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Closed Antegrade Intramedullary Nailing of Femoral Shaft Fracture on a Radioluscent Table Using X-ray or Image Intensifier in a Delayed Setting

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Closed intramedullary nailing is the standard treatment of femoral shaft fractures. This is done ideally using fracture table and C-arm. However, certain equipment is not always available in some hospitals especially in third world countries. The objective was to have an alternative technique to obtain closed method using X-ray or C-arm without fracture table even in a delayed setting.

Design: Descriptive Study

Methods: Patients with closed femoral shaft fracture admitted more than 3 days, distracted on balanced skeletal traction prior to closed antegrade intramedullary nailing with static locked from July 2008 to October 2010. Surgery was done in lateral decubitus position on a radioluscent table. Closed reduction was verified using X-ray or C-arm if available. Number of days prior to surgery, surgical time, intraoperative and postoperative complications, and cases of non union were recorded.

Results: Ninety-six patients underwent closed nailing without fracture table; 78 were reduced via closed method, 44 in Group A (X-ray) and 34 in Group B (Image intensifier). Nine on each group failed via closed method and were opened. Average time was 139 min for Group A and 132 min for Group B. Average days prior to surgery was 18 days for Group A and 17 days for Group B; 3 patients in Group A and 4 in group B had valgus angulation, 1 posterior angulation noted in group B. Malrotation, reamer breakage inside the isthmus, and surgical site infection noted in Group A; no cases of non union in both groups.

Conclusion: Closed antegrade intramedullary nailing without fracture table using X-ray or C-arm for verification of reduction can be feasible. Closed reduction helps us to achieve the biological healing of a fracture even in cases that are delayed as a result of unavoidable circumstances especially in a setting where facilities are limited. The most important factor prior to closed nailing is adequate preoperative traction.

Key words: closed antegrade intramedullary nailing, femoral shaft, skeletal traction, image intensifier, fracture table

The understanding of femoral shaft fractures and their management continues to evolve, allowing improvements in treatment, overall patient care and currently a high success rate. Intramedullary nailing was first reported by Kuntscher in 1940.[11] Closed intramedullary nailing has become the universal treatment for most femoral shaft fractures attested by several studies.[12-21] Union rates in excess of 98% are readily achievable.[14] Numerous studies have demonstrated predictable and rapid fracture union, with a low complication rate.[5,10,15,16,19,20,22] These superior results are primarily attributed to achieving biological fixation of the femur by preserving the surrounding soft tissue, attached periosteum, and fracture hematoma that are vitally important for fracture healing.[20,22] Conventional open reduction requires wide exposure and extensive periosteal stripping to attain reduction thus compromising the osseous vascularity which may possibly lead to delayed union, failed union or infection.[4] Guided by these principles, surgeons provide optimal patient care and early return to function.

Intramedullary nailing is traditionally done using a fracture table and image intensifier. The table assists with fracture reduction by applying sustained longitudinal traction prior to serial reaming and nail insertion. However, such equipments are not readily available in some settings especially in third world countries. Closed intramedullary nailing is usually performed early. However in our setting, certain factors cause delay of surgery; such as limited facilities, medical constraints, room availability, implant availability as well as patient load, hence some patients are not operated within the ideal time of 72 hours.[1] Due to these institutional factors

and other uncontrollable circumstances, surgery is relegated to open reduction due to shortened femoral fracture.

The objective of this study was to have an alternative method for closed intramedullary nailing without fracture table even in a delayed setting using either an x-ray or image intensifier for intra operative verification of successful closed reduction.

Methods

Patients with closed femoral shaft fracture aged 18 and above admitted more than 3 days from July 2008 to October 2010 were included. Excluded were patients with open fracture, multiple fractures, pathologic fractures, delayed cases with sclerosis of the fracture site and a sealed medullary cavity seen on X-ray. Baseline data were recorded and all fractures were classified as to location and Winquist type. The procedure was performed by different surgeons; majority were done by a consultant, followed by senior and junior residents with 1 or 2 assistants.

Upon admission, all patients were placed on a balanced skeletal traction with a distal femoral pin to obtain adequate traction with weights of 20lbs x 10lbs to keep or maintain the fracture overdistracted and align as near anatomic as possible, restoring the length, axis rotation and counteract the muscle spasm. A series of radiographic examinations were done to check adequacy of traction if the patient was not yet amenable to surgery. Traction weights were adjusted after films were seen and deemed necessary to adjust. Twenty four hours prior to surgery, traction was increased to 25lbs to keep the fracture overdistracted and the muscles relaxed. Different types of intramedullary nails were used such as the Russel Taylor (Smith and Nephew), Zimmer, SUN (AO Synthes) and locally made OI Perfecta nail (Orthopedic Innovation GustiloTrading). Groupings of patients were based on the availability of Image intensifier. The X-ray group was Group A while Image intensifier group was Group B.

Measurements of anteroposterior and lateral radiographs were obtained after surgery. The reported incidence of malalignment ranged from 0 to thirty 30 seven percent, malalignment was defined as greater than 5 degrees of angular deformity on sagittal and coronal planes.[7,9,13] Other reports refer to angular deformity as greater than or equal to 10 degrees[20], or greater than 15 degrees[18] or none at all.[2,6] These inconsistencies made comparisons between reports difficult. Angular malalignment was determined in this study using a goniometer measured on all immediate radiographic results in the coronal and sagittal views from the center of the shaft on each fragment. Measurement of more than 5 degrees is considered as malalignment. True leg length was measured to determine the incidence of leg length discrepancy. Postoperative rotational malalignment was assessed by comparing the symmetry of contralateral foot on transverse plane. Mean operative time, complications such as malalignment, malrotation, leg length discrepancy, iatrogenic fracture, cortical comminution, conversion to open nailing, infection and cases of non-union were recorded.

Surgical Technique

The distal femoral pin was removed after induction of anesthesia. Patients were placed in lateral decubitus position on a radiolucent table for easy access. Identification of piriformis fossa took into account the position of the femur relative to the pedestal of the table to allow access of the Image intensifier when available. Incision was done proximal to the tip of the greater trochanter. The piriformis fossa was identified and awl was inserted followed by starter reamer and ball tip guide wire. Closed reduction was performed with manual traction of the femur. Deforming forces were counteracted with towel bump or manipulation on the apex of the fracture. For Group A patients, several attempts to insert the guide wire to the distal fragment were done until the surgeon felt a grating sensation. An intra operative portable X-ray was used to determine the insertion of guide wire to the distal fragment and the alignment prior to serial reaming. Group B patients were guided with the reduction using Image intensifier. The length was assessed intraoperatively by comparing the injured limb to the non injured femur in the same position. The femur was kept in traction manually with the patella facing anteriorly to control the rotation on frontal and sagittal planes. Radiological signs of malrotation were

noted such as cortical step off sign, which is a difference on the thickness of the cortices, and diameter sign which is the difference in diameters of proximal and distal main fragment. After the alignments were noted, nail was inserted and locked proximally and distally using external jig. Repeat x-ray of the whole femur was done to verify position, locking, as well as rotation. If failure of closed reduction after 15 minutes is not achieved, it was then converted into open procedure to minimize prolonged surgery, and considered as a failure of treatment.

Results

A total of 96 patients initially underwent closed antegrade intramedullary nailing of the femur, 78 of whom were reduced via closed method and nailed, 44 (83%) from Group A and 34 (79%) from Group B. Eighteen out of 96 patients failed for closed reduction, with 9 on each group (Figure 1) and was converted to open reduction (Table 1). Baseline data (gender, age, mechanism of injury, location, Winquist type and number of days prior to surgery) of 78 patients successfully done via closed method were recorded (Table 2). Majority of cases were male, 20 to 30 years old. The most common mechanism of injury was secondary to vehicular accident (35), followed by history of fall (6), and sports related injury (3) for group A. For group B it was vehicular accident (27) followed by fall (3), industrial accident (3) and sports injury (1).

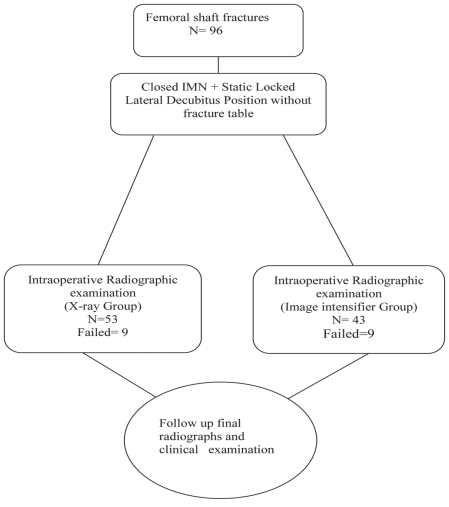


Figure 1. Patient identification flowchart.

Table 1. Comparison of groups (successfully treated).

	Group A	Group B
No of Patients	44 (83%)	34 (79%)
Male	41	30
Female	3	4
Mean age		
15-30	31	25
31-40	7	4
> 40	6	5
Mechanism of injury		
Road accident	35	27
Industrial accident	0	3
Fall	6	3
Sports related	3	1
Location of fracture		
Proximal 3rd	8	7
Middle 3rd	34	22
Distal 3rd	2	5
Winquist- Hansen classification		
0	9 (20%)	9 (26%)
1	11 (25%)	10 (29%)
2	7 (16%)	4 (12%)
3	14 (32%)	6 (18%)
4	3 (7%)	5 (15%)
Length of hospital stays prior to surgery (Days) Mean (Range)`	18 (3-60)	17 (4-68)

Group A: X- ray
Group B: Image Intensifier

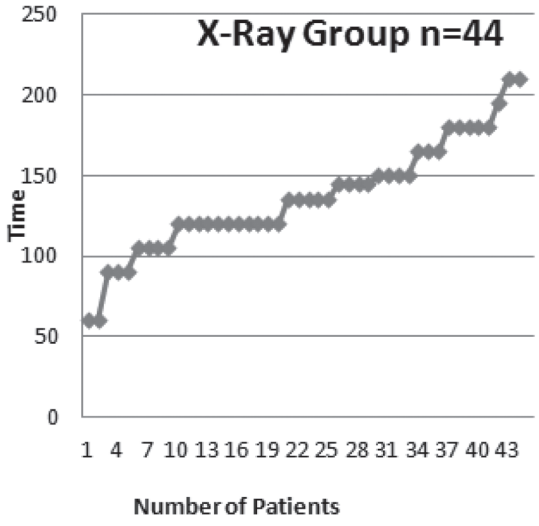
Majority of patients successfully treated on both groups had surgical duration of 2 hours (Figure 2). From skin incision to skin closure, mean operative time was 139 minutes (60-210) for group A while it was 132 minutes (75-210) for group B. Average number of days prior to surgery was 18 days (3 to 60) for group A and 17 days (4 to 68) for group B (Table 2)

As to surgeon classification (Figure 3), 52 percent of Group A was done by the chief resident, 41 percent by a consultant and 7 percent by a junior resident. In Group B, 71 percent was done by consultant and 29 percent by the chief resident of the failed closed reduction results in Group A (n=9), 45% was done by the chief resident, 33%

Table 2. Results.

	Group A	Group B
Mean Operative Time - minutes (Range)	139 (60-210)	132 (75-210)
Radiographic Results		
Varus (>5°)	0	0
Valgus (> 5°)	3	4
Anterior angulation (> 5°)	0	0
Posterior angulation (> 5°)	0	1
Clinical Results		
Malrotation	1	0
Limb length discrepancy (>1 cm)	0	0
Iatrogenic fracture	0	0
Other complications	2 *	0
Non-union	0	0

Group A -X-ray
Group B- Image intensifier
* starting reamer breakage inside the isthmus
Superficial wound infection at nail entry site



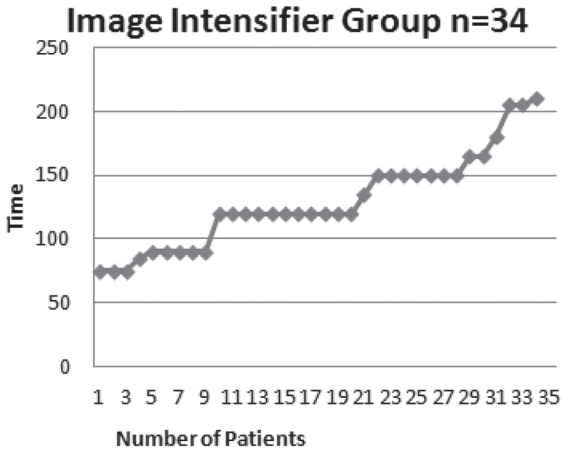


Figure 2. Duration of surgery.

by consultant and 22 percent from junior resident. In Group B (n=9), 56 percent was done by consultant, and 44 percent by the chief resident (Figure 2).

Postoperative radiographic results of Group A revealed 3 patients had valgus angulation, one middle 3rd, Winquist 3 fracture, and two D3rd, Winquist 1 and Winquist 3 fracture. While results of group B revealed 4 patients had a valgus angulation, all were (D3rd fracture) 2 Winquist 1, 1 Winquist 0, and 1 Winquist 3 fracture. One patient in group B developed posterior angulation, a case of a middle 3rd, Winquist 2 fracture.

There were no leg length discrepancies noted on clinical examination but there was one case of external rotation postoperative on a proximal 3rd fracture, Winquist O, from group A. There was 1 reported intraoperative complication in Group A, wherein the starting reamer broke inside the femoral isthmus and was converted to open procedure to extract the tip of reamer inside the isthmus. One patient had postoperative surgical site infection in the proximal incision and was treated with debridement and antibiotics. There were no reported cases of non-union, iatrogenic fracture and osteomyelitis in both groups.

Discussion

Satisfactory results can be expected if principles of closed reduction and nailing are followed. The overall success rate for closed antegrade intramedullary nailing without fracture table was 81% for both groups: 83% for group A and 79% for Group B. Failed reduction cases converted into open reduction were attributed to the surgeons' familiarity with the technique, inadequate traction prior to surgery and those fracture noted to have

soft tissue interposition intraoperative. Femoral fractures, especially distal third have a chance to be fixed in valgus position due to the wide intramedullary canal. The difficulty in checking the coronal alignment while patient is in lateral decubitus position with only manual traction to keep the length and axis in a good alignment is also a factor. A disadvantage in this position would be on the assessment of femur rotation, hence careful evaluation is needed to keep the correct rotation of the femur when guide pin is inserted, when reaming the medullary canal and when the nail is inserted.

Manual traction to reduce fractures and perform intramedullary nailing can be done successfully[8,11,12], a myriad of variations of this technique have been described for closed nailing. Sujata, et al. placed patients in lateral decubitus position without fracture table and image intensifier for closed nailing of femoral fractures less than 2 weeks.[17] Hsein, et al. also placed patients in a lateral decubitus position without fracture table with the aid of an image intensifier for fractures less than 48 hours post injury.[8] No non-union among fractures were reported in these 2 studies.

The shortest duration of surgery on Group A was 60 minutes on 2 patients; the first was done by the chief resident who was familiar with the technique. The fracture has Winquist 0, m3rd location. The second patient was done by a consultant without difficulty in inserting the guidewire to a fracture with Winquist 1, subtrochanteric location. The longest duration on Group A was 210 minutes on 2 patients. The first patient was done by the chief resident and it was his first case with this technique. The resident-surgeon had difficulty in exposing and identifying the piriformis fossa, and inserting the guidewire to the distal fragment. The second case was done by a consultant; the closed reduction was uneventful but had a difficulty in the application of static lock using a Zimmer intramedullary nail.

The shortest duration on Group B was 75 minutes on 3 patients; one patient was done by a consultant with a Winquist 1, m3rd fracture location. Two patients were done by the chief resident with Winquist 1, D3rd location, and Winquist 1 m3rd location. The longest duration was 210 minutes on 1 patient done by the chief resident, a case with Winquist 2, subtrochanteric fracture. There was difficulty in reducing the fracture, because the proximal segment went into flexion after removal of Steinman pin. External rotation caused difficulty in the reduction due to the deforming forces.

The operative time in this study was longer compared to other studies. Such was attributed to surgeon's factor. Familiarity on the technique and type of nail used affected the length of surgery in some cases.

Conclusion

This study proved the feasibility of closed antegrade intramedullary nailing on a radioluscent table using X-ray only or image intensifier on this operative technique. However, it was difficult to check the alignment in the coronal plane (anteroposterior view) and rotation of the femur in lateral decubitus position. Thus femoral fractures could be fixed in a valgus position and malrotation, hence careful assessment on the length axis and rotation of the femur in this position while on manual traction.

Although operative time was longer during the study compared to other studies[8,17], it could have been shortened if surgeons were familiar with the procedure. Wolinsky, et al. stated that the further they progressed in the learning curve, the shorter the nailing time became.[23]

With our experience, both methods for closed intramedullary nailing of femoral shaft fractures on a radioluscent table can be a feasible alternative even in a delayed setting especially in institutions with limited facilities. The technique can be improved as the surgeons become familiar with the procedure. The most important factor for a successful closed nailing is to have an adequate preoperative traction.

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