

Extra Articular Distal Femoral Fractures in the Elderly Treated with Retrograde Nailing Using a Spiral-Locking Blade System

Abstract

Background: The number of elderly patients sustaining long bone fractures is increasing with the rise of elderly population in the western world. Management of distal femur fractures is particularly difficult due to osteoporosis and other associated comorbidities. The key to management would be by surgical stabilization, which allows early mobilization. This study was devised to look into the radiological outcome and complication rate in a series of elderly patients who were treated with retrograde nail using spiral locking blade system for extra articular distal femur fractures. **Materials and Methods:** This is a retrospective study of patients who have undergone retrograde nailing with spiral-locking blade for distal femoral fractures (extra articular) above the age of 70 years in a major trauma center from 2001 to 2015. Notes were assessed for postoperative complications; time to union and final postoperative followup radiographs were assessed for alignment using a scoring system. **Results:** Forty one patients with an average age of 80 years and an average followup period of 9 months were included. The mean radiological score at final followup was 10.34 (range 8–12), with no significant shortening in any of the patients. Thirty patients had excellent radiological score (>10) and 11 patients scored good (8–9). The difference in time to union between Group 1 – simple fracture pattern (3.42 months) and Group 2 – complex comminuted fracture pattern (4.74 months) was not statistically significant ($P = 0.072$). There were five delayed unions but no cutout or metal work failure. **Conclusion:** The retrograde femoral nail with distal spiral-locking blade system can be a good surgical option for the treatment of extra articular distal femoral fractures in the elderly with the possibility of early weightbearing.

Keywords: Distal femur fracture, elderly, retrograde nail, spiral-locking blade

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Introduction

The number of elderly patients admitted with long bone fractures is increasing with the rise of the elderly population in the western world. Management of distal femur fractures is particularly difficult due to osteoporosis and other associated comorbidities.¹ The key to management of these fractures is by surgical stabilization, thus allowing early mobilization.²⁻⁵

Intramedullary nail has the advantage of limited devascularization at the fracture site during surgical approach. Biomechanically, the central location of the intramedullary nail in the bone distributes the load more uniformly than an eccentric plate, hence acting as a load-sharing device.² However, the limitations are that when standard distal locking screws are used, they often fail to gain adequate purchase and cut out subsequently in the osteoporotic bones.^{2,4}

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We present a series of elderly patients with extra articular distal femoral fractures treated with retrograde distal femur nail (DFN) using spiral-locking blade system.

Materials and Methods

This is a retrospective study of patients who have undergone DFN with spiral-locking blade for extra articular distal femoral fractures above the age of 70 years, in one of the largest major trauma centers in the U.K., from 2001 to 2015. Patients treated with plating or other surgical techniques, patients younger than 70 years of age at the time of surgery, and patients with peri-prosthetic fracture around total knee replacement were excluded from the study. Patient notes and radiographs were reviewed and assessed for surgical details, postoperative complications, weight-bearing status, time to union, and outcome at the time of discharge.

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All fractures were classified as per AO classification and postoperative radiographs were assessed for alignment and time to union. Radiological union was defined as bridging callus in all four cortices on both anterior-posterior and lateral views. Clinical union was defined as the absence of pain at the fracture site at clinical review and able to weight bear without pain. Delayed union was defined as the absence of callus in any of the four cortices, over 3 months from the time of surgery. Nonunion was defined as no radiological signs of healing after 6 months of surgery.

The alignment of the distal femur was measured on preoperative and final postoperative followup radiographs. Shortening, varus-valgus, and antecurvatum-recurvatum were measured and are scored as shown in Table 1.⁶ Failure of fixation was defined as protrusion of nail into the knee and/or breakage or cutout of screws.

Implant design: Distal locking

The DFN is available as a titanium implant (Synthes, Umkirch, Germany).⁷ The spiral-locking blade for distal interlocking can be used in cases of osteopenic bone or pathologic fractures. The distal locking screw and spiral-locking blade are introduced with an attached external driver guide. A setscrew is introduced, which prevents bone in-growth into the nail and locks the spiral blade proximally providing a stable angle, and presses against the edge of the spiral blade preventing it from backing out.

Operative procedure

The surgery was performed on a radiolucent operating table with the patient in supine position and the knee flexed to 30°, with a leg roll beneath the knee to ease the insertion of the nail. Access for the retrograde nailing was obtained through transligamentar or medial parapatellar approach.

With the aid of image intensifier, the nail insertion site is identified using a guide wire, which is in the intercondylar notch just anterior to the femoral attachment of the posterior cruciate ligament. Strict central placement should be obtained to prevent malposition of the nail, and alignment must be checked in anterior-posterior and lateral views. A 12.5-mm entry reamer with flexible shaft is inserted over the wire to open the distal intramedullary space. After removal of the entry reamer, the reduction tool is used to aid in fracture reduction and to align the position of the guide rod centrally into the femur. In some cases,

intramedullary reaming was performed to enlarge the canal diameter 1–2 mm larger than the selected nail diameter. The intramedullary retrograde nail was then inserted over the guide pin. To achieve maximum stability, we used the widest diameter nail possible. The nail was locked with at least two interlocking bolts proximally, and distal locking was achieved with one standard screw, a spiral-locking blade, and an end cap.

All patients received supervised physiotherapy for mobilization while they were in the hospital. For the first 6 weeks, nonweight-bearing with early passive and gradual active range of motion of knee was encouraged. After 6 weeks, all patients were allowed to full weight bear as pain allowed. Patients were reviewed in the outpatient clinic at 2, 6, and 12 weeks and thereafter every 4–6 weeks if required with radiographs.

Results

There were 41 patients (14 males and 27 females) treated for distal femoral fractures using retrograde nailing with spiral-locking blade, with an average age of 80 years (range 70–96 years) in this study period. All fractures were extra articular, and for the purpose of this study, patients were divided into two groups using AO classification: Group 1 – simple fracture pattern (26 patients-type 33A1) and Group 2 – complex and/or comminuted fracture pattern (15 patients-type 33A2 and 33A3).

All patients were followed up until fracture union (clinical and radiological) with an average followup of 9 months (range 4–18 months). A hinged-knee brace was used in eight patients for 6 weeks. All fractures united at an average of 3.9 months (range 3–12 months). The average time for union in Group 1 was 3.42 months and Group 2 was 4.74 months. This difference in average time to union between the two groups was not statistically significant ($P = 0.072$). There were four delayed unions and one patient was initially diagnosed with nonunion; however, without any further surgical intervention, the fracture united by 12 months. All patients returned to previous mobility status at the time of discharge from clinic [Figures 1 and 2].

The mean radiological score at final followup was 10.34 (range 8–12) and none of the cases had shortening more than 0.9 cm (score 4) with an average of 0.6 cm. Thirty patients had excellent and 11 patients with good radiological score. The average distance of the fracture line

Table 1: Radiological assessment and scoring on final postoperative followup radiographs

Shortening		Varus-valgus		Antecurvatum-recurvatum		Total score	
Value (mm)	Points	Value	Points	Value	Points	Points	Outcome
0-9	4	0-3°	4	0-3°	4	10-12	Excellent
10-19	3	4-7°	3	4-7°	3	7-9	Good
20-29	2	8-12°	2	8-12°	2	4-6	Fair
>30	1	>12°	1	>12°	1	3	Poor

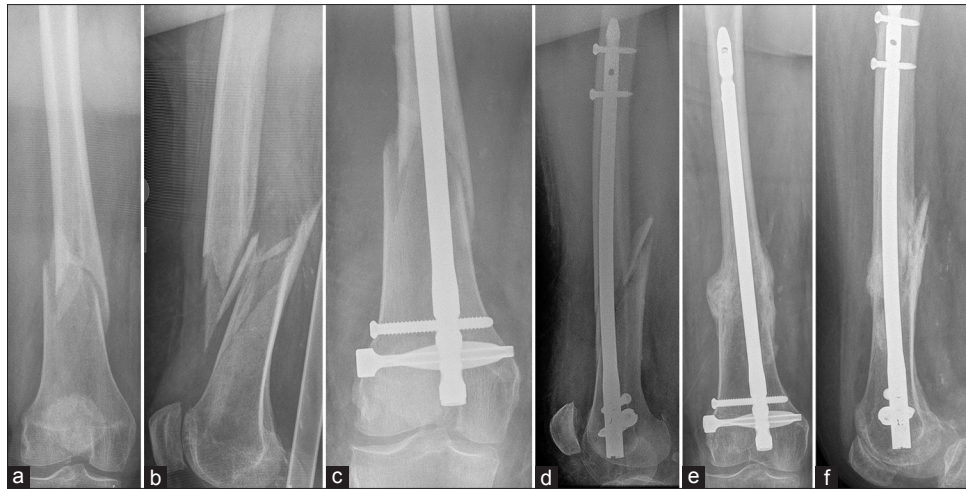


Figure 1: Preoperative (a and b), early postoperative (c and d), and final followup radiographs (e and f) of patient A from our series



Figure 2: Preoperative (a and b), early postoperative (c and d), and final followup radiographs (e and f) of patient B from our series

from the joint line was 10.4 cm (range 4–15.2 cm). The alignments postoperative ranged from 5° of varus to 16° of valgus and from 4° of procurvatum to 12° of recurvatum.

The influence of variables such as gender, type of fracture, nail length, and distance of the fracture from the joint line was assessed against the radiological scores and found not to be statistically significant. The distance of fracture within 10 cm (flare of the distal femur) of the knee joint had an odds ratio of 1.5, and similarly, type of fracture had a 2.8 odds ratio [Table 2].

Three patients had metal work protrusion below the intercondylar notch, but only one patient was symptomatic with a painful knee; however, no revision surgery was done. There was one superficial wound infection, which was successfully treated with antibiotics. None of the patients had any medical complication during the immediate postoperative period.

Discussion

The treatment of distal femoral fractures is quite challenging, especially in the elderly with poor quality of bone. Open reduction and internal fixation with either condylar blade plate or dynamic condylar screw has been the most frequently used implant in the past. However, the rigid internal stabilization with eccentric fixation led to a high incidence of complications including delayed union and implant failure. Plating techniques also generally require a larger exposure with its associated risk of soft-tissue damage, resulting in devascularization of bone fragments with a higher rate of infection and nonunion.^{5,8,9}

Intramedullary devices such as the DFN have the advantage of smaller surgical exposure, as compared to plating techniques, reducing the risk of infection. In this study, we did not observe any incidence of deep infection as shown by previous studies.⁵ However, studies including

Table 2: Comparing odds ratio between different groups/characteristics

Characteristics	Radiological score ≥ 10	Radiological score < 10	OR (95% CI)	P
Gender				
Male	8	6	0.3 (0.07-1.27)	0.10
Female	22	5		
Type of fracture				
Group 1	21	5	2.8 (0.67-11.59)	0.15
Group 2	9	6		
Nail length				
Long	18	10	0.15 (0.01-1.33)	0.09
Short	12	1		
Fracture distance (cm)				
< 10	11	3	1.5 (0.34-7.06)	0.57
≥ 10	19	8		

CI=Confidence interval, OR=Odds ratio

Christodoulou *et al.* have shown no difference in the outcome of retrograde nailing or condylar screw plate in the treatment of distal femoral fractures provided there is minimal soft-tissue injury during surgical exposure.¹⁰

Plating techniques such as minimally invasive percutaneous plate osteosynthesis and less invasive stabilization system are being used to reduce the soft-tissue trauma caused by traditional open methods and use indirect closed plate positioning to aid in reduction. These have demonstrated good functional outcome with reduced infection rates and implant failures.^{11,12} However, the soft-tissue dissection around the fracture site to position the plate and the risk of periosteal stripping and damage to vascularity in part still persist with the above methods. With the poor bone stock and thin cortical bone at the metaphysis in the elderly, despite the use of angular stable systems, it may still result in inadequate screw purchase and failure of implant.¹³

Traditional intramedullary nailing system using standard locking screws have shown to have poor bony purchase, leading to early implant failure. In this study, we did not observe any shortening or cutout of locking screws as reported by previous studies using standard locking screws.⁴ Three patients in our study had prominent distal tip of the femoral nail, and this was attributed to poor surgical technique rather than migration of the nail itself. The major mechanical advantage of DFN is the unique distal spiral-locking blade. The spiral-locking blade with a larger surface area is stiffer, providing more mechanical stability to the fracture fixation with better purchase compared to standard screws, and prevents cutout.^{2,11} The set screw further reinforces and stabilizes the construct.¹⁴⁻¹⁶ Similarly, some studies using intramedullary devices with more than two distal locking screw options have not reported any mechanical failures or screw cutouts and a good clinical outcome due to the increased distal purchase.^{6,17} All our

patients were full weight-bearing at 6 weeks, whereas it might not be possible to allow early weight bearing with plating techniques.

Some of the patients in our study had a radiological score < 10 , suggesting a less than excellent radiological outcome. As expected, the patients with complex fractures (Group 2) had a higher odds ratio [Table 2]. Although this device provides good rigidity compared to traditional nails, comminution in complex fractures (Group 2) may have an increased tendency for toggle at the fracture site, resulting in increasing tendency for malalignment.

Malunion is a well-recognized complication of femoral fractures. A large prospective study by Ricci observing 355 patients showed the incidence of malalignment was 10% in distal third femoral fractures.¹⁸ No studies in literature have so far shown if malalignment is related to the type of fixation. The anatomical flare of the distal femur results in increase bone-nail ratio and longer standard distal locking screws, which allow a degree of toggle of the distal fragment contributing to more instability.¹⁹

The concept of retrograde intramedullary nailing in the distal femoral fractures was developed in an attempt to overcome the limitations of antegrade nailing and reduce some of its shortcomings.^{18,20} However, retrograde nailing has not been as popular as antegrade nailing due to the technical difficulty in using proximal screws as well as inadequacy of bone hold to use standard distal locking screws in osteoporotic fractures. The technical issues with proximal locking can lead to higher risk of neurovascular injury. We have not encountered any such complication; as with adequate surgical care, such complications can be avoided. There is still concern that invading normal knee joint can lead to damage to the chondral surface or ligament injuries, and in the elderly, this type of treatment may be a viable option as there is usually a degree of preexisting arthritis in the knee.

This study has the weakness of any retrospective study as all patients were reviewed retrospectively. There may be an element of selection bias, and we did not objectively access the patients with a functional scoring system.

Conclusion

The retrograde nails (DFN) using the distal spiral-locking blade screw can be a good surgical option for the treatment of extra articular distal femoral fracture in the elderly with the possibility of early weight-bearing.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published, and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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