of the 20 fractures treated by closed intramedullary nailing, majority were closed fractures (80%), while the remaining (20%) were open fractures. This is well in accordance with Winquist.⁷ Transverse and oblique was the most commonest type in our study and it constituted 70%, followed by comminution 20%, spiral fractures of 10% comminuted fractures was common type in our study, which is comparable with that of Jack Wickstorms series.⁸ In our series 65% of patients had only fracture femur, while 35% patients has associated injuries.

The high incidence of associated fractures in our series could be attributed to RTA with high-energy trauma, which was the main mode of injury. In polytrauma patients we often delayed fracture fixation due to risk of fat embolism. Associated fractures were fixed during the management of femoral shaft fractures, in case surgery was needed.

Table 3: The time taken for bony union in various studies.

Sl. No.	Study group	Average time taken for bony union (in weeks)
1.	Bjorn O. Thoresen ⁶	16
2.	Kenneth D. Johnson ⁵	14
3.	Robert J. Brumback ¹⁰	16
4.	Robert A. Winquist ⁷	15
5.	Present series	16

In our series majority of patients consulted us within 24 hours of injury (19 cases), or within 48 hours of injury, while one patient was referred from the PHC. All the cases were stabilized with interlocking and locking bolt. Either static or dynamic locking was done. We often did static locking (12 cases) in our series, except in a couple of cases. In our series reaming of the medullar cavity was done by using flexible reamers with an average diameter of 11.5 mm. The advantages of reaming are to create uniform medullary surface area, to promote osteogenesis, to place large nails which can overcome bending or fatigue failure and overall to provide high rates of union. This fact is also well documented in the literatures. Clatworthy in their literature documented the union rate in reamed group as 28.5±9.33 weeks, whereas nonreamed group was 39.4±15.27 weeks.⁹ Remaining was stopped when cortical chatter was encountered and a nail was inserted which was 1mm smaller than the reamer. Average diameter of the nail used in our series was 11 mm. The average diameter of the nail in our study was 11mm but whereas in other studies it was 13 mm in Clatworthy, 13.5 mm in Brumack and 14 mm in Winquist.^{7,9,10} As the skeletal framework of Indian population is on the lower side compared to the western counter parts. In our series we used lesser diameter nails compared to others.

Duration of surgery varied from 90 minutes to 150 minutes, with an average of 120 minutes. In few cases, the duration of surgery lasted for 180 minutes due to difficulty in reduction of fracture ends. As the site of incision was far away from the fracture site, the chance of deep infection rate was none. In Robert A. winquist⁷ series the average duration of surgery was 80 minutes and Johnson 120-160 minutes.⁵ The positioning of the patients was in supine in the being of our series and later shifted to lithotomy position due to its advantage (20 cases). Skeletal traction was used at the lower end of the femur for 3 cases. The time taken for bony union in our study is comparable with that of Johnson and Thoresen (Table 3).^{5,6}

In our study, the fracture was considered to be united when bridging callus was evident on one or more radiographs, trabeculations were seen to cross the fracture on radiographs of three of the four cortices and the patients had no symptoms that were referable to the fracture when walking with full weight bearing. In our series the gap at the fracture site was usually overcome by thumping the foot towards the long axis of the femur

after the distal locking was done and prior to proximal locking.

The delayed union rate in our series was 5%. There were no non-unions. The incidence of delayed union in our series is comparable with Winquist.⁷ The delayed union was seen in 1 case, but united at the end of 7 months without any further surgical intervention. In our study, shortening of the limb was seen in 4 cases (20%). Out of these 3 were comminuted. None of the patients had more than 2.5 cm shortening. 1 case had 1 cm shortening and 3 cases had 1.5 cm shortening. The union rate in our series was 95%. This high union rate in our series is comparable with the studies of Winquist series.⁷ There was no implant failure in our series. This was probably due to partial weight bearing started only after radiological evidence of callus at the fracture site. The high union rate in our study can be attributed to the preservation of fracture hematoma, using closed technique, early surgical intervention, early mobilization and early weight bearing. The present study it is concluded that closed intramedullary nailing is superior to any other modalities of treatment in fracture shaft of the femur in adults.

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

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