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Fixation of displaced femoral neck fractures

A comparison between sliding screw plate and four cancellous bone screws

In a prospective, randomized trial, 104 consecutive patients with displaced femoral neck fractures were allocated either to fixation with a sliding screw plate or 4 ASIF cancellous bone screws. The patients were reexamined at fixed intervals to determine the time of union. The 2-year-cumulated rate of union was 64 per cent in the plate group and 84 per cent in the screw group.

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Randomized studies comparing the clinical results after different types of fixation for femoral neck fractures are rare, but necessary for comparison.

Fixation with both multiple cancellous bone screws (von Bahr et al. 1974, Høgh et al. 1982) and a sliding screw plate (Frandsen et al. 1984, Svenningsen et al. 1984, Nordkild & Sonne Holm 1984, Skinner & Powles 1986) have achieved good results, but which method is superior has not yet been investigated.

We compared the rate of union in displaced femoral neck fractures after fixation with either 4 ASIF cancellous bone screws or a sliding screw plate.

Patients and methods

In a prospective trial, 104 consecutive patients with displaced femoral neck fractures were randomly allocated to treatment with either a sliding screw plate (SSP) or with 4 ASIF cancellous bone screws.

Criteria for participation were nonpathologic fractures, Garden's Stages 3 and 4 (Garden 1961), and in Stage 4 fractures a delay of less than 24 hours from fracture to arrival at the hospital. One patient was excluded because he died after allocation, but before the planned operation. Thus, 51 patients were treated with a SSP and 52 patients with ASIF screws. Table 1 shows the distribution according to sex, age, and displacement.

Traction through the tibial tuberosity was applied on admission in all the patients, and they were usually operated on the next day. All the operations were carried out by the same team of surgeons. Closed reduction of the fracture was performed under two-plane image-intensifier control.

Table 1. Data for 103 patients with displaced femoral neck fractures

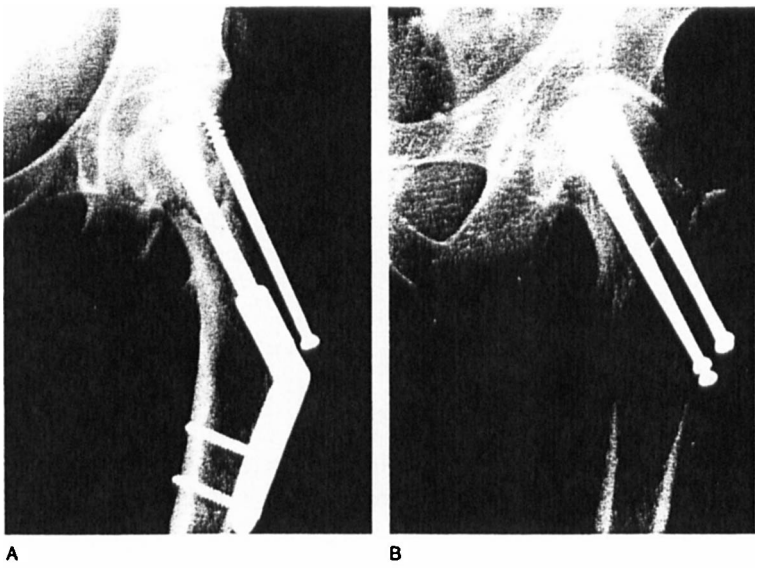
	Sliding screw n51	ASIF screws n52
Female/male ratio	2.6	3.7
Age		
Mean (range)	75 (25–91)	74 (34–92)
Garden's stage		
3	37	33
4	14	19
Quality of reduction		
Good	43	42
Fair	5	4
Poor	3	6

The intention in the SSP osteosynthesis was to place the screw resting on the medial cortex and a little posterior and inferior to the center of the femoral head. The tip of the screw was placed about 5 mm from the articular surface. A supplementary cancellous bone screw was inserted proximal and parallel to the sliding screw to enhance rotational stability (Figure 1).

The intention in the osteosynthesis with 4 ASIF cancellous bone screws was to place the screws parallel and with the two lowermost screws resting on the medial cortex. The tips of the screws were placed in the subchondral bone (Figure 1).

Compression was obtained by impaction after reducing the traction and by early weight bearing in both groups. In the SSP group, compression was also applied by the compressing screw in 42 patients, but not in 9 where the trabecular bone structure was judged to be too weak. Prophylactic antibiotics were not used.

The duration of anesthesia, from intubation to extubation, and the blood loss were recorded for all the patients. As the method of anesthesia influences the blood loss (Sculco & Ranawat 1975, Keith 1977), we



A B

Figure 1. Methods of fixation.
A Sliding screw plate.
B Four ASIF cancellous bone screws.

divided each group with respect to the type of anesthesia.

The quality of reduction was assessed by the Garden (1971) alignment index (Table 1). Clinical and radiographic examinations were made 3, 6, 12, and 24 months after the operation. The patients were divided into the following three groups:

1. *Union*: Radiographically visible trabeculations across the fracture line.
2. *Nonunion*: No radiographically visible trabeculations across the fracture line, including redisplacement or progressive displacement requiring a second operation. The patients were still listed in this group after such an operation.
3. *Lost*: All the patients who died, moved out of the district or refused reexamination.

Radiographic evidence of late segmental collapse occurring in an already united fracture was recorded in both treatment groups.

^{99m}Tc-MDP scintigraphy was performed 2–3 months after the operation; the results have been published by Linde et al. (1986).

The actuarial method of Armitage (1971) was used to present our results concerning union and nonunion, i.e., the union rate for each period in between the reexaminations was calculated and then cumulated. A log rank test (Peto et al. 1977) was used for analysis of the difference between the cumulated rate of union in the two groups. The chi-square test was used to compare the rates of late segmental collapse, and the Mann-Whitney rank test was used for comparison of blood loss and duration of anesthesia.

Results

No peroperative or early postoperative deaths occurred. One patient in the 4 ASIF group and 2 in the SSP group contracted a deep infection. The duration of anesthesia was shorter in the screw than in the plate group, and the blood loss under general anesthesia was lower (Table 2).

All the fractures that united did so within 1 year. The cumulated rate of union in the plate group was lower than in the screw group (Table 3).

Table 2. Duration of anesthesia (min) from the intubation to extubation and the blood loss (ml) during the operation for the two groups

	Sliding screw n51	ASIF screws n52
Duration of anesthesia[a]		
Median	130	108
1–3 quarter	115–145	90–120
Blood loss (general anesthesia)[a]		
Number of patients	43	44
Median	350	200
1–3 quarter	200–500	100–300
Blood loss (epidural anesthesia)[b]		
Number of patients	7	8
Median	200	150
1–3 quarter	50–200	125–300

a $P<0.001$
b NS

Table 3. The rate of union, nonunion, the number of patients leaving the study in each follow-up period, and the cumulated union rate for both groups. I sliding screw plate, II four ASIF screws

Months after operation	Number at start of period		Number of united fractures		Number of patients leaving without union		Number at risk throughout period		Union rate (fraction)		Nonunion rate (fraction)		Cumulated union rate ($P<0.05$) (fraction)	
	A		B		C		D=A−C/2		E=B/D		F=1−E		Gn=1−F1×F2×...Fn	
	I	II	I	II	I	II	I	II	I	II	I	II	I	II
0–3	51	52	0	4	9	5	46.5	49.5	0.00	0.08	1.00	0.92	0.00	0.08
3–6	42	43	15	19	3	1	40.5	42.5	0.37	0.45	0.63	0.55	0.37	0.49
6–12	24	23	10	15	1	2	23.5	22	0.43	0.68	0.57	0.32	0.64	0.84
12–24	13	6	0	0	4	2	11	5	0.00	0.00	1.00	1.00	0.64	0.84
Total			25	38	17	10								

Eighteen fractures had a fair or poor reduction. However, 11 of these united within the first year, and only one was ununited after 2 years.

Late segmental collapse occurred in 3/21 in the plate group and in 5/30 in the screw group (NS).

The device was removed from 4 patients in the plate group and from 8 in the screw group after union of the fracture because of local discomfort or penetration of a screw. Seven plated patients and 3 from the screw group had hip arthroplasty during the 2 years of follow-up.

All except one of the fractures with reduced vascularity from the early postoperative scintigraphic study (Linde et al. 1986) developed either nonunion or late segmental collapse.

Discussion

The actuarial method is commonly applied in epidemiologic studies of survival. The method is, however, equally useful for analyzing time to some other first event; e.g., time to first local recurrence, time to removal of inserted prosthesis, or time to fracture union (Peto et al. 1977). When presenting results with such a method, one takes into account the time dependency of fracture union and an expected large number of patients leaving the study during the follow-up period. This secures an optimum utilization of the observations and therefore the highest statistical precision. The actuarial method was well described by Dobbs (1980) when he assessed the survivorship of Stanmore hip replacements, and by Skinner & Powles (1986) when they assessed the failure rate after SSP fixation of femoral neck fractures. A direct comparison with the union rates from previous studies is not possible, but the "survivorship table" (Table 3) shows all the relevant data concerning union and nonunion from our study. When comparing union rates from different studies, one should be aware of differences in the patients, material; e.g., some have included consecutive patients, others have selected patients, and some included all stages of femoral neck fractures, whercas others included only the dislocated fractures. The reader should especially be aware of the employed calculation method because a mere shift in the method can increase or decrease the rate of failure by as much as 50 per cent (Frandsen 1986).

The sliding compression screw plate, introduced by Charnley (1956) for treatment of femoral neck fractures has today a different design and is available in several versions with minor differences (Kyle et al. 1980). The union rates after fixation with a SSP were in the beginning unsatisfactory (Charnley 1960, Hargadon et al. 1963). The early results of the Richards® lag-screw design were better (Clawson 1964, Rau et al. 1982), and the latest published series have shown results among the best in the treatment of femoral neck fractures (Frandsen et al. 1984, Norkild & Sonne Holm 1984, Skinner & Powles 1986). In the few existing comparative studies, SSP fixation was found to be superior both to McLaughlin nail-plate fixation (Svenningsen et al. 1984) and to sliding nail plate fixation (Nordkild et al. 1985). There are few studies involving fixation of femoral neck fractures with small screws, but all of them have shown union rates as good as after SSP fixation (von Bahr et al. 1974, Søreide et al. 1977, Høgh et al. 1982).

The bending stability after fixation with small screws is as good as after SSP fixation (Engesæter et al. 1984), but it has been demonstrated (Reig-

stad & Syversen 1980, Mackechnie-Jarvis 1983) that the stability is insufficient, as none of the devices reliably bear the body weight. The stability of the weight-bearing unit is increased when compression is applied across the fracture line (Kaessman et al. 1972). This can be obtained with the SSP fixation devices by means of a compressing screw (Charnley 1957, Hargadon & Pearson 1963, Svenningsen et al. 1984, Ort & LaMont 1984, Skinner & Powles 1986). Because of the risk of breaking the trabecular bone thread by tightening the compressing screw, it was used with caution in our patients and was not applied if the bone structure was thought to be weak. The 4 cancellous bone screws can be used as lag screws, but the holding power of these screws is even lower than for the sliding screw (Frandsen et al. 1984) and should therefore be tightened with care.

As the fixation device itself generates only limited compression across the fracture line, impaction of the fracture and early weight bearing as used in our study would appear to be important in securing the stability of the fracture. Surprisingly, Jacobsson & Dalén (1985) found a decrease in femoral head vitality when the fractures were impacted at operation, as the forces applied with a hammer hardly correspond to the forces acting upon the fracture during walking, and early weight bearing favors union (Nieminen 1975).

A single screw does not secure rotational stability, and a SSP osteosynthesis ought to be supplemented with an extra screw or pin (Zickel 1985, Svenningsen et al. 1984, Ort & LaMont 1984). In the other treatment group, we applied 4 ASIF cancellous bone screws as employed by Høgh et al. (1982). The screws were placed parallel as recommended by Zilch & Naseband (1980). However, three parallel screws are probably sufficient (Zilch & Naseband 1980).

It is well known that adequate reduction is essential for a successful result. Only a few of our patients had fair or poor reduction, which is probably the reason why we could not demonstrate that the quality of reduction was of significance.

The rates of late segmental collapse correspond to that found by others (Frandsen et al. 1984, Svenningsen et al. 1984, Nordkild & Sone Holm 1984). Only a few of our patients developed late segmental collapse, and therefore the risk of not finding a true difference between the groups was more than 15 per cent (the risk of an error of the second kind).

Strömqvist et al. (1983, 1984) found that the method of fixation influenced the vascularization of the femoral head, and this corresponds well with the results of the previously reported scintigraphic study (Linde et al. 1986). This showed that SSP fixation lead to a higher number of avascular femoral heads than ASIF screw fixation, which explains the difference between the overall results in the two groups.

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