Cannulated screws for fixation of femoral neck fractures

No difference between Uppsala screws and Richards screws in a randomized prospective study of 268 cases

Magnus Lagerby, Stefan Asplund and Ivar Ringqvist

We compared 2 types of cannulated hip screws in a randomized prospective study of 268 femoral neck fractures. Complications were defined as penetration of the screw into the joint, early redisplacement, nonunion or segmental collapse. During the first year, complications were noted in 31 of 130 patients treated with 3 Richards screws and in 34 of 138 patients treated with 2 Uppsala screws. Secondary arthroplasty was performed in 17 cases in the Richards group and in 16 cases in the Uppsala group. Clinical outcome did not differ between the groups.

Departments of Orthopedics and Research, Central Hospital, SE-721 89 Västerås, Sweden
Tel +46 21 17-30 00. Fax -52 90
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In 1989, Rehnberg and Olerud demonstrated excellent results in femoral neck fractures with the Uppsala screw technique. Since then, the Uppsala screw (Olmed Medical AB) has become a common device for femoral neck fractures in Sweden (Sernbo and Fredin 1993). At the time of introduction of the Uppsala screw, the current method in our department was fixation with the Richards cannulated hip screw (pin) (Smith & Nephew Richards Inc.). In the Richards technique, 3 screws with a 4.8 mm shaft and a 6.86 mm thread diameter are used. In the Uppsala technique, 2 screws with a 6 mm shaft and an 8 mm thread diameter are used. The Uppsala screws are designed to be fixed in the subchondral bone of the femoral head, and both types of screw are inserted over a guide wire (Figure 1). In a randomized study, we compared healing complications, reoperations and clinical outcome in the two methods.

Patients and methods

Study design

From May 1992 to April 1994, 287 cases (285 patients) of femoral neck fractures were included in the study. Pathological fractures were excluded. On admission, the fractures were classified as undisplaced (Garden stages I & II) and displaced (Garden stages III & IV) fractures. Fractures in these 2 groups were randomly assigned to treatment with either 2 Uppsala screws or 3 Richards screws. Randomization was performed in blocks of 4, using a closed-envelope system. The envelopes were drawn in sequential order. The study was approved by the Ethics Committee of Uppsala University and informed consent was obtained from the patients.

If the fracture could not be successfully reduced, it was treated with primary arthroplasty. Radiography was carried out on the operating table and 1 week postsurgery. Clinical and radiographic examinations were performed at 4 and 12 months after surgery. The need for walking aids, reports of pain and the occurrence of any healing complications were registered. Complications were recorded as penetration of the screw into the joint, early redisplacement (within 3 months), nonunion or segmental collapse. Patients who had a complication were excluded from further study.

Figure 1. Uppsala screw (upper) and Richards screw (lower).

Table 1. Median age, gender, living conditions and walking aids prior to injury

Fixation device	n	Age years	Women	Living in institution	1 cane or none	2 canes or more aids	Not ambulatory
Richards screws	130	80 (50–94)	86 (66%)	41 (32%)	83 (64%)	44 (34%)	1
Uppsala screws	138	81 (31–99)	93 (67%)	47 (34%)	88 (64%)	44 (32%)	5 (4%)

Table 2. Radiographic evaluation

Fixation device	Small caput fragment	Adequate reduction	Adequate screw positioning	Posterior cortical support
Richards screws	21 (16%)	96 (74%)	75 (58%)	75 (58%)
Uppsala screws	30 (22%)	98 (71%)	76 (55%)	51 (37%)

Drop-out rate

2 patients died before surgery. In 15 cases, a primary hip replacement was performed because the fracture could not be successfully reduced (7 cases) or because the head fragment was considered too small (8 cases). 1 patient had an acute myocardial infarction and was later transferred without an operation. In 1 patient the surgeon used a sliding screw and plate device, because he interpreted the findings as a lateral femoral neck fracture. After exclusion of these patients, there were 268 cases (266 patients) internally fixated with either Richards screws (130 cases) or Uppsala screws (138 cases). In 28 cases, the patient did not complete the follow-up as planned. These cases were included in the analysis until the time of drop-out.

Surgical procedure

Patients with displaced fractures were treated with skin traction before surgery. All patients were treated as part of the routine practice in our department. The operations were performed by 20 surgeons, with the patient on an extension table. Fluoroscopy was used during all operations. Full weight-bearing was encouraged from the first day after surgery.

Radiographic evaluation

Reduction was considered adequate when (a) the proximal fragment was not inferior to the distal fragment in the anteroposterior view, (b) there was no varus angulation and (c) posterior angulation was less than 5°. Screw positioning was considered adequate when (a) the distal screw was in contact with the calcar, (b) screw tips (at least 2) were within 5 mm from the subchondral bone, (c) screw tips were not penetrating the joint (less than 2 mm past the subchondral bone), (d) screws were parallel (less than 5° deviation), (e) not all screws were in the cranial half of the femoral head and (f) not all screws were in the anterior half of the femoral head.

Posterior cortical support (proximal screw in contact with the femoral neck posteriorly) was noted. The proximal fragment was considered small, if the distance from the caput center to the fracture line in the a-p view was less than 15 mm (Alho et al. 1991).

Statistics

To demonstrate a 20% difference in healing rate (70% versus 90%), at least 130 patients were needed, evenly divided between the groups (alfa 0.05 and beta 0.20).

Group differences regarding age, time lapse to operation, operating time, amount of bleeding and time in hospital were studied, using the Wilcoxon-Mann-Whitney test. The chi-square test was used to compare the 2 groups, regarding dichotomous distributions. Differences in time until complication in the 2 groups were analyzed with the Kaplan-Meier method and the log-rank test. Variables that could influence complications were entered in the multiple logistic regression analysis.

Results

The 2 treatment groups were similar regarding age, gender or living conditions before injury (Table 1). Radiographic evaluation revealed a higher frequency of posterior cortical support in the Richards group ($p = 0.005$); otherwise, there were no significant differences between the 2 groups, including the occurrence of a small proximal fragment ($p = 0.3$, Table 2).

The mortality rate was 4% (10/268) within the first month, 9% (25/268) in the first 4 months and 20% (53/268) in the first postoperative year, with no difference between the groups.

Table 3. Complications (reoperation with endoprosthesis)

Garden stage	Fixation device	n	Early re-displacement	Screw penetration	Nonunion	Segmental collapse	Total complications
I & II	Richards screws	37	0	0	1 (1)	3 (1)	4 (2)
	Uppsala screws	38	0	0	1 (0)	6 (1)	7 (1)
III & IV	Richards screws	93	5 (3)	0	21 (11)	2 (2)	28 (16)
	Uppsala screws	100	3 (2)	2 (2)	17 (7)	4 (4)	26 (15)
Total		268	8 (5)	2 (2)	40 (19)	15 (8)	65 (34)

During the first year, complications were noted in 24% (31/130) of fractures treated with Richards screws and in 25% (34/138) of fractures treated with Uppsala screws. Reoperation with an endoprosthesis was performed in 14% (18/130) and 12% (16/138) of fractures in the Richards and Uppsala groups, respectively (Table 3). There were 2 deep infections, both of which necessitated reoperation. In the Uppsala group, 2 patients showed progressive penetration of a screw into the acetabulum.

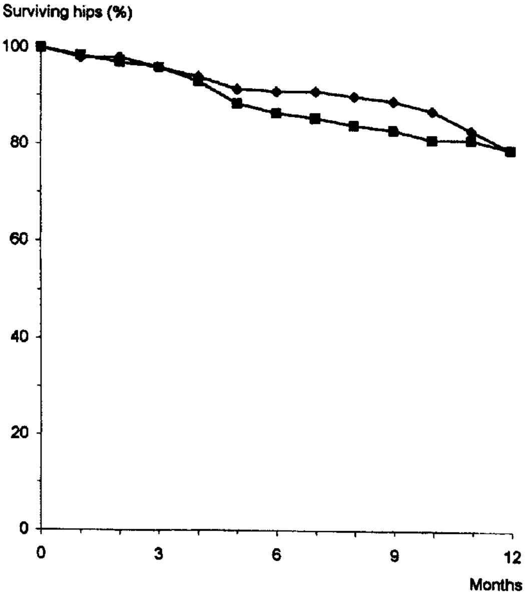

Figure 2. Life-table analysis according to Kaplan-Meier (time until noted healing complication). ◆ Uppsala screws and ■ Richards screws.

Life-table analysis (time until complication) showed no significant difference ($p = 0.10$, one-tailed) between the 2 groups (Figure 2).

Operations were performed percutaneously in 45% of the cases in the Richards group and in 92% in the Uppsala group. The amount of bleeding did not differ significantly between the groups. The need for walking aids and the degree of pain from the hip at follow-up did not differ between the groups. At 1-year follow-up, 34% (54/161) of the patients said that they had moderate pain. 5 patients felt severe pain; of these, 4 had radiographic complications and 1 subsequently developed segmental collapse. 1 year after injury, half (80/160) of the patients still required walking aids. The remaining patients managed either entirely without walking aids or required a single walking stick (Table 4).

In the multiple logistic regression analysis, 3 factors were associated with a significantly higher frequency of healing complications: fractures with a small caput fragment had the highest relative risk, followed by initially displaced fractures and osteosynthesis without posterior cortical support (Table 5). The presence of a small caput fragment implied a nearly 13 times increase in the risk of developing segmental collapse (Table 6).

Table 4. Clinical outcome (results at 1-year follow-up)

		Walking aids			Walking or passive joint motion pain		
Garden stage	Fixation device	1 cane or none	2 canes or more aids	Not ambulatory	None	Moderate	Severe
I & II	Richards screws	12	13	0	16	8	1
	Uppsala screws	20	7	3	21	9	0
III & IV	Richards screws	23	24	2	31	18	1
	Uppsala screws	25	24	7	34	19	3
Total		80 (50 %)	68 (42%)	12 (8%)	102 (63%)	54 (34%)	5 (3%)

Table 5. The relative risk of overall healing complication in relation to various risk factors

Variable	n	Healing complications	Univariate analysis [a]	Multivariate analysis [a]
Small caput fragment	51	24 (47%)	3.8 (2.0–7.3)	4.6 (2.3–9.3)
Initially displaced fracture	193	54 (27%)	2.3 (1.1–4.6)	2.6 (1.2–5.8)
Lack of posterior cortical support	142	43 (29%)	1.7 (1.0–3.0)	2.0 (1.1–3.8)
Imperfect reduction	74	38 (51%)	2.2 (1.2–3.9)	1.7 (0.9–3.3)
Imperfect screw positioning	117	39 (33%)	1.1 (0.6–1.9)	1.1 (0.6–2.0)

[a] Odds ratio (95% confidence limits)

Table 6. The relative risk of segmental collapse in relation to various risk factors

Variable	n	Segmental collapse	Univariate analysis [a]	Multivariate analysis [a]
Small caput fragment	51	8 (16%)	8.7 (2.8–27)	13 (3.3–50)
Lack of posterior cortical support	142	11 (8%)	2.5 (0.8–8.2)	3.8 (1.0–15)
Initially displaced fracture	193	6 (3%)	0.3 (0.1–1.0)	0.4 (0.1–1.4)
Imperfect reduction	74	4 (5%)	0.9 (0.2–3.2)	0.8 (0.2–3.9)
Imperfect screw positioning	117	4 (3%)	0.4 (0.1–1.3)	0.3 (0.1–1.1)

[a] Odds ratio (95% confidence limits)

Discussion

We found a 24% healing complication rate and performed secondary arthroplasty in 13% of all cases. These values are comparable to findings in several previous studies (Skinner and Powles 1986, Elmerson et al. 1988, Lindequist et al. 1989, Herngren et al. 1992). The outcome did not differ significantly between the 2 groups. If the Uppsala screw has a better grip in the subchondral femoral bone, it seems to be compensated by the use of 3 screws in the Richards technique. In a cadaver study, Lindequist et al. (1993) demonstrated better stability with posterior rather than central placement of the proximal screw. In the Uppsala screw technique, the recommendation is to put the proximal screw as high up in the femoral neck as possible (Rehnberg and Olerud 1989b). We found a higher frequency of complications in fractures without posterior cortical support. Posterior support was commoner in the Richards group, which is probably because of the practice of using three screws.

Rehnberg and Olerud (1989a) presented a series of 44 fractures treated with the Uppsala screw technique. All fractures healed. In another study, including a comparison with von Bahr screws, the same authors found only a 16% failure rate with Uppsala screws in the first year (Rehnberg and Olerud 1989b). As demonstrated by Strömqvist et al. (1992), specially interested surgeons can obtain better results than the average surgeon. Our study reflects the results obtained in routine practice at a central hospital.

According to previous findings (Frandsen and Andersen 1981, Elmerson et al. 1988, Alberts and Jervaeus 1990), factors other than the choice of internal fixation device; including the initial displacement, the quality of reduction and the position of the internal fixation, are of importance in the healing of these fractures. In our study, the size of the caput fragment turned out to be the main factor in predicting complications. The disadvantage of using this preoperatively as a predictor is that, in the antero-posterior view, the fracture line is not always visible before reduction of a dislocated fracture. Furthermore, the method does not take into account the magnification of the radiographs. Despite these shortcomings, the size of the proximal fragment is one of several factors to be taken into consideration when deciding how to treat a femoral neck fracture. Improving the treatment of femoral neck fractures implies not only optimizing the technique of internal fixation but learning to predict when osteosynthesis will fail.

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