



Expanding nail or expanding femur? An adverse event with the expandable intramedullary nail

Soham GANGOPADHYAY, Nicholas D. RILEY,* Chellappan K. SIVAJI

Department of Orthopaedics and Trauma, Southend Foundation Hospital NHS Trust, Essex;

**Royal National Orthopaedic Hospital, Stanmore, both in England*

The expandable intramedullary nail is self-locking and has the advantage of reducing operating time and exposure to ionizing radiation. The nail is recommended for simple diaphyseal fractures involving the middle third of long bones, where the nail can bypass the fracture site by at least 5 cm. We encountered a unique complication with the expandable nail in a simple transverse shaft fracture at the junction of the middle and distal third of the left femur in an otherwise healthy 57-year-old man. The fracture was reduced and a 12-mm expandable nail was inserted. Following full expansion, intraoperative radiographs were obtained prior to closure. After six postoperative weeks, it was noted that the nail expanded the femoral canal, converting a simple fracture to a distally progressing comminuted fracture with a butterfly fragment. A review of the intraoperative radiographs showed slight widening of the medullary canal at the level of the fracture. As the alignment was satisfactory and callus was present, no further surgical intervention was considered. The patient was advised not to bear weight and was provided with a locked knee brace in extension to wear for six weeks. Radiographs at 12 weeks demonstrated good progress of healing with adequate callus and the patient was permitted to bear weight as tolerated and commence knee flexion. The fracture united satisfactorily at four months. This adverse experience emphasizes that caution should be exercised when expanding the nail, with close observation of the medullary canal diameter during the later stages of expansion.

Key words: Bone nails/adverse effects; femoral fractures/surgery; fracture fixation, intramedullary.

Intramedullary interlocked nailing is the standard accepted treatment for closed diaphyseal fractures of the femur.^[1] The expandable femoral nail (The Fixion Nailing System, N.M.B. Medical Applications Ltd., Israel) does not require locking and therefore reduces operating time and exposure to ionizing radiation. It has been used successfully to treat femoral shaft fractures.^[2,3] We have used the expandable nail for simple diaphyseal long bone fractures with good results.

We report on a previously undescribed complication of the expandable nail in the femur.

Case report

A 57-year-old man fell from a ladder onto a concrete floor, landing on his left side. He sustained a closed transverse fracture at the junction of the middle and distal third of his left femur (Fig. 1a, b). He had no other injuries and there was no significant past medical history. On examination, there was swelling and deformity at the fracture site with no evidence for distal neurovascular compromise.

The injured lower limb was protected in a Thomas splint and the patient was taken to theater for intramedullary nailing. He was a suitable candidate for

expandable femoral nailing, as he had a simple transverse femoral shaft fracture, more than 5 cm proximal to the distal femoral metaphysis.^[3]

The fracture was reduced and the nailing commenced through the tip of the greater trochanter in the usual fashion. The medullary canal was reamed to 14 mm and a 12-mm expandable nail was used, as per manufacturer's recommendations that the nail should have the ability to expand at least 1 mm. The nail was inserted easily and expanded in accordance with the manufacturer's instructions. The expansion was continued until the indicator needle in the pressure gauge was maintained between 50 and 70 bar. At no stage was the maximum permissible pressure of 70 bar exceeded. Following full expansion, intraoperative radiographs were obtained prior to closure (Fig. 1c, d).

The patient was discharged 72 hours postoperatively partially weight bearing with crutches. He was reviewed at six weeks following surgery. Radiographs revealed new comminution progressing distally from the initial fracture site with a posterior butterfly fragment (Fig. 1e, f). Early callus formation was evident,

indicating that the event had taken place shortly after the operation. There had been no further trauma during this time. A retrospective review of the intraoperative radiographs in comparison with the preoperative X-rays revealed evidence for slight widening of the medullary canal at the level of the fracture (Fig. 1d).

As the alignment was satisfactory and callus was present, no further surgical intervention was indicated. The patient was advised not to bear weight and was provided with a locked knee brace in extension to wear for six weeks. Radiographs at 12 weeks demonstrated good progress of healing with adequate callus and the patient was permitted to bear weight as tolerated and commence knee flexion. The fracture united satisfactorily at four months (Fig. 1g, h). There was some residual knee stiffness, which steadily resolved.

Discussion

The expandable femoral nail is a stainless steel cylindrical nail that is folded longitudinally. Following insertion, it is hydraulically inflated with normal saline using a custom pump with a unidirectional valve. The



Fig. 1. (a, b) Preoperative radiographs of the left femur. (c, d) Intraoperative radiographs. Note expansion of the medullary canal at the level of the fracture in the right view. (e, f) Postoperative radiographs at six weeks showing a widened medullary canal, secondary comminution progressing distally from the fracture site, and early callus. (g, h) Postoperative radiographs at four months. Union has been achieved.

pump can generate a pressure of up to 70 bar and expands the nail diameter by up to 50%. This forces the four longitudinal external bars of the nail against the cortical and cancellous bone to mimic the medullary canal. Self-locking is thus effected. The large frictional contact is said to prevent localized pressure peaks and the ridges of the longitudinal bars provide rotational stability.^[4] The rigidity of the inflated nail to manual deformation is equivalent to the resistance of a fully sealed metal can. The principal advantage is that it eliminates the need for locking, which in turn reduces operating time and exposure to ionizing radiation. In a series of 43 patients with femoral shaft fractures (32A or 32B, AO classification^[5]) treated with the expandable nail, clinical union was achieved after an average of 3.8 months and no complications were reported.^[2] In another series of eight femoral shaft fractures, the average time to union was five months.^[3] Three technical complications were reported. In one patient, the threaded end of the insertion handle was broken during removal and remained inside the nail. In another, there was leakage of saline through the nail, which prevented expansion and the nail had to be replaced. A third patient sustained further trauma and fractured the expandable nail at two months following insertion. The nail was extracted without difficulty after removal of the saline and was replaced with a conventional interlocking nail. The authors recommended that the expandable nail be used only where the nail could bypass the fracture site by at least 5 cm and advised caution when using this device for fractures with a third fragment (AO type B). In another series of 48 surgeries, six complications were encountered: two nonunions (humerus and tibia), one broken nail, one deflation, intraoperative occurrence of a new longitudinal fracture during the inflation of the nail in a patient with osteogenesis imperfecta, and new fracture occurrence in the postoperative period.^[6]

The expandable nail has been successfully used for treating humeral shaft fractures in elderly patients with poor bone quality.^[4] It has also been used for pathological humeral shaft fractures.^[7] The weakened cortical bone in these patients withstood the nails' expansion forces at the maximum inflation pressure of 70 bar and no secondary fractures were reported.

The patient described in this case report had normal bone density for his age with no preexisting comorbidity. He had a simple transverse fracture, which

satisfied the criteria for an expandable nail. We opted for a trochanteric rather than a piriform fossa entry point recommended by the manufacturer. We feel that this technique would not contribute to the comminution at the fracture site as the manufacturer states that fixation is achieved along the entire length of the nail and that the nail adapts itself to the contours of the medullary canal.^[8] Even under close scrutiny, there was no undisplaced comminution on the initial preoperative radiographs. If present, this would explain the intraoperative events. It was thought that the expandable nail enlarged the femoral medullary canal, resulting in a secondary fracture.

Following our experience, we suggest that the diameter of the medullary canal should be closely observed during the later phases of nail expansion. As the nail expands to self-lock, the indicator needle of the pressure gauge should remain steady between 50 to 70 bar. However, if there is any evidence for canal expansion after the longitudinal bars of the nail are flush with the cortex, further expansion of the nail should be discontinued.

References

1. Starr AJ, Bucholz RW. Fractures of the shaft of the femur. In: Bucholz RW, Heckman JD, editors. *Rockwood & Green's fractures in adults*. Vol. 2, 5th ed. Philadelphia: Lippincott, Williams & Wilkins; 2001. p. 1683-730.
2. Lepore L, Lepore S, Maffulli N. Intramedullary nailing of the femur with an inflatable self-locking nail: comparison with locked nailing. *J Orthop Sci* 2003;8:796-801.
3. Pascarella R, Nasta G, Nicolini M, Bertoldi E, Maresca A, Boriani S. The Fixion nail in the lower limb. Preliminary results. *Chir Organi Mov* 2002;87:169-74.
4. Franck WM, Olivieri M, Jannasch O, Hennig FF. Expandable nail system for osteoporotic humeral shaft fractures: preliminary results. *J Trauma* 2003;54:1152-8.
5. Muller ME, Nazarian S, Koch P, Schatzker J, editors. *The comprehensive classification of fractures of long bones*. Berlin: Springer-Verlag; 1990.
6. Öztürk H, Ünsaldı T, Öztemur Z, Bulut O, Korkmaz M, Demirel H. Extreme complications of Fixion nail in treatment of long bone fractures. *Arch Orthop Trauma Surg* 2008;128:301-6.
7. Franck WM, Olivieri M, Jannasch O, Hennig FF. An expandable nailing system for the management of pathological humerus fractures. *Arch Orthop Trauma Surg* 2002; 122:400-5.
8. N. M. B. Medical Applications Ltd. (Disc-O-Tech). Fixion IM. Available from: <http://nmb-med.com/?CategoryID=174>.