FEMORAL SHAFT FRACTURES TREATED BY ENDER NAILS USING A TROCHANTERIC APPROACH

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We describe the use of Ender nails for the internal fixation of femoral shaft fractures by a closed technique via the greater trochanter and report the treatment of 100 patients with 106 fractures, of which 88 were reviewed 12 months or more after operation. There was primary union in 85 fractures (96.6%) and significant angulation, rotation or leg length discrepancy in eight (9%). We discuss the principles of management which we have evolved.

The use of intramedullary nails is now widely accepted as the ideal form of internal fixation of femoral shaft fractures. It was not until the last decade or so that the benefit of closed prograde intramedullary nailing was acknowledged, adding fresh impetus to the popularity of this technique (Böhler 1968; Clawson, Smith and Hansen 1971; Rascher et al 1972; Rothwell 1982; Winquist, Hansen and Clawson 1984).

Ender and Simon-Weidner (1970) first reported the use of multiple flexible nails for the fixation of intertrochanteric and subtrochanteric fractures by a medial supracondylar approach. This was later extended to femoral shaft fractures by the same approach (Eriksson and Hovelius 1979; Pankovich, Goldflies and Pearson 1979; Muckle and Siddiqi 1982). We encountered a high incidence of postoperative knee problems, so we developed a trochanteric approach. Our method can be used for a wide range of fractures of the femoral shaft, including simple, comminuted or segmental injuries extending from the subtrochanteric to the supracondylar regions (Fig. 1). The method is comparatively easy and quick and requires little specialised instrumentation.

PATIENTS, MATERIALS AND METHODS

From June 1984 to December 1986, 100 patients with 106 femoral shaft fractures were treated by internal fixation with Ender nails at Groote Schuur Hospital, Cape Town. On admission the patient was placed in heavy skeletal traction (9 kg) in a Thomas' splint. Surgery was performed on the next available operating list provided the patient was fit for anaesthesia.

The indications for operation were unacceptable fracture alignment, and the desire to rehabilitate the patients as soon as possible. We recorded details of all femoral shaft fractures treated in this way from 75 mm below the tip of the greater trochanter to 45 mm above the intercondylar notch as measured from the most proximal or distal extent of the fracture. The surgery was performed by seven specialists and 13 registrars with varying surgical expertise.

Classification of fractures. A classification based on that described by Pankovich et al (1979) and Tencer et al (1984) was adopted in order to rationalise the postoperative management (Fig. 2).

Type A: Bicortical contact. Simple transverse or short oblique fractures with bicortical contact which maintained longitudinal and lateral stability.

Type B: Unicortical contact. Fractures with a butterfly fragment and/or unicortical comminution maintaining longitudinal but not lateral stability.

Type C: No cortical contact. Comminuted or long oblique fractures, with no cortical contact and thus no longitudinal or lateral stability.

Operative technique. Under general anaesthesia, the patient is placed supine on an orthopaedic traction table in a 'wind-swept' position, making the trochanter of the fractured limb prominent. The foot of the same side is raised maximally and the contralateral leg is depressed maximally (Fig. 3) to facilitate the lateral fluoroscopic view of the proximal femur. The traction is applied either through the existing skeletal traction pin and stirrup or via the boot of the orthopaedic table.

The fracture is reduced under image intensification.
A simple transverse fracture (a) and a segmental fracture (b) of the femoral shaft treated by closed reduction and internal fixation by prograde Ender nails.

If closed reduction is not possible an additional limited open reduction is performed. Through an 8 to 10 cm direct lateral approach, the trochanteric bursa is exposed. An AO awl is used to broach the trochanter near its tip and the hole enlarged to about 2 cm by 1 cm with a bone nibbler. The correct length of nail is selected by using the image intensifier and its end is bent appropriately according to its destination in either the medial or lateral femoral condyle. The first nail is then inserted and passed down the medullary canal to just short of the fracture. Manual reduction then allows the nail to be insinuated into the distal fragment, its tip ending in the posteromedial aspect of the medial femoral condyle. The next nail is similarly introduced and is directed into the lateral femoral condyle and subsequent nails are inserted alternately into medial and lateral condyles. After the introduction of the first nail, the traction is released to minimise the tendency to distraction at the fracture site. The number of nails introduced depends upon the capacity of the medullary canal but more than four are rarely necessary for adequate fixation. The use of the image intensifier during introduction is imperative as cortex perforation or penetration at the fracture site can easily be missed.

The wound is washed out and a suction drain inserted. Antibiotics are reserved for 'high risk' cases only. At completion of the operation, the knee is gently flexed through as full a range as possible.

Postoperative management. The postoperative management is determined by the fracture configuration.
Type A: The fractured limb is elevated, free, on a foam rubber pillow (Fig. 4), and physiotherapy is started immediately, aiming at active straight leg raising and knee flexion to 90° as quickly as possible. Walking with partial weight-bearing is started when leg control is achieved.

Type B: The immediate postoperative management is the same as for Type A fractures, but when leg control is achieved, a cast brace is applied to lend additional lateral stability before the patient is allowed to take partial weight.

Type C: In view of the loss of longitudinal stability, traction is maintained for 3 to 4 weeks, but physiotherapy is as for Types A and B. When the traction period is complete, a cast brace is applied and the patient is allowed up with partial weight-bearing.

RESULTS

Of the 100 patients with 106 fractures, one patient aged 64 with an abbreviated injury score (AIS) of 41 died six weeks postoperatively of septicaemia related to a severely disrupted compound pelvic fracture. Of the 99 remaining patients, with 105 fractures, 17 were lost to follow-up; thus 88 fractures were available for review at least 12 months postoperatively.

The fracture sites ranged from 75 mm from the tip of the greater trochanter to within 45 mm of the intercondylar notch. Eight patients had segmental fractures and nine of the 106 femora had compound fractures. Of all the fractures 93 were reduced and internally fixed by closed prograde means but 13 required limited open reduction because of either muscle interposition or wide separation of loose butterfly fragments.

The procedure, excluding time for anaesthetic induction and positioning on the fracture table, took an average of 50 minutes. Average blood loss was 150 ml, being 130 ml (50 to 250 ml) for closed reduction and 350 ml (100 to 800 ml) when additional open reduction was necessary.

The average hospital stay was 27 days but taking account of concomitant injuries, the average was 21 days for those with an AIS of 18 or less and 35 days for those with an AIS over 18 (Fig. 5).

Union occurred in all but three fractures (96.6% union). Two of the three failures had successful onlay bone grafting and the third had a painless fibrous pseudarthrosis with no loss of function: he declined any further operation.

One case of infection presented some three months after the initial surgery, but this responded to drainage, debridement and antibiotics. There was complete resolution of the infection, solid bone union with the nails in situ, and the range of knee movement was 0° to 135°.

At final review the range of knee movement was over 100° in all cases, as shown in Figure 6. Twenty-six patients showed some femoral angulation, but only four
had angulation or rotation in excess of 10°. Leg length discrepancy of over 10 mm occurred in four patients, all with Type C fractures. One femur was 15 mm long, due to the interposition of a bony fragment and the remaining three were 25, 30, and 45 mm short respectively.

There was trochanteric discomfort in 21 patients: 13 settled spontaneously, requiring no further treatment, seven responded to the removal of protruding nails and one settled after injection of local anaesthetic and steroid.

DISCUSSION

Until 1982, the use of Ender nails was largely confined to intertrochanteric and subtrochanteric fractures (Böhler 1972; Kuderna, Böhler and Collon 1976; Corzatt and Bosch 1978; Chapman et al 1981; Hall and Ainscow 1981), although a few papers reported their use for the fixation of shaft fractures (Pankovich et al 1979; Eriksson and Hovelius 1979; Muckle and Siddiqi 1982), and pathological fractures (Katzner et al 1976).

Our experience with the medial condylar approach was unsatisfactory because postoperative knee stiffness and nail protrusion were very real problems; this led us to change to the trochanteric approach. Some important details emerged during our experience.

**Before operation.** Skeletal traction of at least 9 kg is necessary to overcome any tendency to shortening (Winquist et al 1984). This makes excessive operative traction unnecessary and decreases the risk of perineal injury (Hofmann, Jones and Schoenvogel 1982; Lindenberg, Fleming and Smith 1982). The narrowest diameters of the femoral canal in the AP and lateral projections of standard radiographs are measured. This gives a rough idea as to the number of nails that the femoral canal can be expected to accommodate.

**At operation.** It is important to contour the nail to suit its destination; a nail passing into the medial femoral condyle must be the shape of an elongated S (Fig. 7). Late in our series, fractures with butterfly fragments (Type B) and comminuted fractures (Type C) were sometimes treated by open reduction and the application of Partridge bands (Fig. 8) (Hägglund, Lidgren and Nordström 1982). This did not significantly increase morbidity and greatly reduced the problem of shortening, thus providing an attractive alternative to locking nail systems.

Radiographic review showed that the final position of the femur was the position attained at the time of fixation, in contrast to reported experience with subtrochanteric and intertrochanteric fractures. Great care should therefore be taken to assess the rotational position of the proximal and the distal fragments and to correct varus, valgus, anterior and posterior angulation at the time of insertion of each nail. If there is distraction at the fracture, traction should be released as soon as the first nail has crossed the site, and before it is finally ‘driven home’.

**After operation.** Once dressings have been applied, the knee should be flexed through as full a range of movement as possible. Postoperative management was devised empirically to suit each type of fracture; a flexible commonsense approach is advised.

Trochanteric discomfort resulted from either protruding nails or disturbance of the bursa. The incidence was minimised by ensuring that nails were buried within the trochanter and by modifying the approach to a more proximal mini-Harding type of incision in the gluteus medius tendon and entering the bone near the tip of the trochanter.
We have applied this method of fixation to a wide range of fracture types and levels. Segmental fractures are highly suitable since torsion of the loose fragment is eliminated. We were surprised by the versatility of the technique, finding that it provided a solution to many fractures that would have been difficult to fix internally by any other method.

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