Femoral neck fracture fixation with hook-pins

2-year results and learning curve in 626 prospective cases

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We performed a prospective 2-year follow-up study of 626 consecutive femoral neck fractures treated with closed reduction and hook-pin fixation in all cases. The woman:man ratio was 2.9:1, the displaced:undisplaced fracture ratio 2.6:1. Mean patient age was 78 (18–100) years. The first 476 fractures were operated on by one of six surgeons with special interest in the technique, while the remaining operations were performed by any of the 35 surgeons in the department, all specialists in orthopedic surgery.

Mortality within two years was 31 percent. Healing complications (redisplacement, nonunion or segmental femoral head collapse) in the total material/survivors only were for undisplaced fractures 5/7 percent, for displaced fractures 30/41 percent and for the total material 23/32 percent. According to life-table analysis, the complication rate in the total material at two years was 24 percent. The rate of secondary arthroplasty for healing complications was 13/19 percent. For displaced fractures, as well as for the total material, the group of specially interested surgeons had better results than the department as a whole.

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Originally, hook-pins were developed for fixation of slipped capital femoral epiphysis in children (Hansson 1982). The technique of internal fixation of femoral neck fracture with two hook-pins (Figure 1) was developed in the late 1970s and was described in the literature for the first time in 1983 (Strömqvist et al. 1983). Previous presentations have shown better results after hook-pin fixation than after nailing of femoral neck fractures (Strömqvist et al. 1984, Nilsson 1989), and a low complication rate in a material of 300 patients with hook-pin fixation performed by one of six specially interested surgeons (Strömqvist et al. 1987).

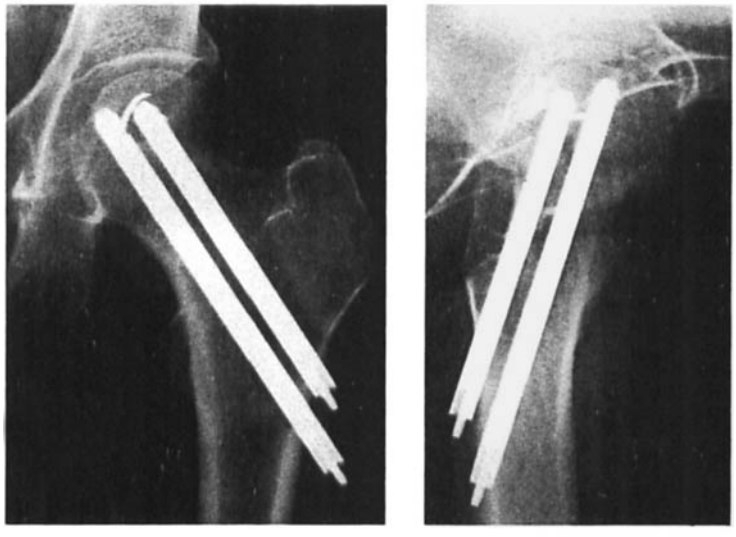
Our aims were to establish the complication rate in an expanded population-based consecutive and prospective material of hook-pinned femoral neck fractures, and to explore the importance of surgical training for reducing femoral neck fracture complications.

Patients

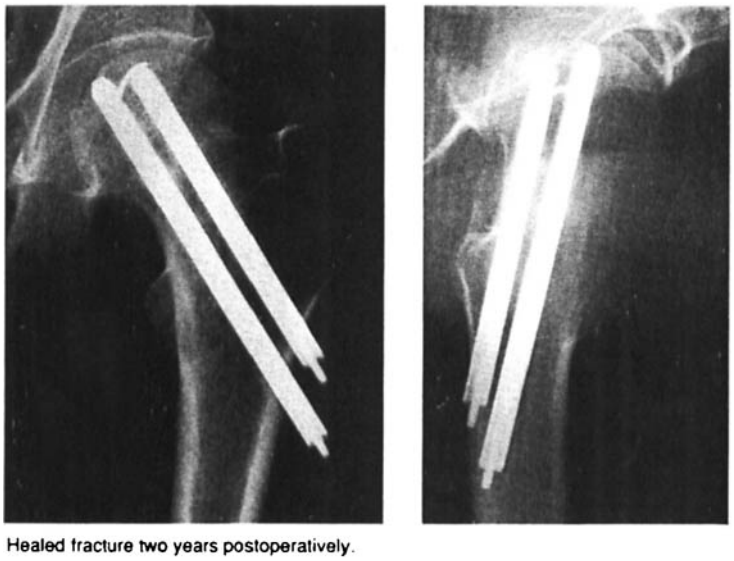
The first 10 cases of femoral neck fracture fixation with two hook-pins were treated in the late 1970s. In a comparative study from January 1981 through February 1982 all femoral neck fracture patients born on an uneven date were operated on with two hook-pins, those born on an even date were operated on with nailing (Strömqvist et al. 1984). From March 1982 on, all femoral neck fractures have been treated with hook-pin fixation at our department (Strömqvist et al. 1987, Nilsson et al. 1989a). All fractures admitted before May 1984 were operated on by a group of six surgeons with special interest in the method (experienced surgeons) while after this time, the operations were performed by any of the 35 surgeons in our department, all specialists in orthopedic surgery (inexperienced surgeons). The end point of the study was October 1985.

All patients operated on during the time period described were included in a prospective 2-year follow-up study. 668 fractures were admitted. For 39 fractures, no follow-up could be done. None of these had had an arthroplasty performed, and no complications were known, but the patients were excluded. One further patient (suffering from rheumatoid arthritis, with a displaced fracture) according to a change in treatment policy for this sub-group, introduced in 1985 (Strömqvist et al. 1988) had a primary total hip replacement, and two patients died before operation. The material thus comprises 626 fractures. Mean patient age was 78 (18–100) years. Woman:man ratio was 2.9:1 and displaced:undisplaced fracture ratio was 2.6:1.

Preoperatively.



After closed reduction and hook-pin fixation.



Healed fracture two years postoperatively.

Figure 1. Displaced femoral neck fracture in a 49-year-old woman.

Methods

Displaced fractures were treated with pin traction on admission. The operation was usually carried out on the day after admission, if no contraindications were present. During operation, an extension table and fluoroscopy were used. A number of patients participating in a tetracycline staining study of femoral head viability had a single dose of this drug pre- or peroperatively, otherwise no antibiotic prophylaxis was given. Full weight bearing was allowed from the first postoperative day except for patients less than 50 years of age with displaced fractures. This group of patients was prescribed a six-week period of nonweight bearing.

The follow-up protocol included radiography on the operating table, within one week postoperatively, and clinical and radiographic follow-ups at 4, 12, and 24 months postoperatively. Mobile symptomatic patients with healing complications were offered the possibility of secondary total hip replacement; patients immobile due to other disease had pin extraction only.

Preoperatively the fractures were classified as undisplaced (Garden [1961] stage 1 or 2) or displaced (Garden stage 3 or 4). As healing complications were regarded: redisplacement and/or nonunion of the fracture and segmental collapse of the femoral head.

In neither of the groups of surgeons was the learning period excluded; the first operations by surgeons in the inexperienced group were supervised by one of the six trained surgeons. In total, 476 operations were carried out by the experienced surgeons and 150 operations by the inexperienced.

The chi-square test with continuity correction was used to compare groups. Life table analysis as proposed by Dobbs (1980) was performed.

Table 1. Two-year results for the total material. Within brackets deceased patients with complication. *P*-value denotes difference between experienced and inexperienced surgeons concerning healing complications

	n	Nonunion		Segm. collapse		Deaths	*P*-value
		Total	THR	Total	THR		
Undisplaced fractures							
Inexperienced	46	2	2	1 (+1)	0	15	0.378
Experienced	129	3	2	2	2	37	
Total	175	5	4	3 (+1)	2	52	
Displaced fracture							
Inexperienced	104	30 (+4)	19	7 (+1)	4	30	0.011
Experienced	347	64	45	28 (+1)	8	110	
Total	451	94 (+4)	64	35 (+2)	12	140	
Total series							
Inexperienced	150	32 (+4)	21	8 (+2)	4	45	0.014
Experienced	476	67	47	30 (+1)	10	147	
Total	626	99 (+4)	68	38 (+3)	14	192	

Results

No mortality within the first 24 hours after the operation occurred. In total, 192 patients died within two years from the operation (31 percent), four of whom with nonunion and three with segmental femoral head collapse. Four patients had a deep infection and three patients subtrochanteric fractures through the entrance of the distal pin, all occurring with new trauma after healing of the cervical fracture. The subtrochanteric fractures were plate-fixated and healed without complications.

Below, figures for the total material/2-year survivors only, are presented.

Complications

The radiographic 2-year result (Table 1) in 175 undisplaced fractures was 5 cases of nonunion and 4 of segmental collapse (one of whom died within two years). For 451 displaced fractures, the complications were 98 cases of nonunion (four of whom died within two years) and 37 of segmental collapse (two of whom died within two years). Among the 434 2-year survivors in the total material, thus, nonunion was seen in 99 cases and segmental collapse in 38, while 297 patients had no radiographic signs of complications at two years. This adds up to a healing complication rate (total material/2-year survivors only) of 5/7 percent for undisplaced fractures, 30/41 percent for displaced fractures and in the total material 23/32 percent. Secondary arthroplasty for healing complications was performed in 13/19 percent of the patients.

The rate of healing complications among two-year survivors was for displaced fractures fairly independent of patient age (Table 2).

Life table analysis

Using life table analysis, the 2-year complication rate was calculated as 24 percent for the total material and 7/33 percent for undisplaced/displaced fractures (Figure 2).

Influence of surgeons

The healing complication rate (expressed in percent) when experienced (E) and inexperienced (I) surgeons were compared (Table 3), were for undisplaced fractures E: 4, I: 9 (N.S.). For displaced fractures the corresponding figures were E: 27, I: 40 ($P = 0.011$) and for the total material E: 23 and I: 31 ($P = 0.014$).

The risk of secondary arthroplasty for a healing complication was for undisplaced fractures E: 3.0 and I: 4 (N.S.) and for displaced fractures E: 15 and I: 22 (N.S.).

Discussion

This material is population-based and prospective, and the 2-year follow-up should cover the vast majority of healing complications (Barnes et al. 1976, Holmberg et al. 1987). The complication rate, thus, is probably close to the ultimate result. However, a minor number of secondary arthroplasties may have been performed after the second postoperative year (Nilsson et al. 1989b) which might increase this figure.

Table 2. 2-year results (percent) of closed reduction and internal fixation in different age groups. Healing complication (Hc)

	Undisplaced fractures					Displaced fractures				
	Age	Healed	Hc	Deaths	Hc/surv	Age	Healed	Hc	Deaths	Hc/surv
60	< 60	94	6	0	6	< 60	68	29	3	30
	≥ 60	61	5	34	7	≥ 60	41	26	33	38
65	< 65	96	4	0	4	< 65	69	29	2	30
	≥ 65	59	6	36	8	≥ 65	40	26	34	39
70	< 70	97	3	0	3	< 70	60	26	14	30
	≥ 70	56	6	38	8	≥ 70	39	27	34	40
75	< 75	91	2	8	2	< 75	57	26	17	32
	≥ 75	53	7	41	10	≥ 75	38	27	36	41
80	< 80	82	4	14	3	< 80	52	30	18	36
	≥ 80	47	7	46	13	≥ 80	34	23	42	40
85	< 85	73	6	21	6	< 85	45	29	26	38
	≥ 85	42	4	54	9	≥ 85	36	21	43	39
90	< 90	66	5	29	6	< 90	44	27	29	38
	≥ 90	50	7	43	13	≥ 90	36	20	44	33

Table 3. 2-year results (percent) of 476 hook-pin fixations performed by experienced surgeons (E; see text) and of 150 operations performed by inexperienced surgeons (I)

Healing complication	Undisplaced		Displaced		Total material	
	E	I	E	I	E	I
Healed	96	91	73	60	77	69
Complication	1	4	12	18	11	14
Complication and THR	3	4	15	22	12	17

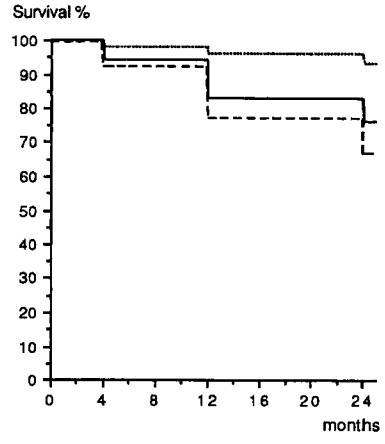


Figure 2. Life-table analysis of the total material and of undisplaced fractures and displaced fractures, respectively. Redisplacement, nonunion and segmental collapse of the femoral head are designated as complications. Continuous line, total material; dotted line, undisplaced fractures; dashed line, displaced fractures.

Functional treatment of undisplaced, impacted femoral neck fractures reduces the total number of operations (Raymaakers 1988, van Vugt 1991). However, redisplacement occurs in 5–20 percent of the fractures most often resulting in arthroplasty. Our study reports considerably fewer complications following primary osteosynthesis in this group. Other valid alternative treatment methods of femoral neck fractures today are primary hip prostheses. Two studies have in an acceptable way compared osteosynthesis and primary arthroplasty. Søreide et al. (1979) compared von Bahr screws with the Christiansen bipolar arthroplasty and concluded that arthroplasty was an acceptable alternative. However, Søreide et al. (1980) published a 5-year follow up of the Christiansen method and were much more cautious as functional results seemed to deteriorate dramatically with time. In the other study van Vugt (1991) randomized intracapsular hip fracture patients aged 71–80 years in good physical and mental condition. In 21 cases, osteosynthesis (DHS-screw-plate) was performed and in 22 cases a cemented bipolar hemiarthroplasty. Primary hemiarthroplasty led to comparable results although at follow-up after two years a tendency to increased incidence of moderate and poor outcome for hemiarthroplasty was apparent and it was concluded that osteosynthesis is justified as primary treatment, even though a fairly extensive primary osteosynthesis had been used. Whether a cemented or an uncemented hemiprosthesis should be used or a bipolar hemiprosthesis or a total hip replacement be performed has not been settled. Cardiovascular complications, infection, and prosthesis dislocation are frequent and the peropera-

tive and postoperative mortality increased (Hunter 1980, Taine and Armour 1985). The clinical results after primary hemiarthroplasty in many cases are not satisfactory as regards pain and hip function, and deteriorate with time (Stinchfield 1957, Whittaker et al. 1972, Jensen and Holstein 1975, Johnson and Crothers 1975, Gingras et al. 1980, Søreide et al. 1980, Diercks and Hollander 1985, Dorr et al. 1986.) Total hip replacement yields better long-term results regarding walking ability and pain (Sim and Stauffer 1980, Taine and Armour 1985, Dorr et al. 1986, Delamarter and Moreland 1987). Still, the risk of general complications is increased, and dislocation of the prosthesis is more common when total hip replacement is performed for cervical hip fracture than for coxarthrosis (Johnsson et al. 1984). However, it should be borne in mind that in contrast to our close to final figures for primary osteosynthesis, the 2-year results after primary arthroplasty will deteriorate significantly with time due to prosthetic loosening and migration (Greenough and Jones 1988, Franzén et al. 1990). The possibility of performing primary arthroplasty in subgroups with inferior prognosis has been proposed. Displaced fractures in rheumatoid arthritis have a very bad prognosis (Strömqvist et al. 1988). Accordingly we changed our policy for these patients in 1985 to primary arthroplasty. Parkinson's disease does not seem to be a factor contraindicating internal fixation (Londos et al. 1989). However, other subgroups with intercurrent diseases, fracture displacement or bone quality hopefully will be identified in the future. Secondary arthroplasty for femoral neck fracture complication has been demonstrated to be a safe procedure with short- and long-term results comparable with primary arthroplasty (Hägglund et al. 1984, Nilsson et al. 1986, Franzén et al. 1990). Quality of life for patients with secondary total hip replacement is inferior than for those with a healed fracture (Nilsson et al. 1991).

The main predisposing factor for healing complications after femoral neck fracture is injury to the femoral head vascularization (Hulth 1965, Strömqvist 1983), while mechanically insufficient procedures for reduction technique and osteosynthesis placement chiefly predispose to redisplacement of the fracture (Garden 1971, Arnoldi and Lemperg 1977, Kofoed and Alberts 1980, Holmberg et al. 1987, Alberts and Jervaeus 1990). As fracture redisplacement is the complication which most often requires hip arthroplasty (Massie 1973, Barnes et al. 1976), the importance of surgical technique should be emphasized. Specialists in orthopedic surgery fare better than general surgeons in femoral neck fracture fixation (Holmberg et al. 1987). The immediate postoperative radiographic outcome is superior for experienced surgeons as compared to inexperienced (Johansson et al. 1986). This study underlines the importance of surgical skill in the often underrated procedure of femoral neck fracture fixation. Especially reduction of the fracture but also the positioning of the osteosynthesis material is of great importance. Our figures do not suggest that super-specialists should perform reduction and fixation of femoral neck fractures but rather, due to the frequency of these fractures, that increased interest should be focused on the procedure and that increased efforts in training junior surgeons should be made.

Hook-pin fixation has been shown to be superior to nailing as regards the postoperative femoral head viability (Strömqvist et al. 1983). It seems very important to use osteosynthesis exerting little trauma to the femoral head vascularization (Rehnberg and Olerud 1989). According to tetracycline studies (Strömqvist and Hansson 1983), virtually every femoral head has some degree of reduced viability after femoral neck fracture. We do not know, however, what degree of viability reduction that is compatible with uncomplicated fracture healing and avoidance of segmental collapse. Further improvements may still be hoped for, but taking into account the results of our study, primary hook-pin fixation performed by well-trained surgeons seems to be one of the methods of choice for treating femoral neck fractures today.

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