CLOSED KÜNTSCHER NAILING FOR COMMINUTED FEMORAL SHAFT FRACTURES

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From a series of 190 consecutive fractures of the shaft of the femur treated by closed Kuntscher nailing, 32 of the more severely comminuted have been studied to determine whether treatment by closed nailing was justified. Radiological criteria were used to divide them into 19 who were moderately comminuted and 13 grossly so. Twenty-four patients were less than 21 years of age and 19 patients had 40 significant associated injuries. Fifteen fractures were nailed on the day of injury, and complications were few. Nineteen patients had a supplementary cast-brace and all those who had been employed returned to work. Twelve patients had shortening of up to two centimetres and two had three centimetres; four had mild rotational deformities; seven had mild restriction of knee flexion; and two had delayed union. There were no infections. The advantages of this technique include a negligible risk of infection and rapid stabilisation of even grossly comminuted fractures, thus facilitating management of other injuries. The 44 per cent incidence of shortening is counterbalanced by early mobilisation and rapid return of knee function. It is concluded that when proper equipment and expertise are available then closed nailing is the treatment of choice for severely comminuted fractures of the femoral shaft.

Kuntscher first described the use of a clover-leaf nail for the internal fixation of fractures of the long-bones (Kuntscher 1940). He used a closed technique with fluoroscopic control and, although the initial results were most impressive, the technique fell into disrepute during the postwar years because of the high incidence of complications reported in the English literature (Watson-Jones et al. 1950).

Modern technology has eliminated many of the difficulties and dangers previously associated with the technique, and over the last decade there has been a resurgence of interest in closed nailing particularly for fractures of the femoral shaft. Several series demonstrating the advantages of this technique over other methods of treatment have been published (Gross and Giebink 1967; Böehler 1968; Clawson, Smith and Hansen 1971; Rascher et al. 1972; Gherlinzoni, Vasciaves and Murena 1975; Kwan and Ma 1975; Winquist, Hansen and Clawson 1977; Rothwell and Fitzpatrick 1978). As experience has been gained practitioners have become aware that, compared to open nailing, a much wider variety of fractures can be adequately fixed internally (Clawson et al. 1971; Winquist and Hansen 1976; Rothwell and Fitzpatrick 1978). This applies particularly to severely comminuted fractures for which conservative management is widely recommended (O'Brien 1963; Dencker 1965; Anderson 1967; Rokkanen, Släts and Vankka 1969; Suiter and Bianco 1971; Gillquist, Liljedahl and Rieger 1971; Rascher et al. 1972; Connolly and King 1973).

Since mid-1972 closed Kuntscher nailing for femoral shaft fractures has become the treatment of choice in Dunedin. From a series of 190 consecutive cases 32 of the more severely comminuted fractures were retrospectively selected for closer study to determine whether treatment by closed nailing was justified. The minimal requirement for selection was that more than 50 per cent of the circumference was missing from both main shaft fragments.

MATERIAL AND METHODS

The 32 fractures (in 32 patients) were divided into those with moderate comminution and those with gross comminution. In moderate comminution one or more large fragments of bone, each greater than 50 per cent of the circumference of the shaft, had been completely separated off from both main fragments, but end-to-end reduction of the main shaft fragments had been obtained which resulted in minimal residual shortening. In gross comminution there had been multiple fragments of bone, making end-to-end reduction impossible and residual shortening inevitable. On these criteria there were 19 fractures with moderate comminution and 13 with gross comminution (Figs 1 to 9).

The age of the 32 patients ranged from 16 to 53 years, 24 being 21 years or younger; there were 26 men and six women. Thirteen fractures resulted from motorcycle accidents, 15 from motorcar accidents and four from other causes. There were five compound fractures. Nineteen patients had 40 significant associated injuries, 18 being other fractures of the lower limb, including nine fractures of the tibiae, and two non-commimuted contralateral femoral fractures.

Our policy is to nail the fracture as soon as the patient has been resuscitated or the other injuries permit (Rothwell and Fitzpatrick 1978). Therefore 15 were nailed on the day of the accident, nine during the first week, six during the second week and the remaining...
Diagrammatic representation of moderate comminution with illustrative radiographs before and after nailing. Figures 1, 2 and 3—A comminuted fracture with a single large fragment. Figures 4, 5 and 6—A comminuted fracture with two large fragments.

Diagrammatic representation of gross comminution with illustrative radiographs before and after nailing.

two at three weeks. Blood gases were always checked before operation and usually every 12 hours for the first two days after operation. The technique of closed nailing has been described previously (Rothwell and Fitzpatrick 1978) and it must again be stressed that to minimise complications the correct equipment is essential and scrupulous attention to the details of technique is mandatory. With comminuted fractures, especially if fresh, alignment is normally easy to obtain and the passage of a guidewire can be facilitated by the help of an unscrubbed assistant to manipulate the thigh while the operator uses a thin nail as a lever in the proximal fragment. Minimal reaming is employed in order not to disrupt the split fragments any further. The average diameter of the Küntscher nail used in these 32 fractures was 11 millimetres (range 9 to 14 millimetres).

**Management after operation.** When the main injury was the femoral fracture, light traction was used for 7 to 10 days during which static quadriceps exercises were encouraged. After release from traction, the knee was mobilised and when 90 degrees of flexion had been gained the patient was allowed to walk with the aid of crutches. In patients with multiple injuries traction was often not employed and the timing of mobilisation depended upon the other injuries. A cast-brace was applied to facilitate walking in 19 patients who had either severe comminution or multiple fractures of the lower limb or both. With this regime 17 patients were discharged by four weeks and included all those in whom the femoral fracture was the main injury, a further 13 by eight weeks and the final two by 12 weeks.

**COMPLICATIONS**

Apart from difficulty with reduction in a small number of these cases there had been no significant operative complications.

After operation two patients developed a fat embolism syndrome confirmed by finding a $P_{O_2}$ of less than 55 millimetres of mercury; both recovered completely. One patient had a non-fatal pulmonary embolus. A nine-millimetre rod had bent in a patient with bilateral femoral fractures and had required manipulation under anaesthesia at one month.

**RESULTS**

When the 32 patients were followed up, the time since operation ranged from six months to eight years. Thirty patients were available for examination and two replied to a questionnaire.

Twelve patients had clinically measurable shortening of up to two centimetres and two patients in the severely comminuted group had shortening of three centimetres. Three patients had a deformity of 15
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Figures 10 and 11—Radiographs of the fracture before nailing. Figure 12—Radiograph at three weeks. Figures 13 and 14—Radiographs at six months at the time he returned to work.

months and the other four by nine months. Twenty-two returned to their previous occupation and seven took on new occupations, only one of which can be regarded as lighter work. There have been no cases of infection, superficial or deep, early or late. Antibiotics were not routinely used either during or after operation.

ILLUSTRATIVE CASE HISTORY

An 18-year-old skydiver was preparing to jump when the plane lurched, throwing him out of the open door. He crashed into the tail segment, sustaining a closed injury to his head and a severely comminuted fracture of the right femur. When he regained consciousness he was able to land safely on one leg. Closed nailing was carried out 24 hours after the injury and within 12 days he was able fully to raise a straight leg and to flex his right knee to 80 degrees. By six months union was sufficiently advanced for him to return to work as a painter and decorator. He had a full range of movement at the knee and no measureable shortening (Figs 10 to 16).

DISCUSSION

This small series further underlines the well-documented advantages of closed nailing: rapid recovery of function of the knee, a short stay in hospital, early mobilisation and return to work, minimal risk of infection, a small surgical scar, and stabilisation of the more complicated fractures. It is appropriate to look more closely at those advantages that are especially applicable to comminuted fractures.

Infection. The low incidence of infection is one of the major benefits of closed nailing. Reported rates of deep infection range from zero to three per cent (Gross and Giebink 1967; Böhler 1968; Carpenter and Couk 1970; Gherlinzoni et al. 1975; Kwan and Ma 1975; Winquist et al. 1977; Rothwell and Fitzpatrick 1978) compared with 1 to 11 per cent for open nailing (Böhler 1951; O'Brien
1963; Dencker 1965; Wickstrom and Corban 1967; Carpenter and Couk 1970; Rush 1970; Miller, Kovacs and Richard 1974). The lower infection rate assumes greater importance in comminuted fractures because open surgery necessitates additional fixation by means of screws and plates or wire circlage to gain adequate stability. The greater exposure and operating time increases the risk of infection especially if the patient also has injuries involving the pelvis and abdomen.

**Stability.** Experience with this series has shown that grossly comminuted fractures are surprisingly stable even when a nail of small diameter is used; this is confirmed by the very low incidence of rotational deformity found at follow-up. It is believed that this is because the musculoperiosteal sheath and haematoma are left undisturbed and act as an "external splint", helping to stabilise the fracture (Rothwell and Fitzpatrick 1978).

**Multiple injuries.** Patients with major comminution frequently have other severe injuries and in this series there was a 60 per cent incidence. If the fracture of the femur is treated by skeletal traction considerable difficulties may arise in the management of the other injuries and open surgery requires additional fixation which increases the risk of infection. Closed nailing solves these problems and stability is usually sufficient to obviate the need for subsequent traction, thus facilitating the management and nursing care of the patient.

**Residual shortening.** A significant incidence of shortening is to be expected in a series of comminuted fractures regardless of the method of treatment. In this series there was a 44 per cent incidence of measurable shortening but only two fractures, or six per cent, gave shortening greater than two centimetres. This is a criticism that could be levelled at the technique, but Dencker (1965), in his review of 1003 femoral shaft fractures treated by a variety of methods, included up to three centimetres of shortening in his "excellent" group. Other series of conservatively treated fractures, including those treated by cast-bracing, report shortening of greater than two centimetres in 13 to 60 per cent (Suiter and Bianco 1971; Kaufer 1972; Connolly, Dehne and Lafollette 1973; Hardy, White and Williams 1979). Furthermore, Rokkanen et al. (1969), when comparing closed and open nailing with conservative treatment, reported that 18 per cent of comminuted fractures treated conservatively had shortening greater than two centimetres as compared with three per cent after closed nailing and four per cent after open nailing. Bearing in mind the other advantages in treating severe comminution by closed nailing, it is considered that the frequency and the amount of shortening in this highly selected series is acceptable.

**Cast-brace.** In recent years the cast-brace has been popularised as a method of functional bracing for the femur. It is usually applied after four to six weeks in traction and is most suitable for comminuted mid-shaft and supracondylar fractures (Mooney et al. 1970; Connolly, Dehne and Lafollette 1973; Wardlaw 1977). Nineteen patients in this series had a cast-brace applied two to three weeks after closed nailing and the cast-brace has become a useful adjunct, safely allowing early weight-bearing especially in those with severe comminution, in those with multiple fractures particularly of the same limb and in those with delayed union. In addition, by closed nailing the period before application of the cast-brace is much reduced, a wider variety of femoral fractures can be managed in a cast-brace and there is no need for ancillary aids such as wedges or pelvic bands.

In conclusion, results from this series of fractures have demonstrated that the treatment of the more severely comminuted fractures of the femoral shaft by closed nailing was justified and has many advantages over other methods. There is no hesitation in recommending that whenever the correct equipment and expertise are available that it should be the method of choice.

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**REFERENCES**


