

Interlocking Nails for Treatment of Femoral Fractures

C.H. Chin, FRCS

C. Yeow, MS

Institute of Orthopaedics and Traumatology, General Hospital, Jalan Pahang, 50586 Kuala Lumpur

Summary

A series of 23 fractures of the femur were treated using femoral interlocking nails. The average follow-up period was 14.8 months. There were 14 closed fractures and 9 compound fractures. Closed nailing was done for 8 patients and open nailing for 15 patients. All the fractures united. There were no superficial or deep infections. The most common complication was leg length discrepancy; shortening occurred in 5 patients whereas lengthening occurred in 2 patients. It is a technically demanding procedure but it is the method of choice in our Institution for stabilising complex fractures of the femoral shaft.

Key words: Interlocking nails, femoral fractures, AO classification.

Introduction

Complex and/or segmental fractures of the femur pose a problem for the surgeon when he attempts to internally fix them. In this Institution, we used to use either intramedullary Kuntscher nail, plate, interfragmentary screw or cerclage wiring or a combination of different methods. Conventional intramedullary nailing does not provide the axial and rotational stability, especially with fractures in the upper and lower third of the femoral shaft, due to the lack of fit in these areas with wide metaphysis¹. Plating of these fractures would require open reduction and massive stripping of the periosteum. There is also a higher risk of infection and weight bearing must be delayed too. It is now generally accepted that interlocked intramedullary nailing is the method of choice to stabilise such fractures and allow early weight bearing^{2,3}.

This retrospective review attempts to identify the specific problems related to the procedure. We would like to present our early results with the Grosse-Kempf and the Russell-Taylor interlocking nails.

Materials and Methods

Between January 1990 and March 1991, 25 patients with femoral shaft fractures were stabilised and internally fixed with interlocking nails. Two patients could not be traced and were excluded from this study. There were 22 men and 1 woman. Their average age was 27 years (range 16 to 65 years). Fifteen right and 8 left femurs were involved.

All the initial injuries were due to high velocity trauma; 17 patients were motorcycle riders or pillion riders, 5 were in cars or vans and 1 was a pedestrian hit by a lorry. Two patients fractured their femurs 2 and 8 months prior to the current admission and had a dynamic compression plate and an intramedullary Kuntscher nail inserted respectively. Both men had trivial falls and the one with the plate refractured his femur, while the other broke the nail in an ununited femur. Seventeen patients had other associated injuries (Table I).

Table I
Associated injuries

Injuries	No of patients
Head/face	10
Ipsilateral tibia/fibula	6
Ipsilateral knee	6
Ipsilateral ankle/foot	5
Upper limb	4
Contralateral lower limb	2
Pelvis/abdomen	2
Chest	1

The waiting time for surgery averaged 20 days (range 7 to 54 days) and the average hospital stay was 31 days (range 16 to 73 days). The Grosse-Kempf nail was used in 19 patients and the Russell-Taylor nail used in 4 patients. The operating time averaged nearly 3 hours (177 mins; range 105 to 300 mins).

The fractures were classified according to the AO classification (Table II)⁴. In addition to the fractured femoral shaft, there were 3 patients with other fractures of the same upper or lower femur, i.e., 32-C2 (and 31-A1), 32-B1 (and 33-A1) and 32-A3 (and 33-B1).

Table II
AO Classification of fractures in 23 femurs

32-A Femur diaphysis, simple fracture (Total=2)		
A-1	A-2	A-3
0	0	2*
32-B Femur diaphysis, wedge fracture (Total=6)		
B-1	B-2	B-3
1*	3	2
32-C Femur diaphysis, complex fracture (Total=15)		
C-1	C-2	C-3
5	5**	5

* One patient in each of these 2 groups had another fracture in the femoral condyle, i.e., 33-B1 and 33-A1.

** One patient had another fracture in the femoral neck region, i.e., 31-A1.

All the fresh fractures were put on tibial pin traction on admission. All the compound fractures were treated initially by wound debridement and intravenous antibiotics. All the closed fractures were nailed on the next available operating day. The compound fractures were nailed after the closure of the initial wound. One patient with compound grade IIIa injury had complete transection of the quadriceps tendon and a large

wound over the anterolateral aspect of the thigh. This required repeated debridement of the infected wound followed by skin grafting and secondary suturing before nailing was done. He waited 54 days before nailing.

Closed nailing was done in 8 patients and open nailing in 15 patients after failure of closed reduction. Significantly, the first 8 nailings were by the open method.

All the patients were given prophylactic antibiotics and operated upon in the supine position on the traction table. The affected leg was kept in traction with the leg extended. Rotational deformity was avoided by keeping the patella pointing vertically. The medullary canal was entered via the tip of the greater trochanter using a curved awl. A ball-tip guide wire was inserted and closed or open reduction of the fracture was done with the aid of the image intensifier. Serial reaming of the medullary canal was performed with the flexible reamer. The medullary canal was overreamed by 1 mm of the nail to be used. The length of the nail was determined by the length of the guide wire within the medullary cavity. The interlocking nail was then introduced and the proximal locking screw inserted with the help of the proximal targeting device.

In the first few patients, insertion of the distal screws was time-consuming. Initially, attempts were made to drill a K-wire through the distal holes with the aid of the image intensifier, followed by overdrilling with the recommended drill bit. With the acquirement of the Howmedica hand-held distal targeting device, the distal locking screws were inserted without much problem in most cases. A 4.5 mm diameter Steinmann pin was mounted on the targeting device and its tip aligned with the distal hole in the nail. The Steinmann pin was then tapped gently into the cortex as the starting point for the drill bit.

The patient with additional pertrochanteric fracture (32-C2 and 31-A1) had the fracture fixed with two 6.5 mm diameter cancellous lag screws passed anterior and posterior to the proximal portion of the nail. The other 2 patients with the additional fractures (32-B1/33-A1 and 32-A3/33-B1) at the femoral condyles had them fixed with the distal screws of the nail passing through the undisplaced fractures.

Postoperatively, the patients were allowed to mobilise on crutches as soon as they were able, usually after 3 to 4 days. The physiotherapist guided them on gradual knee-bending exercises, and those who were able would return thrice weekly for supervised exercises. The patients were encouraged to bear weight partially on the affected leg as soon as they were allowed to mobilise, but full weight bearing without any walking aids was only allowed when there was radiological evidence of bridging callus.

Static locking was done in 21 femurs; 2 distal screws were inserted for 19 of these femurs and 2 femurs had 1 distal screw omitted because they did not catch at the far cortex. Dynamic locking was done in 2 femurs by omitting the proximal screw. Of the 21 static lockings, delayed distal dynamisation was done for 4 femurs at varying periods after the nailing. Two were done for specific reasons (loose distal screws and delayed union), while the other 2 were removed as recommended prior to allowing full weight bearing⁵. However, we have given up this practice and we do not routinely dynamise all the fractures and commencement of full weight bearing does not depend on conversion from static to dynamic locking. Delayed proximal dynamisation was done for 1 patient with lengthening of the femur.

Results

All the 23 patients were reviewed by either one of the authors clinically, together with radiological films. The duration of follow-up ranged from 8 to 24 months (average 14.8 months). All the fractures united with callus formation. There was no superficial or deep infection.

Two patients had varus deformity of between 6 to 10 degrees and 2 others had between 11 to 15 degrees. There was no valgus deformity. Although these 4 patients had varus deformity as measured on the radiographs, this did not translate into functional impairment. Overall, only 13% (3 patients) had angulation in any plane of more than 10 degrees. The few degrees of angulation were of no clinical importance.

There were 3 patients with rotational deformity (2 with internally rotated distal femur of 25 and 30 degrees and 1 with a 10 degree externally rotated femur). None of these 3 patients had any complaints related to their rotational deformity.

Five patients had shortening of between 1 to 1.5 cm (21.7%), while 2 patients had lengthening of 1 and 2 cm (8.7%). Six of the patients had the nail inserted with the femur at a discrepant length. This could have been avoided by measuring the femur again before insertion of the distal locking screws. One patient initially had a lengthened femur and proximal dynamisation was done at 6 weeks postoperatively and he was encouraged to bear weight partially. However, this caused telescoping at the fracture site and resulted in a final shortening of 1.5 cm. We feel that dynamisation was done too early for him.

Eighteen patients regained full range of knee flexion (>135 degrees), 3 patients had knee flexion of between 90 to 135 degrees and 2 patients had knee flexion of less than 45 degrees. Five (26.1%) patients did not regain full range of knee flexion. The 3 patients with knee flexion of between 90 to 135 degrees had fractures involving the same knee (2 fractured patellae and 1 fractured lateral tibial condyle). Of the 2 patients with knee flexion less than 45 degrees, one was an 18 year old man with an extensive laceration of the thigh extending into the knee joint with transection of the quadriceps tendon. The other man defaulted follow-up (and physiotherapy) and only returned for the purpose of this study. There was a large shard of bone which did not unite with the main part of the femur and this was impinging into the vastus intermedius and lateralis.

In the immediate postoperative period, 1 patient had fat embolism which necessitated 5 days stay in the Intensive Care Unit. He recovered completely from the episode. Another patient developed disseminated intravascular coagulopathy (DIVC) during the operation and required massive transfusion of 22 units of blood products.

We did not encounter any difficulty or complication with the proximal locking screw. However, we omitted one of the distal screws in 2 patients because the threaded part of the screw did not catch on the far cortex. We found that if the drill holes were slightly misaligned, the screw threads would impinge on the edge of the nail hole, resulting in the screw threads being blunted.

Discussion

Segmental, complex and rotationally unstable fractures of the femoral shaft are particularly difficult to treat. Before we started using interlocking nails in our Institution, the other alternatives were using a combination of plating or of nailing, supplemented with cerclage wires and interfragmentary screws.

Interlocked nailing provides immediate rotational and axial stability and restores femoral length, allowing the patient to be safely mobilised with early weight bearing. Closed nailing would be the method of choice. This must be preceded by strong skeletal traction and the nailing must be done early before the fracture becomes 'sticky', which makes it difficult to pass a guide wire through.

Due to various constraints in a large hospital like ours, the average time from admission to operation was 20 days. This made it impossible for some fractures to be reduced by the closed method. It is a reflection of the learning curve involved that the first 8 nailings were done by the open method, and of the next 15

INTERLOCKING NAILS FOR FEMORAL FRACTURES

cases only half (7 cases) were done by the open method and 2 of these were for removal of implants (plate and broken Kuntscher nail).

Although the average hospital stay was 30 days, the 13 cases with no other injuries stayed only an average of 5.2 days after the operation (range 3 to 8 days).

For our 23 patients, we used three 10 mm, two 11 mm, sixteen 12 mm and two 13 mm diameter nails. The standard Grosse-Kempf and Russell-Taylor nail starts at 12 mm diameter. The 5 nails smaller than 12 mm diameter were the Grosse-Kempf Small Diameter Nails. The use of these smaller diameter nails needs a different set of drillbits and guide sleeves. We did not delay protected weight bearing (as was recommended with the use of these Small Diameter Nails) in these 5 patients. Russell-Taylor nails were not available in diameters smaller than 12 mm.

Various authors^{3,6} have arbitrarily divided the femur into different zones to show their precise fracture location. We feel that the AO classification of fractures is more than appropriate as it denotes both the location and morphology. In our series there were 15 complex fractures (32-C), 6 cases with wedge fractures (32-B) and 2 cases with simple fractures. Of the 2 simple fractures, one had another non-displaced fracture in the femoral condyle and the other was the one with the ununited fracture and a broken Kuntscher nail. The selection of our cases was skewed towards the more complex or comminuted fractures and we feel that the indications for choosing interlocking nails as the method of fixation are appropriate.

Insertion of the femoral interlocking nail is a technically difficult procedure and there is a learning curve involved. Leg length discrepancy was our most common complication. The length should be adjusted by traction before the start of the operation and assessed and adjusted again before insertion of the distal screws.

In conclusion, we find that the femoral interlocking nail is an effective method and is the treatment preferred in managing complex femoral shaft fractures.

References

1. Winquist RA, Hansen ST, Clawson DK. Closed Intramedullary Nailing of Femoral Fractures. *J Bone Joint Surgery* 1984;66A : 529-39.
2. Kempf I, Grosse A, Beck G. Closed Locked Intramedullary Nailing: Its Application to Comminuted Fractures of the Femur. *J Bone Joint Surgery* 1985;67A : 709-20.
3. Wiss DA, Fleming CH, Matta JM, Clark D. Comminuted and Rotationally Unstable Fractures of the Femur treated with an Interlocking Nail. *Clinical Orthopaedics* 1986;212 : 35-47.
4. Muller ME, Nazarian S, Koch P. The AO Classification of Fractures. Springer-Verlag, 1988.
5. Boyle M. Grosse and Kempf surgical technique. In: *Howmedica Surgical Technique*. Howmedica: Rutherford, New Jersey, 1984 : 2.
6. Thoresen BO, Alho A, Ekeland A, Stromsoe K, Folleras G, Haukebo A. Interlocking Intramedullary Nailing in Femoral Shaft Fractures. *J Bone Joint Surgery* 1985;67A : 1313-20.