TREATMENT OF FRACTURES OF THE DISTAL THIRD OF THE FEMUR

A PROSPECTIVE TRIAL OF THE DERBY INTRAMEDULLARY NAIL

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We report a prospective study of 26 cases of fracture of the distal third of the femur treated with the Derby intramedullary nail. This new design controls rotation and allows compression of the fracture, permitting early weight-bearing.

All the fractures united in good position within four months, 12 of them with minimal external callus.

There were no implant failures and the only serious complication was one case of deep infection.

Fractures of the distal third of the femur are difficult to treat by conventional methods of internal fixation. This is particularly true in elderly patients in whom fractures through the thin cortex of an osteoporotic femur are common. In this region the femur has a wide medullary canal which does not allow a standard femoral nail to provide rotatory stability. Intramedullary nails have been designed with holes through which screws may be inserted in order to control rotation. The siting of these screws requires complex jigs or aiming devices (Kempf, Grose and Beck 1985).

Rigid plates, which can provide compression at the fracture, may produce local osteopenia (Semb 1966; Uththoff and Dubuc 1971) as a result of stress shielding or disturbance of the blood supply; this may lead to refracture after removal of the plate (Chrisman and Snook 1968). The thin distal cortex limits the grip of screws and this has led to the development of specially designed plates (Müller, Allgöwer and Willenegger 1965; Slätis, Ryöppy and Huittinen 1971). These are technically difficult to use and may fail when early weight-bearing is allowed (Winquist and Frankel 1978). The removal of screws used with plates or nails leaves cortical defects which act as local stress raisers, weakening the femur particularly in relation to torsional forces and possibly also resulting in refracture (Bechtol 1952; Brooks, Burstein and Frankel 1970; Burstein et al. 1972).

Because of the problems of operative treatment, surgeons have tended to manage these fractures conservatively (Stewart, Sisk and Wallace 1966; Neer, Grantham and Shelton 1967), but this usually requires a period of bed rest with traction, followed by a period of protected mobilisation. Prolonged recumbency has complications, nursing is difficult and the treatment is costly.

The Derby intramedullary nail has been designed to provide both rotatory stability and interfragmentary compression (Papagiannopoulos et al. 1986) so that it can achieve rigid fixation without the disadvantages outlined above, and meet the criteria for optimal fixation of a long bone fracture given by Frankel and Burstein (1970). It allows the early transmission of physiological loads without external splintage and has been used successfully to treat fractures of the femoral shaft at all levels. This paper reports our experience of its use for fractures below the isthmus of the femur.

PATIENTS AND METHODS

We report the use of the Derby nail in 26 patients. Of these, 16 with an average age of 25 years 2 months were injured in road traffic accidents and 10 with an average age of 73 years 10 months by a simple fall. There were 18 closed fractures and 8 compound fractures, of which three were Grade I, three Grade II and two Grade III by the criteria of Holzach and Matter (1978–9). Seven of the patients had other significant injuries including fracture of the contralateral femur in two, of the contralateral tibia in three and one case each of abdominal and chest injury. Seven fractures were transverse, 16 were comminuted but did not involve the knee, while in three there was an intracondylar element which entered the joint.

Management. The patients with multiple injuries had their operation as soon as resuscitation had produced...
cardiovascular stability, between the first and sixth day after injury. Isolated closed fractures had internal fixation on the next available operating list, with a mean delay of 24 hours. Of the compound fractures, Grade I cases had urgent exploration and primary intramedullary nailing while Grade II and Grade III fractures had initial debridement and traction and were nailed two to three weeks later when the skin wounds had healed. Patients with compound fractures were given antibiotics on admission and these were continued until the skin had healed. Prophylactic antibiotics were given to cover the operations for both early and delayed internal fixation.

**Implant and operation.** The Derby intramedullary nail is a stainless steel tube of closed cross section which has been shaped to match the normal physiological curve of the femur (Fig. 1). It is available in a range of lengths suitable for all adult femora. Strong metal wings hinged within the distal 5 cm of the nail (Fig. 2) can be fanned out progressively under the control of a rod which is actuated from the proximal end of the nail. These wings can be locked in any attitude with a grub screw. They control rotation and act as an anchor against which compression can be applied to the fracture. This is provided by a proximally placed nut, which is placed over an antirotation washer (Fig. 3).

Reduction and nailing was carried out as a closed procedure in six of the simple fractures and in one Grade III compound fracture; the other 19 fractures had open reduction and nailing. Operation time varied with the complexity of the fracture and became less with experience. It ranged from 45 minutes to 2 hours 30 minutes, averaging 1 hour 16 minutes.

**Review.** All the patients and their radiographs were reviewed at intervals by one of the authors. Follow-up ranged from 12 to 28 months (average 22 months). The functional result was assessed according to the criteria of Schatzker and Lambert (1979).

- **Excellent.** No pain, full extension, with less than 10° loss of flexion, no varus, valgus or rotational deformity and perfect joint congruence.
- **Good.** As for excellent but with minimal pain or one of the following: loss of more than 1.2 cm of length, 10° varus or valgus deformity, loss of more than 20° flexion.
- **Fair.** As for excellent but with two or more of the criteria listed above.
- **Failure.** Disabling pain or any of the following: flexion 90° or less, over 15° varus or valgus deformity, incongruency of joint surfaces.

**RESULTS**

All 26 fractures had united by 12 weeks, 12 of them with minimal subperiosteal callus and complete disappearance of the fracture line on the radiographs. The other 14 cases had united with external callus which formed between 4 and 12 weeks after operation (see Figs 4 to 9). There were no cases showing cortical resorption or diffuse osteoporosis, no mechanical failures and no refractures after nail removal.

Functional results were excellent in 21 and good in three patients. The 21 patients with excellent results walked normally, without a limp or the use of walking aids. The three patients with good results had full extension of the knee but had lost 20° of flexion. All had
solid union in anatomical alignment with no shortening. Full weight-bearing began at an average of 13.5 days for those under 65 and 20.3 days for the older patients.

The average time in hospital after operation for the 15 patients under 65 years of age was 16.1 days, but some of the nine older patients were transferred from the orthopaedic wards, after an average of 17.8 days, to a geriatric rehabilitation unit for a period before discharge. Excluding our oldest patient, a lady of 93 who has remained in hospital for reasons not related to her fracture, the older patients went home after an average of 32 days.

Nineteen patients were able to return to their original job by 40 days after operation, six elderly retired patients had returned to their previous activity level after an average of 70 days and one patient with bilateral femoral fractures had requested a lighter job.

Complications. There was one case of deep infection in a 32-year-old man 10 months after treatment of a femoral fracture by open reduction and nailing augmented by a cancellous bone graft. The fracture had united; infection was treated successfully by intravenous antibiotics after removal of the nail and all infected granulation tissue, there being no evidence of infection one year later. Three patients had pulmonary emboli, two patients had evidence of mild adult respiratory distress syndrome, and one patient had deep venous thrombosis in the calf. All recovered uneventfully.

DISCUSSION

Conservative treatment of fractures of the distal femur, advocated by Watson-Jones (1955) and by Charnley (1961) involves prolonged periods of bed rest. Cast bracing has allowed this period to be reduced but not abolished (Pratt et al. 1980). Internal fixation can
produce excellent results in the hands of experts (Schatzker, Horne and Waddell 1974–5) but the methods currently available have drawbacks which make the ultimate goal of early mobilisation with full weight-bearing difficult or impossible to achieve (Stewart et al. 1966; Neer et al. 1967).

Plates developed by the Swiss AO group specifically to treat supracondylar fractures are versatile, but it is difficult to obtain the anatomical reduction and rigid fixation which is necessary (Schatzker and Lambert 1979; Pritchett 1984). When these implants have been applied correctly excellent results have been reported (Schatzker and Lambert 1979; Slätis et al. 1971; Schatzker et al. 1974–5), but it is clear that when AO principles are not observed the results are poor, especially in the osteoporotic bone of elderly patients (Brown and D’Arcy 1971; Zickel et al. 1977).

Intramedullary nails are inherently stronger than plates which are necessarily sited in an eccentric position (Allen et al. 1968), but for fractures below the medullary isthmus a standard nail does not control rotation of the fragments unless it is augmented with screws (Huckstep 1975; Kempf et al. 1985). This can be an exacting exercise even using jigs or sophisticated aiming devices. The Derby nail controls rotation and the axial compression which can be applied adds rigidity (Papagiannopoulos, Pratt and Rees 1985). The nail is easier to insert than either the Huckstep or the Grosse and Kempf nails, so that the operation time is shorter.

Our results show that the Derby nail provides excellent fixation in fractures of the femur below the medullary isthmus, with a minimal complication rate and no osteoporosis or refraction. There have been no mechanical failures either in this series or in cases of fracture at higher levels which are to be reported separately. Early weight-bearing has been encouraged and this has allowed early discharge from hospital in nearly all our cases.

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REFERENCES
