INTRAMEDULLARY LOCKING NAILS IN THE MANAGEMENT OF FEMORAL SHAFT FRACTURES

J. CHRISTIE, C. COURT-BROWN, A. W. G. KINNINMONTH, C. R. HOWIE

From the Royal Infirmary of Edinburgh

Intramedullary locking nails have proved to be of considerable advantage when treating complex, comminuted or segmental femoral shaft fractures. We have reviewed 117 patients with 120 femoral shaft fractures treated with the Strasbourg device. These included 20 compound fractures, 13 pathological fractures and two non-unions. Rehabilitation and union rates have been very satisfactory and there have been no serious infections in the series. Communion of the proximal femur has occurred in six patients and there have been three femoral neck fractures, but all of these have healed without further complications.

A number of femoral shaft fractures have in the past been considered unsuitable for nailing because of comminution or because the fracture was too proximal or too distal. The available methods of fixation have not been able to provide adequate stabilisation, and many surgeons have therefore used traction and cast bracing.

The development of Küntscher's (1967) closed rodding technique, the closed intramedullary nailing of Winquist, Hansen and Clawson (1984), and the introduction of locking nail systems (Klemm and Schellman 1972; Kempf, Grosse and Lafforgue 1978; Huckstep 1979), have now made it possible to provide excellent stabilisation of almost all femoral shaft fractures (Fig. 1), however comminuted and at whatever level between the lesser trochanter and the condyles.

This ability to fix complex shaft fractures makes it necessary to assess the indications, advantages and complications involved, and in this article we present our experience of treating femoral shaft fractures with the Strasbourg locking intramedullary nail system (Kempf, Grosse and Lafforgue 1978).

MATERIAL AND METHODS

One hundred and twenty femoral fractures in 117 patients were treated with locked intramedullary nails in the Edinburgh Royal Infirmary Trauma Unit between the end of 1983 and 1986. Of these 120 fractures, 105 were secondary to trauma, two were non-unions in previously conservatively treated fractures and 13 were pathological fractures. There were 75 men in the series with a mean age of 33 years (range 16 to 83 years) and 42 women with an average age of 65 years (16 to 95 years).

Most of the fresh fractures, including the majority of the compound fractures, were nailed within the first 12 hours after admission. When nailing was delayed beyond this period skeletal traction of 25 or 30 lb was applied to maintain length and facilitate operative reduction later. Surviving patients were followed up (average 17 months, range 6 to 28 months) until rehabilitation was complete and the fracture united or until the nail was removed. Eight patients moved to other parts of the country but the final outcome was established by correspondence with their local orthopaedic service.

We used the classification of Winquist et al. (1984) to describe comminution of the fractures. Type I has no significant comminution and there is cortical integrity around the circumference of the fracture. Type II has more than 50% cortical integrity at the fracture site and is potentially unstable while Type III with less than 50% is rotationally unstable. Type IV has extensive comminution and has therefore no longitudinal or rotational stability.

Operative technique. The closed technique described by Winquist et al. (1984) was used in 91 patients. The patient lies supine on the traction table and a distal femoral Steinmann pin is inserted. Slight adduction of the injured leg allows access to the greater trochanter. The contralateral leg is flexed to 90° at the hip and knee, abducted to 30° and secured on a support (Fig. 2). A back rest is placed against the ipsilateral chest wall and flexes the trunk towards the unaffected side. This prevents the patient being pulled around the perineal post and stabilises the position of the pelvis.

The wound was left open during the nailing procedure in 17 of the compound fractures which were
rodded on the day of injury, and in 10 of the pathological fractures which required open biopsy and additional stabilisation with bone cement, the fracture was exposed at operation. Transfixion or locking screws were placed through the proximal end of the nail for proximal fractures (18 patients) and distal screws for distal third fractures (32 patients). A static lock (when transfixion screws are used both proximally and distally) was used for all Type III and IV fractures, whatever their site (44 patients). In addition, where there was an oblique proximal or an oblique distal fracture a static lock was used as these fractures are liable to rotate and shorten. Segmental fractures and pathological fractures also required a static lock. Early in the series the closed technique was augmented by a limited exposure of the femur in four patients, but this is seldom now required.

There were 20 compound fractures of which eight were Type I, four Type II and eight were Type III. All but three of these fractures were nailed on the day of injury and were dealt with in two stages. First the wound was excised meticulously; copious irrigation was used and the wound left open unless the skin edges fell together easily. Then the patient was placed on an orthopaedic table and routine closed nailing performed. Three compound fractures were nailed between 2 and 10 days after the initial wound excision. Figures 3, 4 and 5 show a severe comminuted Type III compound fracture that was fixed with an intramedullary nail with proximal and distal transfixion screws (static lock). The fracture was extensively grafted on the day of injury and pig skin was used as a primary dressing on the wound. Split-skin grafting was undertaken after 36 hours and the fracture subsequently united with incorporation of the bone graft and with 90° of flexion at the knee.

Most operations were accomplished within an hour and a half of the initial skin incision; only three took longer than 150 minutes and these were all early in the series. The majority of procedures now take little more than one hour.

Forty-six patients had multiple injuries, including 17 with head injuries requiring either urgent decompression or intracranial pressure monitoring. A further two patients had unstable spinal injuries. The majority of these 46 patients had femoral nailing within 14 hours of injury.

After care. Postoperatively, the patients were placed on a knee mobiliser and most achieved over 90° of flexion within 48 hours. Once they had regained quadriceps control the patients were allowed to take partial weight using crutches, provided other injuries did not preclude this. All patients were seen by one of the authors as outpatients and assessed with regard to late complications, knee flexion, mobility and evidence of union of the fracture.

RESULTS

In the traumatic fractures the time to bony union averaged 17 weeks with a range of 10 to 28 weeks. Union was considered to have occurred when the fracture site was painless and there was radiographic evidence of continuous external bridging callus.

The majority of patients achieved at least 130° of knee flexion though after the more distal fractures flexion was sometimes restricted for several months.
Weight-bearing was allowed early in the more stable fractures, most of which had dynamic fixation with a cross-screw at one end of the nail. With the more comminuted or unstable fractures weight-bearing was not allowed for 4 to 14 weeks.

Pathological fractures (mainly through secondary deposits from breast, lung and kidney) mostly required static fixation; seven required additional stabilisation with bone cement. This allowed early mobilisation, and gave satisfactory relief of pain. There were no implant failures despite the underlying pathology. All of these patients required postoperative radiotherapy.

One patient with a subtrochanteric fracture secondary to severe Paget's disease was stabilised by a nail and an oblique proximal screw. Despite protected weight-bearing the screw fractured and the nail cut out of the proximal fragment. The nail was therefore removed and a Richards' screw substituted.

Of the two patients with non-union one healed in 18 months. The other, who had a segmental Type III compound fracture, remains unhealed at 19 months; this patient continues to mobilise but in view of her age and condition no further action is proposed.

Complications

Infection. There were no bony infections in the series but there was one superficial wound infection which required excision and drainage. Fourteen patients had prolonged seepage from the suction drain site after the drain had been removed and four of these had a positive culture; all dried up within two weeks without specific treatment. It was thought that this serous discharge might be due to the drain being placed close to the proximal end of the nail and that this encouraged drainage from the medullary cavity to persist. We now place the drain in the subcutaneous layers and excessive drainage has proved to be less of a problem.

Comminution of the proximal fragment during insertion of the nail occurred in six patients. In each case it was due to the starting point for nail insertion being too far lateral in the greater trochanter, causing an oblique insertion. Static fixation was used to control the instability caused by this comminution and all these fractures healed without delay.

Delayed union occurred in two patients; one required stabilisation with a larger nail after further reaming of the medullary canal; the other was bone-grafted and cross-screws were inserted to provide rotational stability. Both fractures healed within three months of operation.

Implant failure. Two nail fractures occurred, both at the proximally placed junction of solid and slotted portions of the nail. This is recognised as an area of increased stress and a weak point in the device. Neither patient's progress was hindered and their fractures healed satisfactorily. Three other nails showed stress lines at the same site after removal of the nail which would presumably have fractured if there had been delay in fracture healing.

Shortening of more than 2 cm developed in two patients. They had unstable spiral distal fractures that were treated with a dynamic lock (distal screws only) when a static lock (screws at each end of the nail) would have been more appropriate.
Femoral neck fracture. Three patients, all women with relatively small medullary cavities, developed femoral neck fractures after insertion of the nail. None of these fractures had been visible on the initial radiographs and they were probably caused by the force required to drive the nail into the reamed femur. These fractures were treated with multiple AO cancellous screws placed around the proximal end of the nail, and all healed within three months.

Lateral rotation deformity. A 15° lateral rotation deformity developed in one patient.

Pudendal nerve neuropaxia. Three patients complained of perineal paraesthesia, but all three resolved within three months. This paraesthesia was thought to be due to pressure from the perineal post on the terminal branches of the pudendal nerves when traction is applied to the injured leg.

One patient fell off the operating table, but did not sustain a significant injury. A back rest is now routinely placed against the ipsilateral chest wall and this serves to stabilise the patient.

Deaths. One patient, with multiple carcinomatosis, died on the operating table. Three other elderly patients died within four months of the operation, but from causes unrelated to their femoral fracture.

DISCUSSION

In 1897 Nicolaysen described the principles of intramedullary nailing and it is sad that both he and later Hey Groves (1922), who was the first to use massive intramedullary nails, were prevented from achieving greater success by the inferior quality of metal that was available to them. Gerhard Küntscher (1967) had the benefit of stainless steel and became not only the foremost exponent of femoral nailing but the pioneer of the closed nailing technique, and there is no doubt that this method has stood the test of time. Winquist et al. (1984), Willenegger, Perren and Schenk (1971) and others have amply demonstrated the remarkable results that can be achieved using this technique. The development of the locking nail system has allowed extension of closed nailing to fractures that were not previously considered appropriate for intramedullary fixation, and this has added very significantly to the usefulness of the closed technique. Our own results confirm that most femoral shaft fractures can now be handled by closed intramedullary nailing, and so far without serious late complication. We are aware that Smith (1964) experienced a very high incidence of infection when treating open compound shaft fractures by primary intramedullary nailing, but in our experience early nailing of compound femoral fractures has been surprisingly trouble-free.

It may well be that the routine administration of prophylactic cephalosporins has contributed to the reduction in the incidence of infection. Winquist et al. (1984) also report very low infection rates in their large series of closed intramedullary nailing procedures, which included a large number of compound fractures. Over the years they have changed from a policy of delayed nailing of compound fractures to nailing on the day of injury. It has been gratifying in our series that there has been no serious infection and that none of the compound fractures, many of which were serious Type III injuries, developed osteomyelitis.

Various reports in the literature suggest that early surgery after injury protects against the development of the adult respiratory distress syndrome (Border, La Duca and Seibel 1975; Goris et al. 1982; Riska and Myllynen 1982). Though this may not be definitively established, it is generally accepted that early intramedullary fixation of long bones after multiple injury does not predispose the patient to the adult respiratory distress syndrome or to fat embolism. None of our 42 patients with more than one long bone injury have developed either a florid fat embolus syndrome or the adult respiratory distress syndrome.

Closed femoral nailing under image intensification does not introduce any great risk of irradiation to the staff, particularly with the newer equipment. So long as adequate reduction can be achieved on the operating table before surgery begins it is usually fairly easy to pass the guide wire across the fracture site by feel and without the need for repeated x-ray visualisation. The insertion of distal transverse transfixion screws does involve some increased exposure to irradiation, though this is small, and the "freehand technique" should be practised with lead glove protection to minimise the risk.

Perhaps the most worrying complications in our series have been the three femoral neck fractures which required internal fixation. We believe they were caused by an inappropriate choice of site for insertion of the nail into the trochanter. It is important to avoid an oblique insertion which may cause relative jamming of the nail. Winquist et al. (1984) believed comminution of the proximal fragment to be related to insertion of the nail into the tip of the greater trochanter and they now introduce the device into the piriform fossa. We believe that the optimum site of insertion is variable but can be determined by careful inspection of the pre-operative radiographs. Should there be any doubt at the time of surgery a hand-held reamer can be inserted into the medullary canal and its position and direction visualised on the image intensifier screen.

Conclusions. Continuous traction is rarely used now in our department for the treatment of adult femoral shaft fractures and we believe that early closed nailing, with locking screws to enhance stabilisation, is the method of choice. The operation is somewhat complex and requires considerable experience, but the excellent stabilisation and rapid mobilisation that can be achieved offer considerable advantages.
REFERENCES


