Acta Orthop Scand 55, 521–525, 1984

Two-year follow-up of femoral neck fractures

Comparison of osteosynthesis methods

For 14 consecutive months, all 152 femoral neck fracture patients ≥50 years of age admitted to the Lund University Hospital were operated on with two hook-pins if born on an uneven date and a four-flanged nail if born on an even date. A clinical 2-year follow-up revealed a 35 per cent mortality. Among survivors, radiographic healing complications were seen in undisplaced fractures in 1/13 pinned and 5/14 nailed ($p>0.05$) and in displaced fractures in 12/36 pinned and 23/32 nailed ($p<0.01$). This outcome correlated well with the early postoperative scintimetry. Reoperation within 2 years had been performed for seven pinned and 19 nailed fractures. In hook-pinning, thus, less than one patient out of 12 needed a reoperation with THR within 2 years. This figure is interpreted as strongly favouring hook-pinning before arthroplasty as the primary procedure in femoral neck fracture.

Björn Strömqvist
Lars Ingvar Hansson[1]
Lars T. Nilsson
Karl-Göran Thorngren

University Departments of Orthopaedic Surgery in Lund, S-211 85 Lund, Sweden and Umeå[1], Sweden

In spite of the large number of internal fixation devices designed for the treatment of femoral neck fractures (Tronzo 1974, Strömqvist 1983), prospective studies comparing the clinical results after different types of internal fixation (Frandsen & Andersen 1981) are rare. Probable reasons for this are the high mortality rate and the necessity of a follow-up of at least 2 years to detect the majority of healing complications (Öhman et al. 1969, Garden 1971, Barnes et al. 1976, Strömqvist et al. 1984). While redisplacement and non-union are obvious complications within the first postoperative year, segmental femoral head collapse most often occurs during the second postoperative year, and infrequently later (Barnes et al. 1976, Calandruccio & Anderson 1980).

This investigation comprises a clinical and radiographic 2-year follow-up of a prospective, randomized population-based series of femoral neck fractures, treated either with a 4-flanged nail (Rydell 1964) (Figure 1) or with hook-pins (Hansson 1982) (Figure 2). The early postoperative scintimetric evaluation of the present material has been published previously (Strömqvist et al. 1983).

Material and methods

All intracapsular femoral neck fractures in patients ≥50 years of age admitted to the Lund University Hospital from January 1981 through February 1982 were included, a total of 152 fractures. The hospital is the only one in the area for treatment of fractures, covering a population of 170 000 persons.

All patients with an even birthdate were treated with the 4-flanged nail (Figure 1), and those with an uneven birthdate with two hook-pins (Figure 2).

Fractures with minor displacement, Stages I and II according to Garden (1961), were grouped together as undisplaced fractures, while those with major displacement, Stages III and IV, were called displaced.

Thus, 70 fractures, 18 undisplaced and 52 displaced, were treated with the nail (mean patient age was 79 (53–95) years), while 82 fractures, 24 undisplaced and 58 displaced, had pins (mean patient age 78 (52–94) years).

Routines for fracture treatment and follow-up were: preoperative tibial traction for all displaced fractures, postoperative scintimetry 1–2 weeks after nailing and radiographic and clinical follow-up at 4, 12, and 24 months after the operation or until reoperation or death.

All fractures were operated on by one of six surgeons, with similar distribution between the two types of internal fixation. The operation was performed with the patient placed on an extension table, and fluoroscopy, usually bi-plane, was used. Anatomic or slight (<15°) valgus position was the aim of the fracture reduction and the nail as well as the distal pin were placed as in Figures 1 and 2; i.e. entering the femur just below the trochanter minor level, touching the medial cortex of the femoral neck and ending centrally in the head of the femur. The proximal pin was inserted parallel to the former,

Figure 1. Femoral neck fracture after osteosynthesis with a four-flanged nail.

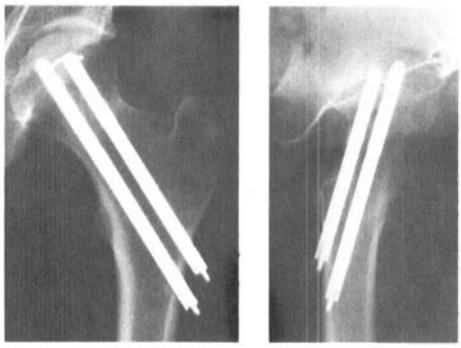

Figure 2. Femoral neck fracture after osteosynthesis with two hook-pins.

preferably touching the posterior femoral neck cortex. Immediate full weight-bearing from the first postoperative day was allowed for all patients. Prophylactic antibiotics were not used.

The radiographic healing complications were listed as: redisplacement, non-union and segmental collapse. The recognition of a depressed segment of the femoral head, varying from a deep wedge to a thin cortical shell (Brown & Abrami 1964) established the diagnosis of segmental femoral head collapse.

Results

No deep infections were seen. One nailed patient sustained a subtrochanteric fracture after a new fall. This fracture was stabilized with a sliding screw and plate and was uneventfully healed at 2 years.

1. Mortality

No patients died during the operation or the immediate postoperative course, but five patients died while still in hospital within 14 weeks of the operation. In all, 22 patients died within 4 months of the operation, another 20 within the first postoperative year and 15 during the second year; i.e. 57 of 152 patients were dead within 2 years of their femoral neck fracture (Table 1).

2. Two-year follow-up

a. Radiographic evaluation. None of the 57 patients who died within 2 years of fracture had radiographic complications diagnosed. Only six of these 57 were seen at 1 year, however; the others were in too bad a medical condition for follow-up.

At 2 years postoperatively, 95 fractures remained for evaluation, 46 treated with the nail and 49 with pins.

In all, radiographic complications were seen in 28 of 46 nailed fractures and in 13 of 49 pinned fractures (Table 2). This difference is significant ($p<0.01$).

Five of 14 nailed, undisplaced fractures had developed complications. For the pinned, undisplaced fractures, complications had occurred in one out of 13 (Table 2); this difference, however, is not significant ($p>0.05$).

For the displaced fractures the complications amounted to 23 out of 32 for nailed and 12 out of 36 pinned fractures (Table 2). This difference is significant ($p<0.01$).

Segmental collapse accounted for all the six complications developing among undisplaced fractures (Table 3). In nailed displaced fractures, redisplacement/non-union accounted for 14 and segmental collapse for nine of 23 complications. In 12 pinned displaced fractures with radiographic complications, eight were caused by redisplacement/non-union and four by segmental collapse.

No difference was noted between the nail group and the pin group regarding fracture position after reduction or placement of the internal fixation device, whether studied in the total material or in the fractures developing radiographic complications only. Nor was there any difference in these aspects when the group of fractures developing radiographic complica-

Table 1. Two-year results of total material (n = 152). Redisplacement, non-union and segmental collapse are grouped together as radiographic healing complications.
*** = 0.001 < p < 0.01*
N.S. = P > 0.05

	No complication	Radiographic healing complication	+	Total
Nailed	18	28	24	70
	**	**	N.S.	
Pinned	36	13	33	82
	54	41	57	152

Table 2. Established radiographic healing complications versus uncomplicated 2-year results (n = 95), 46 with nailed and 49 with pinned fractures.
*** = 0.001 < p < 0.01*
N.S. = P > 0.05

		No complications	Radiographic healing complication		Total
Undisplaced fractures	/ Nailed	9	5	N.S.	14
	\ Pinned	12	1		13
Displaced fractures	/ Nailed	9	23	**	32
	\ Pinned	24	12		36
Total	/ Nailed	18	28	**	46
	\ Pinned	36	13		49

tions was compared with the group with uncomplicated healing at 2 years.

b. Reoperation. Reoperation because of redisplacement/non-union had been performed or was scheduled for 11 of 14 nailed fractures and five of eight pinned fractures (Table 3). Segmental collapse had led to reoperation in eight of 14 nailed fractures and in two of six pinned (Table 3).

3. Correlation of clinical results and postoperative scintimetry

Of 138 patients submitted for 1–2 weeks postoperative prognostic scintimetry using ^{99m}Tc-MDP, 92 survived long enough to develop healing complications or an uncomplicated 2-year result radiographically.

According to the scintimetry, there was a good prognosis (ratio < 1.0) (Strömqvist 1983) in 48 cases, 45 of whom showed no signs of complications at 2 years (Table 4). The remaining three had all developed segmental collapse; their scintimetric outcome was close to the border between a good and a bad prognosis.

A bad prognosis according to scintimetry (ratio ≤ 1.0) occurred for 44 fractures. Thirty-seven of these had developed healing complications (redisplacement/non-union in 20 and segmental collapse in 17 cases), while seven fractures with bad scintimetric prognosis showed no radiographic signs of complications at 2 years. Three of these patients, however, complained of increasing hip pain of recent onset at the 2-year follow-up.

Discussion

The study presented includes every femoral neck fracture in a patient ≥50 years of age admitted to the department for 14 consecutive months, which makes it representative concerning age, sex, fracture displacement and mortality (Alffram 1964, Barnes et al. 1976, Jensen & Töndevold 1979, Strömqvist 1983).

Table 3. Incidence of reoperation in nailed (n = 28) and pinned (n = 13) fractures with radiographic healing complications within 2 years of fracture

		Redisplacement/Non-union		Segmental collapse		Total
		Reop.	Not reop.	Reop.	Not reop.	
Nailed	/Undisplaced	–	–	3	2	5
	\Displaced	11	3	5	4	23
Pinned	/Undisplaced	–	–	1	–	1
	\Displaced	5	3	1	3	12
Total		16	6	10	9	41

*Table 4. Accuracy of healing complication prediction of early postoperative scintimetry (n = 92). Intact femoral head uptake = uptake higher than or equal to that of the intact side. Deficient femoral head uptake = uptake lower than that of the intact side. *** = $p < 0.001$.*

		No complication	Radiographic healing complication	Total
Femoral head uptake	/Intact	45	3***	48
	\Deficient	7	37	44
	Total	52	40	92

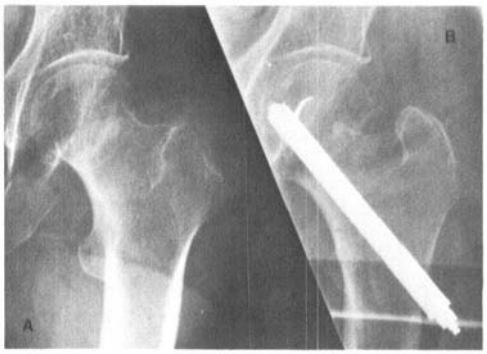

Figure 3. Impacted femoral neck fracture. Disimpaction and a fracture diastasis were noted immediately after nailing.

The complication rate of the present investigation showed significantly lower values in the pin group, whether the total material or the displaced fractures only were studied. Inadequate fracture reduction and inadequate internal fixation could be ruled out as a reason for this, as well as for the development of radiographic complications in the individual case. Instead, the superiority of the pins corresponded well to the difference in postoperative scintimetric results and was predicted previously (Strömqvist et al. 1983). It is most probably accomplished by the atraumatic insertion method used for the hook pins: the pin channel is predrilled and the hook is inserted with a screw mechanism. Predrilling is also used for the core of the four-flanged nail, but the flanges are prepared for using a punch, and hammered in; the hook is also hammered in. In femoral neck fracture, the transosseous blood supply to the femoral head must by definition be absent. The ligamentum teres circulation is inadequate for supplying the whole of the head of the femur with blood (Kolodny 1925, Trueta & Harrison 1953, Sevitt & Thompson 1965), although single cases have been demonstrated by Sevitt (1964, 1981) and Catto (1965) where revascularization has been accomplished solely by this route. For practical purposes, thus, femoral head vascularization after an intracapsular fracture is wholly dependent on the retinacular vessels. It is our opinion that the fracture separation often caused by the insertion of the flanged nails (Figure 3) inflicts additional injury on already strained retinacular vessels. The rather high incidence of complications recorded in displaced fractures operated on with the four-flanged nail is comparable to that reported by Frandsen & Andersen (1981) with a three-flanged Thornton nail.

Reoperation within 2 years from fracture had been performed in seven out of 82 pinned fractures (six out of 58 displaced). The reoperation frequencies of many previous investigations have probably been lowered by a rather short follow-up, after which only patients with a complication, who were active enough to seek medical attention on their own initiative, have been reoperated. The figures presented must question the policy of primary hip arthroplasty for femoral neck fracture, whether in general or for displaced fractures only.

Concerning redisplacement/non-union, the figures presented represent the ultimate result, while segmental femoral head collapse may be expected to occur in a few further cases during the third postoperative year, probably in those with bad prognostic scintimetry and reporting recent onset of hip pain in spite of a normal radiograph at 2 years. Most authors conclude that 20–25 per cent of the collapses occur later than 2 years postoperatively (Barnes et al. 1976, Calandruccio & Anderson 1980).

In this study, no radiographic signs of healing complications were noted at 2 years in seven fractures with unfavourable prognosis according to scintimetry. Four of these were pinned and three nailed. Should all of them later develop segmental collapse, the significances presented would still not be affected.

Three of 48 fractures with a favourable scintimetric prognosis developed complications; this may be explained by the fact that they had

borderline values, which was also the case for three of the fractures with an unfavourable prognosis and an uncomplicated healing course.

The multitude of internal fixation devices for femoral neck fractures on the market today can and should be reduced on scientific grounds with prospective randomized studies like that presented by Frandsen & Andersen (1981) and the present investigation, to the benefit of the increasing number of femoral neck fracture patients (Nilsson & Obrant 1978, Zetterberg & Andersson 1982, Swanson & Murdoch 1983) and of strained hospital resources (Lewinnek et al. 1980).

References

Alffram, P. A. (1964) An epidemiologic study of cervical and trochanteric fractures of the femur in an urban population. *Acta Orthop. Scand.* Suppl. 65.

Barnes, R., Brown, J. T., Garden, R. S. & Nicoll, E. A. (1976) Subcapital fractures of the femur. *J. Bone Joint Surg.* **58**-B, 2–24.

Brown, J. T. & Abrami, G. (1964) Transcervical femoral fracture. *J. Bone Joint Surg.* **46**-B, 648–663.

Calandruccio, R. A. & Anderson, W. E. (1980) Post-fracture avascular necrosis of the femoral head. *Clin. Orthop.* **152**, 49–84.

Catto, M. (1965) A histological study of avascular necrosis of the femoral head after transcervical fracture. *J. Bone Joint Surg.* **47**-B, 749–776.

Frandsen, P. A. & Andersen, P. E. (1981) Treatment of displaced fractures of the femoral neck. *Acta Orthop. Scand.* **52**, 547–552.

Garden, R. S. (1961) Low-angle fixation in fractures of the femoral neck. *J. Bone Joint Surg.* **43**-B, 647–663.

Garden, R. S. (1971) Malreduction and avascular necrosis in subcapital fractures of the femur. *J. Bone Joint Surg.* **53**-B, 183–197.

Hansson, L. I. (1982) Osteosynthesis with the hook-pin in slipped capital femoral epiphysis. *Acta Orthop. Scand.* **53**, 87–96.

Jensen, J. S. & Tøndevold, E. (1979) Mortality after hip fractures. *Arta Orthop. Scand.* **50**, 161–167.

Kolodny, A. (1925) The architecture and the blood supply of the head and neck of the femur and their importance in the pathology of fractures of the neck. *J. Bone Joint Surg.* **23**, 575–589.

Lewinnek, G. E., Kelsey, J., White, A. A. & Kreiger, N. J. (1980) The significance and a comparative analysis of the epidemiology of hip fractures. *Clin. Orthop.* **152**, 35–43.

Nilsson, B. E. & Obrant, K. J. (1978) Secular tendencies of the incidence of fracture of the upper end of the femur. *Acta Orthop. Scand.* **49**, 389–391.

Öhman, U., Björkegren, N. Å. & Fahlström, G. (1969) Fracture of the femoral neck. A five-year follow-up. *Acta Chir. Scand.* **135**, 27–42.

Rydell, N. (1964) Osteosynthesis of medial collum fractures with the "spring-loaded nail". *Acta Orthop. Scand.* **35**, 149–157.

Sevitt, S. (1964) Avascular necrosis and re-vascularisation of the femoral head after intracapsular fractures. *J. Bone Joint Surg.* **46**-B, 270–296.

Sevitt, S. (1981) Bone repair and fracture healing in man. In: *Current problems in orthopaedics,* Ch. 13:4. Churchill Livingstone, Edinburgh, London.

Sevitt, S. & Thompson, R. G. (1965) The distribution and anastomoses of arteries supplying the head and neck of the femur. *J. Bone Joint Surg.* **47**-B, 560–573.

Strömqvist, B. (1983) Femoral head vitality after intracapsular hip fracture. *Acta Orthop. Scand.* Suppl. 200.

Strömqvist, B., Hansson, L. I., Palmer, J., Ceder, L. & Thorngren, K. G. (1983) Scintimetric evaluation of nailed femoral neck fractures with special reference to type of osteosynthesis. *Acta Orthop. Scand.* **54**, 340–347.

Strömqvist, B., Brismar, J., Hansson, L. I. & Palmer, J. (1984) ^{99m}Tc-MDP scintimetry after femoral neck fracture – a three-year follow-up study. *Clin. Orthop.* **182**, 177–189.

Swanson, A. J. G. & Murdoch, G. (1983) Fractured neck of femur. *Acta Orthop. Scand.* **54**, 348–355.

Tronzo, R. G. (1974) Hip nails for all occasions. *Orthop. Clin. North Am.* **5**, 478–491.

Trueta, J. & Harrison, M. H. M. (1953) The normal vascular anatomy of the femoral head in adult man. *J. Bone Joint Surg.* **35**-B, 442–461.

Zetterberg, C. & Andersson, G. B. J. (1982) Fractures of the proximal end of the femur in Göteborg, Sweden, 1940–1979. *Acta Orthop. Scand.* **53**, 419–426.