

Fixation of femoral neck fractures

A four-flanged nail versus threaded pins in 200 cases

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Two methods of internal fixation for cervical hip fractures were compared in a "randomized to surgeons" type of study. One hundred patients were treated with the Rydell four-flanged nail and 100 with the Gouffon pins. Redisplacement, nonunion, or segmental collapse occurred in 27 patients operated on with the Rydell nail and in 29 patients operated on with the Gouffon pins. According to the actuarial method of follow-up, the failure rates after 2 years were 31 and 33 percent in the two groups.

I report a clinical and radiographic 2-year follow-up of a randomized trial comparing the four-flanged nail of Rydell (1964) with the Gouffon pins.

Patients and methods

This study comprised 200 consecutive patients with femoral neck fractures admitted to the surgical department at Ljungby Hospital (Ljungby, Sweden) between September 1984 and November 1987. On admission, traction through the tibial tubercle was applied in displaced fractures. Closed reduction was performed under general or epidural/spinal anesthesia, with the patient placed on an extension table, and using biplane fluoroscopy. The majority of the patients were operated on within 24 hours.

For fixation, either a four-flanged Rydell nail or Gouffon's pins were used. The channel for the four-flanged nail is predrilled, whereas the flanges are prepared with a punch, and the nail is hammered in. The Gouffon pins are threaded for 2.5 cm from the tip and inserted as a screw without predrilling. The nail and the distal pin were intended to be placed centrally in the femoral head and along the medial cortex. The other two Gouffon pins were inserted parallel to the first pin posteriorly and anteriorly, preferably touching the inside of the cortex of the femoral head.

Mobilization started the day after surgery, when the first postoperative radiographs had been taken. Immediate full weight bearing was allowed. Prophylactic antibiotics were not used. Clinical and radiographic follow-up was done at the outpatient clinic 4, 12, and 24 months after the operation.

The initial fracture displacement was classified according to Garden (1961). The quality of reduction was considered good if the anterior-posterior Garden angle was 160° - 175° and there was no anterior or posterior angulation exceeding 15° . The position of the Rydell nail was considered poor if placed in the upper and/or anterior third of the femoral head, if the nail penetrated the femoral head cortex, or if the distance between the nail and the femoral head cortex exceeded 10 mm. The position of the pins was considered poor if the angle between the pins was more than 5° (nonparallel), if the distance from the articular cortex to the tip of any pin exceeded 10 mm, if any pin penetrated the femoral head cortex, or if all the pins were placed in the upper half of the femoral head.

Union was defined by the presence of bony trabeculae across an obliterated fracture line. The healing complications were listed as early redisplacement (within 4 months), nonunion, or segmental collapse. Nonunion was diagnosed when redisplacement of the fracture occurred later than 4 months or when nonunion was evident at the last follow-up 2 years postoperatively. Segmental collapse was diagnosed from the appearance of a clearly visible depressed segment of the femoral head.

Before the trial, one group of 4 surgeons had, for many years, used Rydell's nail while another group

of 3 had ample experience with Gouffon pins. The two groups were comparable as to number of years of training and practice. Every day, 1 surgeon in each group was on duty. Randomized cards indicating the group of surgeons to whom the patient was to be allotted were kept in sealed envelopes that were opened on the day of the operation. The surgeon on duty of the group to whom the patient was allotted then used the technique with which he was familiar—randomized-to-surgeons type of trial (Van der Linden 1980, Rudicel and Esdale 1985).

The results are presented according to the actuarial method (Armitage 1971) and also after a follow-up of 2 years or until failure. The chi-square test was used to study univariate correlations.

Comparability of study groups

The median age was 78 (46-94) years in the nailed group (28 men) and 76 (49-100) years in the other group (30 men). The number of patients with Garden stages III and IV fractures was almost the same (Table 1). There was no difference in the duration of operation or in that of hospitalization. Neither was there any difference when the displaced fractures in both groups were compared as to the results of reduction and as to the position of the nail or pins (Table 2).

Results

There were no deaths during the operation or during the immediate postoperative course, but 2 patients in each group died while still in the hospital. After 1 year, the mortality was 16 percent and after 2 years 25 percent.

Of the 200 patients included in the trial, 42 died without any known radiographic healing complication, leaving 158 patients who were followed for 2 years or until redisplacement, nonunion, or late segmental collapse occurred (Table 3).

After 2 years, 27 fractures of the 100 treated with the four-flanged nail had failed compared with 29 of the 100 fractures in the other group. According to the actuarial method of analysis, the cumulative failure rate was respectively 31 and 33 percent among patients operated on with the Rydell nail or the Gouffon pins. Removal of the fixation device was performed in 6 patients, and 28 were reoperated on with an endoprosthesis (13 in the nail group and 15 in the pin group). Of the united fractures, 18

Table 1. Failures and reoperations (in brackets) in patients operated on with the Rydell nail or the Gouffon pins followed for 2 years or until failure

| | n | Redisplacement or nonunion | Segmental collapse |
|--------------|------------|----------------------------|--------------------|
| Nail | | | |
| Nondisplaced | 12 | 1 (1) | 1 (0) |
| Displaced | 66 | 17 (11) | 8 (5) |
| Pins | | | |
| Nondisplaced | 15 | 1 (0) | 2 (1) |
| Displaced | 65 | 19 (13) | 7 (3) |
| Total | 158 | 38 (25) | 18 (9) |

Table 2. Results in displaced hip fractures followed for 2 years or until failure. Nail/Pins

| | Healed | Redisplacement or nonunion | Segmental collapse | Total |
|----------------------|--------|----------------------------|--------------------|-------|
| Reduction | | | | |
| Good | 39/36 | 8/9 | 6/6 | 53/51 |
| Poor | 2/3 | 9/10 | 2/1 | 13/14 |
| Nail position | | | | |
| Good | 38/36 | 9/11 | 7/6 | 54/53 |
| Poor | 3/3 | 8/8 | 1/1 | 12/12 |

Table 3. The cumulative success rate, using the actuarial method, of 200 femoral neck fractures operated on with the Rydell nail or the Gouffon pins. Failure was defined as redisplacement, nonunion, or late segmental collapse

| Fixation device | Interval (yr) | No. at start | No. failed | No. with-drawn ^a | Cumulative success rate |
|-----------------|---------------|--------------|------------|-----------------------------|-------------------------|
| Nail | 0-1 | 100 | 21 | 13 | 0.77 |
| | 1-2 | 66 | 6 | 9 | 0.69 |
| Pin | 0-1 | 100 | 23 | 14 | 0.75 |
| | 1-2 | 63 | 6 | 6 | 0.67 |

^aDead, no patient was lost to follow-up.

Table 4. Complications in different age groups in displaced fractures followed for 2 years or until failure. Nail/Pins

| | Age | | | | | |
|-------------------------|-----|-------|-------|-------|-------|-----|
| | 50 | 51-60 | 61-70 | 71-80 | 81-90 | 90 |
| Redisplacement/nonunion | 0/0 | 1/1 | 2/1 | 8/10 | 5/5 | 1/2 |
| Segmental collapse | 0/0 | 0/1 | 1/1 | 4/3 | 2/2 | 1/0 |
| No. of patients | 1/0 | 6/7 | 17/15 | 23/26 | 15/14 | 4/3 |

developed segmental collapse and 9 were reoperated on, still without difference between the groups. Of the undisplaced fractures, two developed nonunion and three segmental collapse (Table 1).

In 29 patients (14 nail, 15 pins) the reduction was poor. Only five of these fractures healed compared with 75 of 102 with good reduction ($P < 0.001$). When the position of the nail or the pins was poor (13 nail, 14 pins), only six fractures healed compared with 74 of 104 ($P < 0.001$).

In displaced fractures, more nonunions and segmental collapses were seen in patients over the age of 70 ($P < 0.01$) in both groups.

Discussion

Rudicel and Esdaile (1985) have drawn attention to a variation of the classical trial design, called "randomized to surgeons" design, which was originally proposed (Van der Linden 1980) to avoid bias in favor of the participants' pretrial routine. In this type of trial the patients are randomized to two groups of specialists in the procedures to be compared, whereas in the classical design, each participating surgeon performs the two procedures in a random order. In the present study the "randomized to surgeons" design was opted for because, as Gross (1988) pointed out, it eliminates the learning period, as well as the ethical problems.

The mortality in this study was 25 percent after 2 years, which is comparable to figures given by others (Frandsen and Andersen 1981, Strömquist et al. 1984, Svenningsen et al. 1984, Christie et al. 1988, Elmerson et al. 1988, Lindequist et al. 1989, Rehnberg and Olerud 1989).

Initial displacement, the quality of reduction, the position of the fixation device, and the age of the patient were the most important factors predicting the outcome in this study, and this is in agreement with many other authors (Garden 1961, 1971, Barnes et al. 1976, Frandsen and Andersen 1981, Skinner and Powles 1986, Elmerson et al. 1988, Lindequist et al. 1989). The type of fixation device can influence the outcome (Barnes et al. 1976, Svenningsen et al. 1984, Strömquist et al. 1984, Rehnberg and Olerud 1989, Lindequist et al. 1989), but in this study, as well as in Elmerson's study (1988), there was no difference in healing complications between the nail and the pins.

Elmerson et al. (1988) also compared the four-flanged nail and the Gouffon pins. The complication rate was lower in the present study (Table 4) after a

follow-up of 2 years. In displaced fractures the reduction was good in 80 percent and the position of nail or pins was good in 82 percent as compared with 68 percent and 74 percent, respectively, in the study by Elmerson et al. (1988). Their study used the classical trial design. The difference in overall failure rate between the two studies could be due to the difference in study design. Better results may be expected when surgeons persist in using the method in which they are skilled rather than when changing method in a random order. The importance of training has been stressed also by Holmberg et al. (1987) and Strömquist et al. (1987). Hence, the claim that choosing this trial design is to the benefit of the patients entered (Gross 1988).

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