



Internal fixation of femoral neck fracture

No difference between the Rydell four-flanged nail and Gouffon's pins

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Two methods of internal fixation of femoral neck fractures were compared in a prospective randomized study of 223 patients. Radiographic evidence of early redisplacement, nonunion, or late segmental collapse occurred in 45 of 122 patients operated on with the Rydell four-flanged hook nail and in 33 of 101 patients operated on with Gouffon pins. According to the actuarial method of follow-up, the failure rates after 2 years were respectively 41 and 35 percent in the nail and pin groups, which is a nonsignificant difference.

In Gothenburg, Sweden, the proportion of patients reoperated on with an endoprosthesis in complications following femoral neck fractures has been fairly constant, about 18 percent, since 1965 (Zetterberg et al. 1985). The damage to the vascular supply of the femoral head at the moment of the fracture is responsible for a major part of these complications (Müssbichler 1970, Rokkanen and Slätis 1974, Holmberg and Thorngren 1984). However, also the type of fixation device may influence the the outcome (Frandsen and Andersen 1981, Frandsen et al. 1984, Strömqvist et al. 1984, Svenningsen et al. 1984, 1985).

We report a prospective, comparative study of patients with femoral neck fracture randomly treated with either a four-flanged Rydell (1964) nail or with three or four Gouffon pins (Howmedica, Inc.).

Patients and methods

Totally, 263 patients with a femoral neck fracture were admitted to our department from November 1982 through October 1983. There were 185 women with a mean age of 79 (34-98) years and 78 men with a mean age of 72 (18-95) years. Only

4 men and 1 woman were younger than 50 years of age. Two patients died before surgery was performed. Because we were unable to reduce the fracture in 16 patients, they were treated with a primary endoprosthesis.

In displaced fractures, preoperative tibial pin traction was applied on admission. Internal fixation was performed as soon as permitted by the anesthesiologic resources; the majority were operated on within 24 hours of admission. The method of internal fixation was decided by the operation nurse according to a random numbers table. The operations were done by 29 different surgeons, 9 of whom performed more than 10 operations each.

Of the 245 patients entering the study, 20 patients died within 3 months after the operation without evidence of failure, 2 patients went abroad and were lost to follow-up, leaving 223 patients who were followed for 24 months, or until death or until any radiographic healing complication occurred. The four-flanged nail was used in 122 patients and three or four Gouffon pins in 101 patients. Nine patients refused a radiographic examination 2 years postoperatively, but 5 of them were examined clinically.

Operation technique. The operations were performed under spinal anesthesia with the patient placed on an extension table. Displaced fractures were reduced by the closed method using fluoroscopy. The nail or the distal pin was intended to be inserted through the femoral neck along the medial cortex and into the central part of the

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femoral head. Then, the proximal two or three Gouffon pins were inserted parallel to the first pin posteriorly and anteriorly, preferably touching the inside of the cortex of the femoral neck. The mean duration of the operation with the four-flanged nail was 28 ± 13 min, and with the Gouffon pins 38 ± 18 min ($P < 0.001$).

Postoperative management. The patients were mobilized the day after the operation. Prophylactic antibiotics were not used. A combination of 0.5 mg dihydroergotamine methansulfonate and 5,000 IU heparin sodium (Orstanorm® (with heparin)) was given subcutaneously twice daily for 1 or 2 weeks as an antithrombotic prophylaxis.

Follow-up. The patients were followed for 2 years with radiographs at 1 and 6 weeks, 3 and 6 months, and 1 and 2 years postoperatively. Those who had a failure of the osteosynthesis were not followed further.

Radiographic assessment

The initial fracture displacement was classified according to Garden (1961).

From radiographs taken at the operation, the quality of the reduction and the internal fixation was evaluated as either satisfactory or unsatisfactory. The reduction was satisfactory 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 unsatisfactory 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 Gouffon pins was considered bad 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 more than 2 mm, or if all the pins were placed in the upper half of the femoral head.

Radiographically, union was defined by the presence of bony trabeculae across an obliterated fracture line. The healing complications were listed as early redisplacement (within 3 months), nonunion, or a segmental collapse. Nonunion was

diagnosed when redisplacement of the fracture occurred later than 3 months postoperatively or when nonunion was evident at the last follow-up 2 years after the fracture. Segmental collapse was diagnosed from the appearance of a clearly visible depressed segment of the femoral head.

Statistics

The results are presented according to the actuarial method (Armitage 1971), and also traditionally after a follow-up of 24 months or until failure in each case (Table 1).

In the 2-year follow-up, all the 78 patients with a known radiographic healing complication were counted as failures even if they were dead. Patients with a known healing complication were compared with the 92 patients who at the 2 year follow-up had a healed fracture without any signs of late segmental collapse. The results in these two groups of patients were used to study – by multivariate analysis with Pitman's test (Bradley 1968) and Mantel's (1963) test – the association between the healing and various factors, i.e., the initial fracture displacement, the quality of the reduction and of the internal fixation, the interval from the fracture accident to operation, the method of internal fixation, and the age and sex of the patients.

The chi-square test with Yates' correction and Fisher's exact test were used to study univariate correlations.

Results

The mortality rate was 9 percent (23/261) within 3 months, 19 percent (49/261) within 1 year, and

Table 1. Two different methods of assessment of results after internal fixation of femoral neck fracture using the Rydell four-flanged nail or Gouffon pins. Failure was defined as radiographic evidence of early redisplacement, nonunion and/or late segmental collapse

Method	Number of patients assessed (percent failures)	
	Nail	Pins
After a follow-up, of 2 years or until failure	90 (50)	80 (41)
By the actuarial method after 0–2 years	122 (41)	101 (35)

Table 2. The cumulative success rate, using the actuarial method, of 223 femoral neck fractures operated on with the Rydell four-flanged nail or Gouffon pins. Failure was defined as radiographic evidence of early redisplacement, nonunion and/or late segmental collapse

Fixation device	Interval (years)	Number at start	Number failed	Number withdrawn		Cumulative success rate (Px)	SE (Px)
				dead	lost to follow-up		
Nail	0-1	122	36	10	4	0.69	0.043
	1-2	72	9	16	2	0.59	0.048
Pins	0-1	101	31	10	3	0.67	0.048
	1-2	57	2	8	-	0.65	0.050

SE (Px) was calculated after Greenwood's formula.

Table 3. Incidence of fracture failure and reoperations in 90 patients operated on with the Rydell four-flanged nail and in 80 patients operated on with Gouffon pins, followed for 2 years or until failure (N 170)

	Garden stage	n	Redisplacement/ nonunion (reop)	Segmental collapse (reop)	Total compl.
Nail	Nondisplaced	21	3 (1)	1 (-)	4
	Displaced	69	34 (26)	7 (3)	41
Pins	Nondisplaced	24	1 (-)	2 (1)	3
	Displaced	56	24 (19)	6 (6)	30
Total		170	62 (46)	16 (10)	78

33 percent (85/261) within 2 years after fracture.

Two patients operated on with the four-flanged nail had a superficial wound infection and another 2 patients had infected nonunions. These latter patients died of sepsis a few days after removal of the nail. One patient operated on with Gouffon pins was treated for deep vein thrombosis and 2 patient operated on with the four-flanged nail were treated for pulmonary embolism and deep vein thrombosis.

Of the 223 patients followed, 44 died without any known radiographic healing complication and 9 were lost to follow-up, leaving 170 patients who were followed for 2 years or until redisplacement, nonunion, or late segmental collapse occurred (Table 1).

After 2 years, 45 fractures of 122 treated with the four-flanged nail and 33 of 101 fractures operated on with Gouffon pins had failed. The cumulative failure rate according to the actuarial method of analysis was respectively 41 and 35 percent among patients operated on with the four-flanged nail or the Gouffon pins. This difference was not significant (Tables 1 and 2). Forty-four patients were reoperated on with an endoprosthesis (23 in the nail group and 21 in the pin group), 5 with resection of the femoral head, and

in 7 patients only removal of the fixation device was performed (Table 3).

By multivariate analysis, five factors were found to be associated with radiographic healing complications: an initially displaced fracture ($P < 0.001$), nonsatisfactory reduction ($P < 0.001$), or nonsatisfactory position of the fixation device ($P < 0.01$), an interval to operation exceeding 24 hours ($P < 0.01$), and old age ($P < 0.05$). Sex and type of fixation device had no independent correlation with the failure rate.

In 40 patients with displaced fractures the reduction was unsatisfactory. Only nine of these fractures healed compared with 45 of 85 with a satisfactory reduction ($P < 0.001$). In patients with a displaced fracture, the position of the fixation device was satisfactory in 92 patients, and the fracture healed in 48. In 33 patients, the internal fixation was unsatisfactory, and only six healed ($P < 0.001$).

Thirty-six of 67 displaced fractures operated on within 24 hours after the fracture healed as compared with 18 of 58 operated on later ($P < 0.01$). The position of the fixation device or the interval to operation had no influence on the outcome of the undisplaced fractures.

No difference was noted between the two

fixation methods regarding initial fracture displacement, postoperative reduction, position of fixation device, and interval to operation.

Discussion

In a population of patients with femoral neck fractures, there will be a considerable loss to follow-up, mostly because of a high mortality rate. The type of follow-up will influence the results of the study (Skinner and Powles 1986, Frandsen 1986), and as shown here (Table 1). Therefore, we have also presented our results using an actuarial method, which takes in account patients with different periods of follow-up (Table 2). This statistical method was well described by Dobbs (1980) when assessing total hip replacement and by Skinner and Powles (1986) when assessing femoral neck fracture.

When comparing the results of treatment of fracture of the femoral neck, several problems arise. Different definitions of end points, such as nonunion, necrosis, and healing have been used (Brown and Abrami 1964, Kofoed and Alberts 1980, Frandsen and Andersen 1981, Skinner and Powles 1986). However, we believe that problems with definitions of end points and fracture classification were minimized in our prospective randomized study.

Multivariate analysis was used to identify factors influencing the failure rate. This method can also contribute to eliminate the influence of confounding factors. In this and other studies, the most important factors predicting the outcome of the fracture were the degree of initial displacement of the fracture, the quality of reduction, the position of the fixation devices, and the age of the patients at fracture time (Garden 1961, 1971, Barnes et al. 1976, Kofoed and Alberts 1980, Frandsen and Andersen 1981, Høgh et al. 1982).

Contrary to Barnes et al. (1976) and Holmberg (1985), but in agreement with Brown and Abrami (1964) and Manninger et al. (1985), our study showed that internal fixation within 24 hours after fracture gave a better result than if the operation was delayed.

The complication rate of 16 percent in nondisplaced fractures and 57 percent in displaced fractures agrees well with other investigations (Banks 1962, Holmberg and Thorngren 1984). The Rydell nail was shown by Strömqvist (1983) using scintimetric methods to harm the vitality of the femoral head more than did the LIH-hook pin. The reoperation rate of the displaced fracture treated with the Rydell flanged nail was 36 percent within 1 year of the survivors in Strömqvist's (1983) series and 42 percent after 2 years in this series (Table 3), which are similar results.

In a later study of the LIH-hook pin, Strömqvist et al. (1987) had 33 percent healing complications and 20 percent salvage arthroplasties in the displaced fracture group. In the undisplaced fractures, 5 percent had healing complications, which were all treated by secondary arthroplasty. This is a better result than obtained with either of the two methods used in our study.

We found no difference in complication rate between the Rydell nail and the Gouffon pins. However, the latter method was new at our department and the operation took a longer time. With increased experience, it might have been possible to achieve better results. The operations were performed by all 29 staff members during the 1-year period of our study, whereas the operations in the study of Strömqvist et al. (1987) were performed by only 6 specially trained orthopedic surgeons, which contributed to their better results (Johansson et al. 1986). A type II (B) error, i.e., too few patients may also have introduced a bias into our study.

With ^{99m}Tc -scintimetry, Holmberg and Thorngren (1984) showed that the femoral head had a decreased vitality before internal fixation in half of the displaced fractures; these fractures later developed avascular complications. In our study half of the displaced fractures healed when the reduction or position of the fixation device was satisfactory, or when the internal fixation was performed early. However, when these factors were not optimal, the healing rate was less than one third.

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