# The Grosse-Kempf nail for distal femoral fractures

## 2-year follow-up of 25 cases

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**Totally, 25 patients with an infraisthmic fracture of the femur, treated with a Grosse-Kempf slotted nail, were followed up for a median of 21 (8–44) months. The median age of the 9 males and 16 females was 45 (18–90) years. No deep infections occurred. An excellent result was obtained in 14 patients, good in 5, fair in 5, and poor in 1 patient in whom intraoperative splintering led to a 9-cm shortening. We conclude that intramedullary locked nailing of fractures of the infraisthmic, extraarticular part of the femur compares favorably with alternative methods.**

Intramedullary nailing has become (Grosse and Kemp 1978) a prevailing treatment for femoral shaft fractures, whereas distal intraarticular femoral fractures, which require an exact reconstruction of the joint, are often treated with open reduction and plate fixation (Schatzker et al. 1974, Schatzker and Lambert 1979, Kolmert and Wulff 1982). How should we then treat the metaphyseal extraarticular femoral fractures?

We have attempted an analysis of the special features of the extraarticular metaphyseal femoral fractures, and report a series where locked intramedullary nailing was used.

## Patients and methods

Between 1982 and 1988, we treated 28 distal metaphyseal fractures using the Grosse-Kempf slotted, locked intramedullary nail (Table 1). One patient died of multiple injuries and 2 patients could not be traced for the follow-up. Nine of the remaining 25 patients who could be traced were males and 16 were females, with a median age of 45 (18–90) years. The fracture was defined as a distal metaphyseal fracture when (1) it was located in the distal one third of the femoral shaft, (2) allowed fixation of the locking screws in the distal fragment, and (3) did not have any intraarticular component. However, in 3 cases the fracture extended to less than 8 cm from the femorotibial joint line, allowing a bicortical fixation by only one of the distal locking screws.

Ten fractures had been sustained in traffic accidents (Figure 1). Fifteen fractures were caused by low-energy trauma, usually from a fall at the same level (Figure 2). Five patients were classified as multitraumatized, and they had an Injury Severity Score exceeding 20 (Baker et al. 1974). Twenty fractures were closed and five were open Grade I–II. Five fractures were transverse or short oblique with a butterfly fragment not compromising the longitudinal stability. Ten fractures were long-oblique or spiral, and 10 were comminuted.

Nineteen operations were performed during the first day after admission, four during the first week, whereas 2 patients were operated on respectively 23 and 60 days after their injury. The operations were performed with the patient in the supine position on a traction table with the foot in a traction shoe (Strømsøe et al. 1990). In 8 recent cases, however, a condylar traction pin was used to prevent a varus deviation of the fracture. The pull of the hamstrings resulting in recurvation was controlled better by using condylar traction than by shoe traction.

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Table 1. Observations in 25 patients with distal femoral fracture

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 23 | 1 | 2* | 0 | 3 | 1 | 2 | 0 | 12 | 0 | 0 | 1 | – | – | – | 1 | 1 | 1 |
| 2 | 85 | 2 | 1 | 0 | 2 | 1 | 1 | 0 | 16 | 1 | 0 | 3 | +7 | – | – | 2 | 1 | 3 |
| 3 | 56 | 1 | 1 | 0 | 3 | 1 | 2 | 0 | 22 | 1 | 0 | – | – | +11 | – | 2 | 1 | 2 |
| 4 | 81 | 2 | 1 | 0 | 2 | 1 | 1 | 0 | 24 | 0 | 0 | 4 | – | – | – | 1 | 1 | 3 |
| 5 | 19 | 1 | 2* | 0 | 1 | 1 | 1 | 0 | 19 | 1 | 0 | 1 | – | – | – | 1 | 1 | 1 |
| 6 | 87 | 2 | 1 | 0 | 2 | 1 | 2 | 1 | 12 | 2 | 1 | 9 | – | –9 | +15 | 2 | 1 | 4 |
| 7 | 39 | 2 | 1 | 0 | 2 | 1 | 1 | 0 | 16 | 1 | 0 | 1 | +8 | +21 | – | 1 | 1 | 3 |
| 8 | 29 | 2 | 2* | 1 | 1 | 1 | 1 | 0 | 16 | 0 | 1 | 1 | – | – | – | 1 | 1 | 1 |
| 9 | 32 | 2 | 1 | 0 | 3 | 1 | 2 | 0 | 12 | 0 | 0 | – | – | – | – | 1 | 1 | 1 |
| 10 | 68 | 2 | 1 | 0 | 2 | 1 | 2 | 0 | 8 | 0 | 0 | – | – | – | – | 1 | 1 | 1 |
| 11 | 80 | 2 | 1 | 0 | 3 | 2 | 1 | 0 | 44 | 0 | 0 | 3 | – | – | – | 1 | 1 | 3 |
| 12 | 88 | 1 | 1 | 0 | 2 | 2 | 2 | 0 | 37 | 0 | 0 | – | – | +4 | – | 1 | 1 | 1 |
| 13 | 20 | 1 | 2* | 0 | 1 | 1 | 2 | 0 | 22 | 0 | 0 | – | – | – | – | 1 | 1 | 1 |
| 14 | 84 | 2 | 1 | 0 | 2 | 1 | 2 | 0 | 41 | 0 | 0 | – | – | – | – | 1 | 1 | 1 |
| 15 | 26 | 1 | 2 | 0 | 3 | 1 | 1 | 2 | 19 | 0 | 0 | – | – | – | – | 1 | 1 | 1 |
| 16 | 39 | 2 | 1 | 0 | 3 | 1 | 2 | 0 | 12 | 2 | 1 | – | +5 | – | – | 2 | 1 | 2 |
| 17 | 24 | 2 | 1 | 2 | 1 | 1 | 1 | 0 | 38 | 1 | 0 | – | – | – | +15 | 1 | 1 | 2 |
| 18 | 87 | 2 | 2 | 0 | 2 | 1 | 2 | 2 | 28 | 0 | 0 | – | – | – | – | 1 | 1 | 1 |
| 19 | 70 | 2 | 1 | 0 | 3 | 1 | 2 | 0 | 22 | 0 | 0 | – | – | – | – | 1 | 1 | 1 |
| 20 | 18 | 2 | 2 | 1 | 1 | 1 | 1 | 0 | 25 | 0 | 0 | – | – | – | – | 1 | 1 | 1 |
| 21 | 90 | 1 | 1 | 0 | 3 | 2 | 2 | 0 | 13 | 0 | 0 | 3 | – | – | – | 2 | 1 | 3 |
| 22 | 86 | 1 | 2 | 1 | 3 | 1 | 2 | 0 | 27 | 1 | 0 | – | – | – | – | 2 | 1 | 2 |
| 23 | 24 | 1 | 2* | 2 | 3 | 1 | 1 | 0 | 37 | 0 | 0 | – | – | +5 | – | 1 | 1 | 1 |
| 24 | 23 | 2 | 2 | 0 | 2 | 1 | 1 | 0 | 40 | 0 | 0 | – | – | – | – | 1 | 1 | 1 |
| 25 | 87 | 2 | 1 | 0 | 2 | 1 | 1 | 0 | 9 | 1 | 1 | – | – | – | – | 1 | 1 | 2 |

A Case
B Age
C Sex: 1 male, 2 female
D Trauma energy
  1 low
  2 high
  * Injury Severity Score > 20
E Wound grade (Gustilo and Anderson 1976)
F Type of fracture
  1 transverse
  2 oblique/spiral
  3 comminuted
G Location
  1 distal
  2 distal, < 8 cm from joint
H Type of locking: 1 dynamic, 2 static
I Complications
  1 unstable fixation, additive plaster cast
  2 superficial infection
J Follow-up time, months
K Pain
  1 moderate
  2 severe
L Edema
  1 moderate
M Shortening, cm
N Malalignment, degrees, – varus, + valgus
O Malalignment, degrees, – antecurvatum, + recurvatum
P Malrotation, degrees, – internal rotation, + external rotation
Q Flexion of the knee
  1 > 120°
  2 90°–120°
R Extension of the knee: 1 deficit 0°–5°
S End results
  1 excellent
  2 good
  3 fair
  4 poor

Twenty-one nailings were performed without opening the fracture site. In 2 cases, a plate used to treat a previous shaft fracture had to be removed. In the 2 cases operated on late, a plate to treat the index fracture had loosened and had to be removed before nailing. Thus, four operations were done by opening the fracture site.

The femoral shaft was reamed 1 mm above the nail diameter aiming at the insertion of a 13-mm nail if the width of the isthmic part of the medullary canal did not presuppose the insertion of a larger nail. The distal targeting was performed manually by using an angled awl with a long shaft as a guide and an image intensifier. Twelve nails were locked dynamically with a distal double locking screw, whereas 13 fractures were locked statically with proximal and distal screws.

Macrodex® was given intraoperatively and on the first postoperative day. Antibiotics were given to patients with open fractures and when the fracture was opened. To enhance consolidation, three fractures were dynamized by removing the distal screw at 12, 32, and 40 weeks, respectively.

The patients were followed with regular outpatient examinations until healing of the fracture and restoration of function. Radiographically, a fracture was considered healed when calcified callus surrounded more than one half of the bone circum-

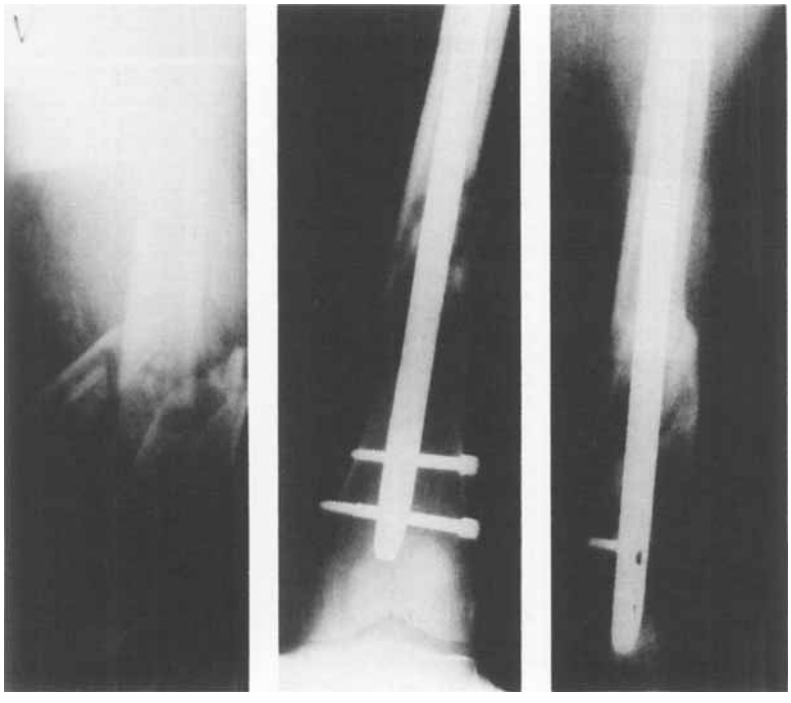

Figure 1. *Case 22.* An 86-year-old man. A traffic-accident victim. Open fracture Grade II with comminution. Immediate operation. The screws were removed 1 year later. Walks with a cane. Knee flexion limited to 110°. Follow-up was 2 years, and the result was good.

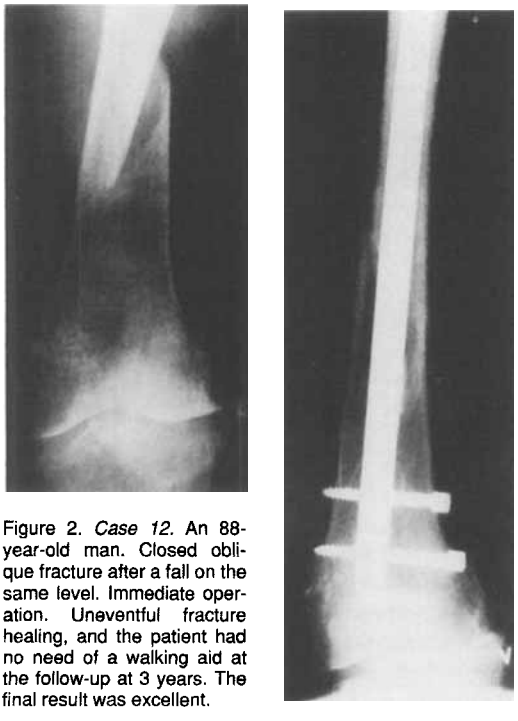

Figure 2. *Case 12.* An 88-year-old man. Closed oblique fracture after a fall on the same level. Immediate operation. Uneventful fracture healing, and the patient had no need of a walking aid at the follow-up at 3 years. The final result was excellent.

ference. All the patients were examined by the authors at a median of 21 (8–44) months after the injury. The two follow-up periods less than 12 months after injury were due to the patients' deaths from unrelated causes at 8 and 9 months, respectively. All the complications and the end state were recorded and classified.

## Results

The median radiographic consolidation time was 14 (9–52) weeks.

We had three local complications and no severe general complications. Intraoperative splintering in Case 6, an 87-year old woman, resulted in poor fixation of a statically locked nail and 9-cm shortening in spite of fixation in a plaster cast. Two superficial infections were treated successfully with antibiotics. Otherwise, there were no deep infections.

Progressive, immediate weight bearing, limited by pain only, could be allowed in 8 cases. Full weight bearing was allowed a median of 9 (2–14) weeks after the operation.

At follow-up, 5 patients had moderate and 2 severe pain in the fracture area. Three patients had inconvenience in the trochanteric area due to nail protrusion. Five patients had moderate edema in the operated-on limb, probably as sequelae after deep venous thrombosis. Three patients did not return to their previous occupation because of sequelae of the fracture, and 6 had reduced their activities.

Four patients had a shortening of respectively 1, 3, 4, and 9 cm.

After consolidation, there were no radiographic varus deformities exceeding 5°. There were two valgus deformities of 8° and 9°, respectively. Recurvation was recorded twice, one of 11° and the other of 20°. The clinical examination showed two external malrotations of 15°. Six patients had a restriction in knee flexion to 90°–120°. No one had an extension deficiency exceeding 5°.

At the final follow-up the distal locking screws had been removed in 4 patients. In 5 patients, all the implants had been removed, and in 2 patients this was planned.

According to the classification of Thoresen et al. (1985), an excellent result was obtained in 14 patients, 5 patients had a good result, 5 a fair result, and 1 a poor result. In patients under 60 years of age, we had 12 excellent or good and one fair result. In patients 60 years of age and older, we had seven excellent or good and five fair or poor results ($P$ = 0.04, Fisher's test). In high-energy injuries, we had eight excellent or good results and one fair result. In low-energy injuries, there were 11 excellent or good and five fair or poor results.

## Discussion

Distal metaphyseal fractures (also called infraisthmal fractures), excluding the intraarticular condylar fractures, could not be treated satisfactorily with intramedullary nailing before locking nails were available. Various alternative methods were therefore used (Kolmert and Wulff 1982). Mechanically, these fractures represent a special category of the femoral shaft fracture; the isthmic part of the medullary canal is too wide to permit a tight fit of the nail to provide rotational and longitudinal stability.

Compared with femoral shaft fractures at higher levels, the patients in this study were clearly older and more often female (Alho et al. unpublished data). Kolmert and Wulff (1982) found that the distal extraarticular femoral fractures were predominantly a fracture of the elderly, and were, more often than the intraarticular condylar fractures, caused by moderate trauma, confirmed by our series. Thus, the treatment problem of a distal metaphyseal femoral fracture often becomes a problem of osteoporotic bone.

Although the flare of the distal metaphysis excludes the lining effect of the cortical bone, which exists in the isthmic area, we were able to control the alignment equally well as in higher femoral shaft fractures, and the rotation even better. The ability of the distal locking screws to retain length and rotation of the fracture during healing proved good (Figure 1).

Shortening of some dynamically locked fractures was the major cause of the impaired final result. Obviously, this was due to misjudgement of the longitudinal stability of the fracture. Static locking should be used even in distal fractures if the fracture is not absolutely stable longitudinally, which is only true in transverse fractures. In a recent review of 99 nailed fractures, no negative effects of static nailing were observed (Strømsøe et al. 1990).

The removal of the nail was only performed if the patient had complaints that could be attributed to the implant, and its removal was seldom considered necessary. In 3 cases, the distal screws were removed to dynamize the bone-implant construct (Grosse et al. 1978), and thus to enhance healing. In some cases, some of the screw heads caused mechanical irritation and were removed after fracture consolidation.

The use of locking nails with expanding wings in the distal part represents an alternative method and has been reported for the infraisthmic fractures of the femoral shaft by different authors (Brooker and Brumback 1988, Papagiannopoulos and Clement 1987). Brooker and Brumback (1988) reported less shortening after nailing all of their fractures statically.

Another, well-documented alternative for the treatment of this type of fracture is the condylar plate, used as the angle-blade plate or the 90° Dynamic Condylar Screw plate. However, as Schatzker et al. (1974) and Schatzker and Lambert (1979) pointed out, this method is demanding and requires an extensive surgical exposure of the fracture site. Even when the operation is done exactly according to the recommendations of the ASIF Group, a secondary autologous cancellous bone graft is often necessary.

The present study shows that the intramedullary locked nailing may be used in the distal, extraarticular femoral shaft fractures and gives good results. Failures caused by misjudging the fracture comminution and stability can be avoided by constant use of static nailing.

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