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A study of result of closed interlocking intramedullary nailing in femur shaft fracture

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Abstract
Background: Rigid interlocking intramedullary nailing for femoral shaft fracture is ideal for use in adolescents and elderly 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 with high union rate and low rate of infection and implant failure. 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 30 cases of fracture shaft of the femur admitted in orthopaedics wards of SSG Hospital & Medical College Vadodara. Total 30 cases considered for closed intramedullary interlocking nailing. Patients were followed up postoperatively for 6 months for clinical and radiological evaluation and functional outcome.
Results: In 43.33% cases closed intramedullary nailing given excellent healing of fracture, in 48.7% cases healing was good, and 7.7% cases poor healing was observed due to associated injuries.
Conclusions: The advantages of this procedure include that no fracture site is opened, there is a shorter operation time, less radiation exposure, It is concluded that closed intramedullary interlocking nailing method given good result in treatment of shaft fractures of femur, especially suitable for multiple trauma and obese patients.

Keywords: Intramedullary nailing, femur, diaphysis fractures, interlocking

Introduction
Closed intramedullary nailing, first reported by Hey Groves 1918 and later popularized by Kuntscher in 1940 is now the treatment of choice for most femoral shaft fractures [1, 2]. 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 major 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. Studies have demonstrated predictable and rapid fracture union, with a low complication rate [3]. These superior results are primarily attributed to achieving a form of biological fixation of the femur by preserving the surrounding soft tissue and fracture hematoma that are vitally important for fracture healing [4, 5]. Closed femoral nailing usually requires a fracture table and continuous traction for fracture reduction. Multiple radiation exposures are required for closed reduction and passage of guide wire in distal fragment. A closed intramedullary nailing technique with percutaneous stab fracture reduction to obtain easy and quick internal fixation of acute femoral shaft fractures especially in obese and

polytrauma patients and distal 1/3 femoral fractures in which there is marked sagging of distal fragment because of gravity and gastrocnemius muscle pull. But still it had its draw backs in references to comminuted fractures of the femurs as it is not providing rotational stability and axial length but however, other methods of plate osteosynthesis increases risk of excessive soft tissue trauma, considerable blood loss, definite risks of infection, non-union and morbidity due to prolong immobilisation. 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, The advantages is no fracture site is opened, there is a shorter operation time, less radiation exposure [19], no specialized equipment, less learning curve for surgeon 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 [6, 7, 8].

Material and Methods

This prospective study was carried out at SSG Hospital & Medical College Baroda from October 2017 to September 2018. A total of 30 patients aged from 20 yrs. to 60 yrs. were selected according to inclusion and exclusion criteria.

Inclusion criteria

1. Closed diaphyseal fracture of femur.
2. Adults (>18 years).
3. Location of fracture.
4. Duration of fracture less than 04 weeks

Exclusion criteria

a) Open fracture (Gustilo type II,III)
b) Pathological fracture.

Management

1) 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 specially in distal 1/3rd. Blood gas levels were monitored for early diagnosis of fat embolism. Blood transfusion was done in 8 cases preoperatively because fracture shaft of the femur is associated with loss of 1,200 ml of blood into the soft tissue due to polytrauma.

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 for radiological examination.

After fitting in the inclusion criteria of the admitted 30 patient, thorough history was elucidated, complete physical examination performed and investigations carried out. All cases were recent (0 to 5 days). All the patients were counselled about their condition which necessitated an urgency of the surgical procedure they had to undergo. Informed consent was taken from all the Patients. Preoperative ceftriaxone (1gm) was given on induction and interlocking intramedullary nails (8-11 mm of diameter and 30 to 42 cm long) were used. Antibiotics were continued for 1 week. Patients were mobilized on second post-operative day.

Surgical techniques [20]

Step 1: Nail entry site approach

Under general or spinal anaesthesia, patient was placed in the supine position on the operating fracture table. A 4-6 cm skin incision is made from the tip of the greater trochanter proximally in line with the femoral shaft. Incise the fascia of the gluteus maximus in line with its fibers Identify the subfascial plane of the gluteus maximus. Palpate the piriformis fossa. Entry is made with pointed awl under C-arm. Pass a guide wire into the proximal canal until its tip is at the fracture site. Enlarge the proximal canal using a 8-mm reamer to allow easy passage of the guide rod.

Step 2: Fracture reduction

Insert the guide wire until the tip is 1cm proximal to the distal end of the proximal canal. Reduce the fracture by manipulation with hands under c arm guidance and pass the guide wire into the main distal fragment. This is usually easy in most fractures and can be done within several minutes.

No need of accurate reduction at the time of passage guide wire. comminuted fracture were handled gently.

Step 3: Reaming

Reaming was done with cannulated flexible/rigid medullary reamers for closed nailing. The reaming was started with 8mm end cutting reamer 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 1 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.

Step 4: Nail insertion

Determine the length of the nail either preoperatively by measuring the opposite femur or by intraoperative measurement of the guide wire. Drive the selected nail into the canal manually with simultaneous traction of the distal femur with fracture table. Insert the proximal screws, and check for any gap at fracture site and correct rotation of the limb before distal locking and docking was done if necessary.

Step 5: Distal locking

1 or 2 distal locking must be done regularly. With a C-arm a good image of the distal femur should be obtained in a lateral position. Distal locking is always completed with the AP and lateral guide of the image intensifier

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, 4 patients were given blood transfusion. Knee and ankle exercises were started. Functional outcomes were measured according to the classification proposed by Klemm and Borner regarding the motion of the hip and knee, and the fracture alignment (Table 1).

Patients were allowed partial weight bearing after six weeks

when callus was seen on X Rays and full weight bearing after fracture heals. Patients were followed up for fortnight for first visit and then every month for subsequent visits for total time period of about 6 months In each visit the progressive healing of fracture site was evaluated with clinical and radiological examination.

Table 1: Functional results after fracture femur shaft (Klemm and Borner) [9]

Excellent
Full hip and knee motion
No muscle atrophy
Normal radiological consolidation
Good
Minimal loss of hip and knee motion
Less than 2 cm muscle atrophy
Less than 50 axial deviation
Poor
Moderate (25%) loss of hip and knee motion
More than 2 cm muscle atrophy
Axial deviation 50 to 400

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 AK slab and traction in few cases. Gradual knee joint motion started either actively or with the help of C.P.M. machine on the 2nd day. Non-weight bearing mobilization with the help of crutches were taught and advised to continue knee exercises. Sutures were removed on the 12th postoperative day and patient was discharge on the following day.

Follow-up

Patients were reviewed and radiographs were taken at 6 weeks (1½ months) 12 weeks (3 months) 16 weeks (4months) 20 weeks (5 months) and 24 weeks (6 months) 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 6 weeks and complete weight bearing by the end of 4 months. 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.

Observation and Results

Following were the observation during present study-

Table 2: Age distribution

Age (years)	No of patient
>18	2(6.66%)
18-30	7(23.33%)
31-40	13(43.33%)
41-50	5(16.66%)
51-60	3(10%)
Total	30

Table 3: Sex distribution

Sex	No of patients
Male	22(73.33%)
Female	8(26.66%)
Total	30

Table 4: Location of fracture

Fracture site	No of patients
Proximal third	6(20%)
Middle third	21(70%)
Distal third	3(10%)
Total	30

Total number of patient were 30 and all patients were followed up for the period of 6 months.

Age range was between 20 and 60 yrs. and mean age was 36 yrs. 22 (73.33%) were male and 8(26.66%) were female patients due to more outdoor activities. In 19(63.33%) patients there as left sided fracture and in 11 (36.66%) right sided fracture had been recorded. 6 (20%) patients had fracture of upper third, 21(70%) of middle third and 3 (10%) of the lower third of femur. Out of 30, 6 fracture pattern were comminuted and 24 were non - comminuted

Table 5: Mechanism of injury (n=30)

Cause	Number of patients
Motor vehicle accident	24(80%)
Fall	06(20%)

In our study, 24 (80%) fracture were due to motor vehicle accident and 6 (20%) were due to fall due to heavy transportation and advanced industrialisation.

Table 6: Associated injuries

Associated injury	No. of patients
Head injury	4 (13.33%)
Chest injury	1 (3.33%)
Abdominal injury	2 (6.66%)
Spinal fracture	0
Tibial fracture	3(10%)

In our study 4 patients (13.33%) had head injury and 1 patient (3.33%) chest injury. 2 patient had abdominal injury (6.66%) and 3(10%) patient had associated tibia fracture. Associated injuries leads to poor prognosis due to delay in fixation and poor general health of patient.

Table 7: Timing of surgical stabilization of fracture.

Time after injury	No. of fractures
< 48 h	3 (10%)
Within 5 days	20 (66.66%)
Within 10 days	7 (23.33%)

In our study, 20 patients (66.66%) were operated within 5 days after hemodynamic stabilisation and physician fitness of patient. 3(10%) patient were operated early on day of trauma to decrease risk of blood loss and fat embolization.7 (23.33%) patient were operated after 1 week <10 days due to associated head and abdominal injuries.

Table 8: Time of healing

(Weeks)	Patients
10-12	0
12-14	0
14-16	8(26.66%)
16-18	16(53.33%)
18-20	4(13.33%)
20-22	2(6.66%)

The average time of healing was 17 weeks. In 8 patients (26.66%) fractures healed in 14-16 weeks, in 16 patients (53.33%) fractures healed in 16- 18 wks, in 4 patients (13.33%) in 20 weeks, in 2 patients (6.66%) fracture healed in 22 wks.

Table 9: Complication

Complication	No. of fractures
Delayed union	1 (3.33%)
Early Post-operative pain	3(10%)
Limb shortening (>2cm)	1 (3.33%)
Superficial infection	2 (6.66%)
Malalignment (External rotation deformity $>5^0$)	1(3.33%)
Post op knee and ankle stiffness	2(6.66%)
Deep infection	0
Implant breakage	0
Non union	0

The delayed union rate in our series was 1 case (3.33%). There were no non-unions. The incidence of delayed union in our series is comparable with Winquist. but united at the end of 8 months without any further surgical intervention. In our study, shortening of the limb was seen in 1 cases (3%) of comminuted fracture less than 2.0 cm The union rate in our series was 96.66%. This high union rate in our series in comparable with the studies of Winquist series of 98%. There were 2 (6.66%) superficial infections they were treated with debridement and antibiotics. 1 patient had malalignment of external rotation of $>5^0$ which causes limping but no long term hazard on weight bearing. 2(6.66%) patient had knee stiffness which may be due to poor knee range of motion exercise and quadriceps strengthening exercise which were allowed to mobilize properly with help of physiotherapist. Early post-operative pain found in 3(10%) patients which were given analgesics iv 3 days followed by oral for 5 days. None of patient had deep tissue infection occurred that required nail removal. No implant loosening of screws or breakage. No any distal neurovascular deficit. No incidence of non-union.

Table 10: Functional results.

Results	Number
Excellent	13 (43.33%)
Good	14 (48.7%)
Poor	3 (7.7%)

The functional results were considered excellent in 13(43.33%) patients and good in 14(48.7%) patients, 3 (7.7%) patients had poor results. The relatively high rate of poor function was attributed to a particular group of patients with significant associated injuries and comminution of fracture pattern [22]. The mean hospital stay of our patients was 8 days. Most patients without a life- threatening injury were discharged after 5-to 7 days.

Discussion

Fracture shaft femur are at an increase in the present, due to high-speed transportation and rapid industrial development. Intramedullary (IM) nailing has become the preferred method of treatment for fractures of femur in skeletally mature population. It includes a small incision, minimum soft tissue dissection, preserves the biology, intact hematoma resulting in excellent healing of the fracture and a fast recovery [15, 16]. Interlocking bolts also provide rotational stability and maintain length thus ensuring the conditions for a prompt return to full weight bearing and union of the fracture. However the closed approach makes IM nailing a technically demanding procedure plus they could not maintain the length and rotational control in complex fractures Several recent large series have shown closed IM nailing as the treatment of choice for closed middle- third fracture of the femur. An important point to emphasize is that closed reaming of the intramedullary canal deposits local bone graft material at the fracture site [10, 11]. On the contrary, open reduction and internal fixation of the fractured femur require stripping This often results in extensive soft tissue damage and increased blood loss and raises concerns of fracture non-union and infection [17, 18]. Therefore, the open technique is not followed as a routine procedure in most cases. Nonetheless, because it requires no special equipment and achieves quick stabilization. The primary advantage of the closed fixation method compared to open fixation is that the bony structure can be restored with an intact soft tissue envelope. Many published studies have demonstrated superior results of closed femoral nailing, such as reliable fracture healing and a low infection rate [7].

Accurate closed reduction of fracture is not required for passage of the guidewire. This high union rate in our series in comparable with the studies of Winquist series [9]. 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. 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 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. A satisfactory reduction is usually achieved later with a larger reamer. Henceforth, we preserve the surrounding soft tissues, and the reamed fragments of bone collected in the flutes of the reamers also remain around the fracture site as local bone graft material. More importantly with this approach, acute nailing also helps avoid multiple c-arm exposures to hands and helps in early reduction. 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 End so advantage of the technique is that time needed to complete the entire procedure is short, a benefit that is crucial for emergency surgery (Hajek *et al*.) [21]. In our method the fracture healing was not compromised by the technique. In a recent and the largest study of closed, reamed femoral nailing, Wolinsky *et al*. [12] reported union rate of 93.6% after initial nailing and an overall union rate of 98.9% after an additional procedure. 95.4 % demonstrated union rate We demonstrated acomparable union rate (96.6%) to that of closed methods. Gharehdaghi *et al*. [13] reported 6 cases of external rotation deformity and non-union 6 cases which when compared to our study had 1 case of external rotation deformity and none non-union. Furthermore, Meena R C *et al*. [14] all reported infection in 2 patient which is

comparable only 2 cases of superficial infections in our study.
In our experience, because an discussed the use of 1 or 2 distal screws in the treatment of femoral shaft fractures in a biomechanical and clinical study [21]. In an emergency procedure, we believe that single distal locking is particularly useful and can be performed without increased morbidity with help of C-arm. Our technique reduces the radiation exposure to a great extent.

Conclusion
Closed intramedullary nailing is gold standard treatment for acute femoral shaft fractures nowadays. However, with careful patient selection and a proper surgical technique, it can be as safe and effective as the closed method. The union rate is high, and the complication rate is very low, less learning curve procedure is quick, with preservation of local vascularity and intact hematoma, pain relief due to immediate fracture stabilisation, early post-operative mobilization and it requires no specialized equipment. So in study it is concluded that closed intramedullary nailing is superior to any other modalities of treatment in fracture middle third shaft of the femur in adults and also in emergency cases of polytrauma and obese patients too.

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