

Treatment of acute fractures of the Femoral Shaft with reamed Intramedullary Interlocking AO Nails

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Abstract

Objective: To review and audit our experience with closed intramedullary interlocking nailing for acute femoral shaft fractures.

Methods: All patients admitted to The Aga Khan University Hospital, over the last six years and with a minimum follow-up of twelve months, with acute fractures of the femoral shaft were included in the study. All patients treated for established non-unions and infections or with pathological fractures were excluded from the study.

Results: There were 89 fractures, 74% of whom were closed and 50% were associated with other orthopedic injuries. Most of these were younger patients involved in high velocity road traffic accidents. The union rate was 88% with 4.4% of fractures going into non-union. The remaining 8% of the fractures went into a phase of delayed union, but ultimately united, making the overall success rate to be 95.6%. The mean time for union was 11.5 weeks. At the final clinical follow-up, 4% of the patients had minor pain, 7% had limp, 4% had leg length discrepancy of more than 2cm and 4% had decreased range of motion at the hip or knee joints. We had a 4% rate of superficial infection. There were 3 cases of pudendal nerve neuropraxia and 2 cases of deep vein thrombosis.

Conclusion: Intramedullary Interlocking nailing is a safe and effective treatment modality for acute fractures of the femoral shaft. Proper surgical decision making regarding static versus dynamic mode of locking can avoid problems of delayed union (JPMA 54:423;2004).

Introduction

The art of treating femoral shaft fractures is a delicate balance between restoration of limb length and alignment, and at the same time achieving early mobilization of the limb. This is, however, prevented by strong muscular forces, which become specifically important when the fracture is either proximal or distal.

Various treatment modalities have been used to treat these fractures with Intramedullary (IM) nailing being the gold standard. IM nails are weight sharing implants which allow immediate weight bearing after static locking even in unstable fractures. They have the advantage of providing greater fatigue strength, better stability in all planes specially if locking screws are used and providing reamed bone at the fracture site.¹⁻⁵

Intramedullary fixation may be categorized biomechanically as dynamic or static. The decision between using static and dynamic nail is dictated by the anatomical level; fracture pattern and the comminution of the fracture. Comminution of the fracture is most commonly categorized by the method of Winquist and Hansen.⁶ Surgical judgment dictates what type of IM fixation is needed. Intramedullary interlocking nailing is a new surgical technique introduced in our country less than a decade ago. Despite it being a technically simple procedure in expert hands we experienced few difficulties in mastering its technique. This study is an audit of our initial 89 cases where we will analyze our

outcome and surgical errors in their treatment.

Patients and Methods

It is a retrospective study from January 1993 to December 1998 in which charts of all the patients with acute femoral shaft fractures treated with IM nailing at the Aga Khan University Hospital were reviewed. All adult patients with acute femoral shaft fractures were included. The patients having a follow-up of less than six months, with femoral shaft fractures treated by K-nails, ender rods, or conservatively were excluded. Pathological fractures and nailing done for nonunion were also excluded from the study. The initial study population was 117 but 28 patients were excluded because of the above reasons. The final study population was 89 patients. A comprehensive Proforma was developed to record the data from the files and all the x-rays of the patient.

The age ranges were from 15 to 70 years. The average age was 36 years and most of them were younger patients. There were 73 males and 16 females. Fifty-three percent of patients had right femoral shaft fractures, while 47% had the left side involved. The mechanism of injury was road traffic accidents in 63 (70.8%) patients; fall in 16 (17.9%) and gun shot wounds in 10 (11.2%) patients. Sixty-six (74%) patients had closed fractures while 23 (26%) had open fractures. Among them, 3 (3.3%) had grade I; 5 (6%) had grade II; 9 (10%) had grade IIIA; 4 (4.4%) had grade IIIB; and 2 (2.2%) had grade IIIC open fractures. In our

series according to Winquist and Henson classification of fracture⁶, we had 11.2% type I, 19.1% type II, 16.9% type III and 52.8% type IV fractures. According to fracture geometry there were 4.4% transverse, 6.7% oblique, 7.8% spiral and 80.9% comminuted fractures. Twenty percent patients had associated ipsilateral fractures of the tibia and 3.3% had an associated fracture neck of femur. In our series, 10 (11.2%) fractures were fixed using dynamic locking and rest of fractures (88.8%) by static locking technique, among them 3 were dynamized later. Associated fractures of neck of femur were fixed by AO cannulated screws as we did not have the facility of the reconstruction nail in our institution at that time. All of them healed in due course of time. The associated tibial fractures (18 patients) were fixed by IM nailing in vast majority (77.8%) of the cases, 16.7% (3/18) were treated conservatively, while 5.5% were fixed using AO External Fixator. All of them healed satisfactorily. The mean duration of surgery was 180 minutes (range 120 to 540 minutes) $\pm$ SD (76 minutes) and the mean hospital stay were 15.5 days, the range being between 3 to 90 days. The mean follow-up time was 9.2 months; ranging from 14 to 96 months. All the patients were called in a special outpatient clinic at the time of this study for their final clinical evaluation.

Malunion was generally regarded as shortening (>1 cm), malrotation ($>10^\circ$), angulatory deformity ($>15^\circ$), or any combination thereof.

In evaluation of nonunion and delayed union group of patients, we found 2 patients with nonunion had initially comminuted fracture while other 2 patients had transverse fracture; in delayed healing group there were 2, 1 and 5 patients who had transverse, oblique and comminuted fracture geometry respectively. All 4 patients with nonunion were treated by exchange intramedullary nailing and all healed in due course of time. No patient required bone grafting as a treatment of nonunion.

Results

The clinical outcome showed that 88% patients had a good early union (Figure 1); 7 (7.8%) had delayed union among them 3 were those which were later dynamized but they healed after an average of five months period; 4.4% had non-union, among them 2 were victims of gunshot and one each of fall and RTA. (Figure 2). The overall success rate was 96%. Mean time for union was 11.5 weeks (SD 3.2 weeks) ranging from 7 to 48 weeks. The average time for union was more in gun shot injuries (mean 14.3 weeks, SD 3.5) and in road traffic accidents (mean 11.1 weeks, SD 2.8) as compared to fractures due to falls (mean 10.5 weeks, SD 3.1). It was also higher in open fractures (mean 11.6 weeks) as compared to closed fractures (mean 10 weeks) ($p<0.01$).

Clinical follow up at the time of final evaluation showed that four patients (4.4%) had pain on prolonged activity; six (6.7%) had a limp; four (4.4%) had leg length discrepancy of less than 2 centimeters; and four (4.4%) had a decrease in the range of motion at the hip and knee joints.

Complications included bed sores in two (2.2%) patients; pudendal nerve neuropraxia in three (3.3%); a broken nail in three (3.3%); pulmonary embolism in one (1.1%); deep venous thrombosis in two (2.2%); distal fragment valgus in one patient; deep infection in two (2.2%) and proximal migration of the nail in one (1.1%) patient.

Discussion

A femoral shaft fracture usually occurs as a result of motor vehicle accidents, automobile-pedestrian accidents, gunshot injuries, falls from a height, or plane crashes. They can sometimes be life threatening and frequently occur in multiply-injured patients.^{1,2} Treatment goals include allowing early mobilization of the patient, restoration and maintenance of normal length and alignment, the ability to consistently achieve union, and to maintain a normal, functional range of motion in the hip and knee. The sum of hip and knee range of motion and flexion should total at least 160° to allow the patient comfortable stair climbing.^{3,7}

These injuries were virtually always treated with closed means until 1940, when Gearheart Kuntcher introduced his rigid nail for early mobilization of the injured German soldiers in World War II. At present, the ideal treatment for skeletally mature patients with a femoral shaft fracture from the level of the lesser trochanter to within 6 to 8 cm of the distal subchondral bone is closed Intramedullary (IM) nailing. Recent orthopedic literature also supports closed IM nailing as the treatment of choice for femoral shaft fractures in adolescents.¹

Open fractures of femur are not very uncommon. They have been reported as high as 23% by Brumback⁵ and 16.5% by Winquist.⁶ Because of the surrounding large muscle mass of the femur, a significant amount of energy absorption is required to create an open fracture of the femur. Therefore, even a grade I open femoral shaft fracture should be considered a high-energy injury.⁸ Brumback² described 469 fractures of the femur treated by IM nailing with 23% open fractures. More than half of these open femoral shaft fractures were grade III open fractures. In the study by Lhowe and Hansen⁸ there were 42 patients with open fractures, with 36% grade I, 45% grade II and 19% grade III.

One of the major risks in the primary nailing of these open injuries is deep infection causing osteomyelitis and later on requiring implant removal.⁹ This infection rate in open fractures treated by immediate IM nailing is variable

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One of the major risks in the primary nailing of these open injuries is deep infection causing osteomyelitis and later on requiring implant removal.⁹ This infection rate in open fractures treated by immediate IM nailing is variable in different studies ranging from 1.5 to 6% depending on the grade of the open fracture.^{2,5,8,10} All open fractures in our study were managed with a thorough wound debridement and were nailed only if they were able to reach the operating room within the first eight to ten hours. Deep cultures were always taken and prophylactic antibiotics were given for a minimum period of five days. If the patient arrived

late, then only wound debridement was performed and they were nailed secondarily once the deep tissue cultures returned negative. There were six (6.7%) patients who developed wound infection. Two (2.2%) patients with grade III injuries developed deep wound infection. These were managed with systemic antibiotics, surgical debridement and early removal of the implants. The implants were removed at an average of 4-6 weeks after the primary surgery. The fractures were subsequently managed by a hip spica cast and eventually healed without any significant malunion. None of them developed osteomyelitis. We also had four (4.4%) cases of superficial wound infection, which were managed conservatively and did not cause any significant morbidity or a change in the final outcome. Three of these presented with grade III open fracture and one presented with grade II fracture. The total number of open fractures in this series was 23. Of these, 35% had grade I and grade II open fractures while the rest of 65% were all Grade III and above. Another related factor for the development of deep infection in these two cases might be their inadequate earlier treatment and wound care at some local private hospital before presenting to our hospital. Different studies have concluded that early IM nailing is effective regardless of the soft tissue injury, but that this treatment is still controversial for type III injuries. Our data also support earlier studies.

Most large series^{1,4,11} of femoral shaft fractures treated with closed IM nailing report a nonunion rate of less than 1%. Nonunion is probably due to a lack of blood supply at the fracture site caused either by an open fracture or by open reduction and surgical manipulation at the fracture site. Other potential causes of nonunion include inadequate stabilization of the fracture site, wound infection, or distraction at the fracture site.

Delayed union is seen more commonly than nonunion, and is seen more frequently in multiple trauma patients and open fractures.^{2,3,8} In our study, 8% had delayed union, mostly resulting from open injuries as a result of road traffic accidents and gunshot injuries. Similarly the average time for union was significantly higher in open injuries as compared to closed injuries. The initial energy of trauma was the major factor for these fractures going into delayed union. We recommend that these delayed unions should be dynamized very early in the course of their treatment.

Before the introduction of interlocking nailing, unlocked Kuntshner intramedullary nailing often failed to provide adequate fixation. Sufficient cortical contact between the proximal and distal fragments was needed so that axial and rotational loading could be withstood without loss of length or rotational alignment of the fracture. The

advent of statically locked IM nailing more complex fractures of femoral shaft were treated with IM nailing. Rotational and axial control is a potential problem in healing highly comminuted fracture with the old nails. The advent of the statically locked IM nails used in this study has been very useful to overcome this problem. In our study rotational alignment which was measured clinically was found satisfactory in over 90% of the patients. Three patients developed external rotational malalignment ($>10^\circ$) while 1 patient had internal rotational deformity ($>10^\circ$) at the time of clinical and radiological union.

Despite the large number of IM nailing of the femur reported in literature, little is known about pudendal nerve palsy, which occurs as a compression neuropathy due to pressure between the perineum and the counter-traction post. In many large series¹²⁻¹⁵, this complication has not been reported at all or is reported rarely. However when it was specifically looked for, a much higher incidence (as high as 17%) was noted. The current study substantiates that pudendal nerve palsy can occur after IM nailing of the femur. Sensory terminal branches of the pudendal nerve appear to be more susceptible to palsy postoperatively than do the motor branches that control the sexual function. Fortunately most palsies were transient. Because the smaller diameter perineal post of the traction table concentrates the traction forces in a smaller contact area, the narrowest post has been blamed as a causative factor in pudendal nerve palsy after IM nailing. The symptoms generally resolved within 3 months, and there was no permanent deficit.

IM nailing can be categorized biomechanically as dynamic or static. Dynamic stabilization implies that intact cortical bone of the major proximal and distal fragments of the fracture can share a portion of axial and rotational forces across the fracture, thereby preventing shortening and rotation. Static interlocking describes the interlocking construct in which both the proximal and distal interlocking screws have been inserted. Shortening and malrotation are controlled by transferring the axial and rotational stresses through the nail rather than through the site of fracture. Our experience substantiates other reports in literature that dynamic Intramedullary femoral stabilization should be performed only for the transverse or short oblique fractures of the femoral isthmus with Winquist type I or type II comminution.⁴ Any increase in comminution at the site of fracture that is noted during the procedure is an indication for the static interlocking.⁵

Malunion after femoral shaft fracture has been discussed extensively in the literature. Shortening of 1 cm is quite acceptable in most femoral shaft fractures, but shortening of more than 2 cm is typically symptomatic. We used

static IM nailing in our vast majority of cases ($>90\%$), and our study also proves that with the increased use of locked IM nails, shortening is becoming less of a problem.¹⁴ Angulatory deformity after IM nailing has also been reported for femoral fractures. This was noted to occur in approximately 1.5% of patients after an IM nailing in Winquist⁶ and co-workers' series.

We had one case of segmental femoral fracture in which the distal fragment was quite small. Despite static nailing there was a residual valgus angulation of about 15° . We recommend open reduction in such cases to avoid malunion.

The patient with proximal migration of the nail highlighted the need for static locking. He ended up with a 2 cm shortening because of dynamic locking in an unstable fracture.

All three cases of nail breakage had nonunion. These patients were walking full weight bearing despite nonunion. All of them had been statically locked at the time of initial fixation. Analyzing their x-rays retrospectively we think that these were strong cases for dynamization during the course of treatment, with possible bone grafting. This intervention could have avoided the final outcome of nail breakage and nonunion. We recommend dynamization of a statically locked fracture as early as three months if it not showing signs of periosteal callus and bridging.

All the 4 cases were treated by over reaming and bigger sized nails were used to fix them without bone grafting. Good healing was achieved in all of them after this revision procedure. In a local study^{15,36} comminuted fractures (20 close and 16 open) were treated by IM nailing, all united in mean time of 34 weeks with 5 patients requiring additional procedure in the form of bone grafting.

Conclusion

Our review of the initial 89 cases performed at our institution has shown it to be a successful experience. The overall healing rate was 96%. We certainly think that interlocking intramedullary nailing is the treatment of choice for unstable femoral shaft fractures. The technique is simple to learn and once mastered it is associated with very few complications. Orthopedic centers in Pakistan can learn a lot from our initial experience and avoid some of the potential complications as highlighted in the discussion.

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