

Internal fixation of femoral neck fractures

Dynamic Hip and Gouffon screws compared in 73 patients

Jens L. Sørensen, Jens-Erik Varmarken and John Bømler

A prospective, randomized study comparing the Dynamic Hip screws and the Gouffon screws in the treatment of femoral neck fractures was terminated before the planned number of patients had been admitted, owing to a preponderance of early failure of the Gouffon screws (P 0.014); thus only 73

patients entered the study. After three years' follow-up, 25/38 Gouffon screws and 12/35 Dynamic Hip screws had failed. Six patients treated with Gouffon screws and 14 treated with Dynamic Hip screws had died. The outcome still favoured the use of Dynamic Hip screws (P 0.02).

University of Copenhagen, Department of Orthopedics, Gentofte Hospital, DK-2900 Hellerup, Denmark
Correspondence: Dr. Jens L. Sørensen, Department of Plastic and Reconstructive Surgery, Rigshospitalet, DK-2100 Copenhagen, Denmark. Tel +45-35 45 28 05. Fax +45-35 37 66 45
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In comparative studies of femoral neck fractures differences in the occurrence of complications have been discovered between the methods tested (Kofoed and Alberts 1980, Frandsen 1986). At our department Gouffon screws (Howmedica, Inc.) and Dynamic Hip screws (DHS, Synthes) have been used randomly in the routine treatment of femoral neck fractures. Activated by the fact that the two methods had not previously been compared, a prospective, randomized study, highlighted during the investigation by a request in *Acta Orthop Scand* (Editorial 1988), was undertaken with the view of assessing the relative merits of the two methods.

Patients and methods

All adult patients with non-pathological, intracapsular femoral neck fractures, Garden (1961) Stage II-IV, were included in the study consecutively, after having given their informed consent. Since Stage I fractures were not routinely operated on, they were not included

in the study. Following a random allocation the fractures were either treated with three Gouffon screws or a DHS device.

The study was initiated in February 1985 and was planned to run until a total of 260 patients had entered, but owing to a difference in early failure rate between the two methods, the study was discontinued after the admission of only 73 patients. The material thus comprised 18 men, median age 81 (52-88) years and 55 women 76 (54-94) years old. 38 patients were treated with Gouffon screws and 35 with DHS (Tables 1 and 2).

Operation technique

The operations were performed as emergencies by the orthopedic registrar on duty. The fractures were reduced on an extension table under a biplane intensifier. In no cases were reductions found to be unattainable. The Gouffon screws were introduced parallel to a guide wire, the two lower screws preferably with calcar support, and all three with their tips placed sub-

Table 1. Outcome of femoral neck fractures treated either with Gouffon screws or Dynamic Hip screws

	Fracture stages			Reduction			Implant position			Failure rate
	II	III	IV	Good	Fair	Poor	Good	Fair	Poor	
Gouffon	5	22	11	22	5	11	14	18	6	25/38
DHS	5	21	9	25	4	5	12	13	9	12/35
Total	10	43	20	47	9	16	26	31	15	37/73

Table 2. Observations in 73 patients operated on for femoral neck fracture

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	2	63	1	1	3	10	1	3	1	-	-	4	3	-	1	4	4	3	2	-
2	2	71	1	2	4	20	2	1	3	1	1	3	3	-	4	4	1	3	4	2
3	2	81	2	2	4	24	2	3	3	2	2	4	3	-	2	3	4	5	4	2
4	1	74	1	1	2	46	2	1	1	2	1	1	4	-	38	1	1	1	1	0
5	2	82	4	2	6	-	1	1	1	-	-	1	1	3	3	1	4	5	2	1
6	2	66	1	1	3	20	1	2	2	-	-	1	4	-	39	1	1	2	1	1.5
7	1	67	1	2	2	16	1	1	1	-	-	1	1	22	13	1	4	5	1	0
8	2	87	2	2	4	20	1	1	1	-	-	1	4	-	38	1	2	1	1	1
9	2	73	1	1	3	13	2	3	3	2	2	1	4	-	41	1	1	1	1	2
10	2	67	1	2	2	30	1	1	3	-	-	1	4	-	38	1	2	1	1	0
11	2	67	1	2	3	42	2	2	1	1	1	1	4	-	40	1	1	1	1	1
12	2	76	1	1	3	34	2	1	2	2	1	4	3	-	3	4	4	3	2	1.5
13	2	72	2	1	3	83	1	1	3	-	-	4	3	-	3	4	4	5	4	4
14	2	94	3	1	5	-	1	1	1	-	-	1	1	22	13	1	3	5	3	0
15	1	79	1	1	2	47	2	2	2	2	2	4	3	-	2	4	1	3	4	2.5
16	2	72	1	1	5	-	1	1	2	-	-	4	3	-	3	4	2	5	2	1
17	2	79	3	1	2	27	2	1	2	2	1	1	1	13	1	1	4	5	2	1
18	2	67	1	1	4	18	1	1	1	-	-	2	1	5	4	1	4	5	4	2
19	2	73	1	2	4	10	2	3	2	2	2	4	3	-	8	4	4	5	4	2
20	2	67	1	2	3	18	2	1	2	2	2	1	4	-	39	1	1	1	1	1
21	1	52	2	2	4	7	2	1	1	2	2	2	3	-	1	3	2	5	4	2
22	2	63	1	2	4	9	1	3	2	-	-	4	3	-	3	4	4	5	4	1
23	2	57	1	1	3	20	2	1	3	2	1	1	3	-	16	2	1	2	1	1
24	1	80	3	1	3	16	1	1	1	-	-	1	1	2	2	1	4	5	1	1
25	2	77	1	1	5	-	1	2	2	-	-	4	3	-	13	4	1	2	4	1
26	2	69	3	2	3	25	2	1	2	1	1	3	1	24	13	1	4	5	4	1
27	2	80	1	1	3	20	1	1	3	-	-	1	4	-	35	1	4	2	2	2
28	1	76	1	1	3	18	2	3	1	2	2	4	1	19	11	1	4	5	4	3
29	2	81	3	2	3	54	2	3	2	2	2	4	3	-	8	3	4	5	4	1
30	1	81	3	1	3	15	1	1	1	-	-	1	4	-	32	1	3	1	1	0
31	2	54	1	2	4	15	2	3	2	1	2	2	3	-	2	4	1	3	2	1
32	2	84	2	2	3	32	1	1	2	-	-	4	3	-	33	4	2	3	4	1
33	2	90	4	2	3	12	2	1	2	1	1	1	1	2	2	1	4	5	2	0
34	2	83	4	1	3	28	1	1	2	-	-	2	1	11	1	1	4	1	2	2
35	1	82	1	1	3	18	2	2	1	1	1	1	4	-	1	1	1	1	1	1.5
36	1	73	1	2	3	30	1	1	1	-	-	1	4	-	37	1	1	1	1	0
37	2	80	1	1	5	-	1	1	3	-	-	1	4	-	37	1	3	4	4	0.5
38	2	68	1	2	4	48	1	3	2	-	-	4	3	-	3	4	1	3	4	3
39	1	87	4	1	2	23	1	1	3	-	-	1	1	0	0	1	-	-	-	-
40	2	93	2	2	3	15	2	1	1	2	1	4	3	-	4	3	4	5	4	2
41	2	86	1	1	3	12	2	1	2	1	1	1	4	-	35	1	1	1	1	0
42	2	77	2	2	3	12	2	3	2	1	1	3	3	-	6	4	2	3	3	1
43	2	66	1	2	3	9	1	1	2	-	-	1	4	-	34	1	1	1	1	0.5
44	2	79	1	1	3	15	2	1	2	2	1	4	3	-	34	2	4	5	2	1
45	2	87	4	2	3	81	2	1	2	1	1	2	2	-	4	1	4	5	2	-
46	2	76	1	2	2	28	1	1	1	-	-	1	4	-	34	1	1	1	1	0
47	2	77	2	2	2	19	2	1	3	1	2	4	3	-	2	4	2	5	4	2
48	2	65	1	1	4	25	2	1	1	2	2	2	3	-	2	4	1	5	4	4
49	2	75	1	1	3	16	1	1	2	-	-	1	1	2	1	1	4	5	2	0
50	1	84	4	1	2	33	2	1	1	2	2	4	4	-	32	1	4	4	2	1
51	1	88	2	2	2	32	1	1	3	-	-	1	1	27	3	1	-	-	-	-
52	2	70	1	2	3	306	1	1	2	-	-	1	1	7	3	1	2	2	1	1
53	2	81	2	1	4	1	1	3	2	-	-	4	3	-	2	4	2	3	2	2
54	2	75	2	1	4	35	1	1	2	-	-	4	1	16	10	4	4	5	4	1.5
55	2	75	1	1	4	31	1	2	3	-	-	1	1	5	3	1	3	5	2	2.5
56	2	79	1	1	4	144	1	3	3	-	4	3	3	-	1	4	5	5	4	2
57	1	81	2	2	4	15	2	3	2	2	2	2	3	-	1	4	4	5	4	2
58	1	58	1	2	3	24	1	1	1	-	-	1	4	-	39	2	1	1	1	2
59	2	89	1	1	3	31	2	2	2	2	1	4	3	-	2	4	4	5	4	1
60	2	70	1	1	4	10	2	3	1	2	1	3	3	-	3	4	3	2	2	2
61	1	88	3	1	3	38	2	1	1	2	1	1	4	-	35	1	4	3	1	2
62	2	73	3	2	3	12	1	2	3	-	-	1	4	-	31	1	1	1	1	2
63	2	75	1	1	3	29	2	1	2	2	2	4	4	-	39	1	4	5	2	3
64	2	90	2	2	3	26	2	1	1	2	1	1	1	11	3	1	3	1	2	1.5
65	1	87	1	2	3	97	1	1	2	-	-	1	1	19	3	1	4	5	1	1
66	2	82	2	2	2	33	2	1	1	2	2	4	3	-	3	4	2	3	4	2
67	2	78	2	2	4	72	2	3	2	2	1	4	3	-	3	4	4	5	4	4
68	2	71	1	1	4	76	2	3	1	2	1	4	3	-	3	4	1	5	2	-
69	2	82	4	1	3	21	2	2	3	2	1	1	4	-	29	1	4	1	1	1
70	1	86	1	1	3	72	1	1	1	-	-	1	4	-	30	1	1	-	1	1
71	1	83	3	1	3	16	1	-	-	-	-	1	1	0	0	1	-	-	-	-
72	2	72	2	1	4	21	2	1	1	2	1	4	1	25	23	1	3	5	4	0.5
73	2	82	1	2	3	207	2	1	2	2	1	1	4	-	38	1	1	1	1	0

Legends to Table 2

A Case	L Gouffon screws with calcarine support
B Sex	1 yes
1 male	2 no
2 female	M Complications
C Age at fracture (years)	1 none
D Social function group at admission	2 redisplacement
1 independent	3 non-union
2 slightly dependent	4 osteonecrosis
3 moderately dependent	N Attendance at follow-up
4 totally dependent	1 dead before final follow-up
E Fracture side	2 lost to final follow-up
1 right	3 reoperated on before final follow-up
2 left	4 successful follow-up
F Garden stage	O Interval operation-death (months)
1-4 I-IV	P Last control after operation (months)
5 I progressed to III	Q Reoperation
6 I progressed to IV	1 no reoperation
G Latency fracture-operation (hours)	2 removal of implant
H Osteosynthesis	3 hemiarthroplasty
1 Dynamic hip screw	4 total hip arthroplasty
2 Gouffon screws	R Social function group at last follow-up: as D
I Reduction	S Walking ability at last follow-up
1 good	1 as before fracture
2 fair	2 one stick now, none before
3 poor	3 two sticks now, none before
J Position of implant	4 two sticks now, one before
1 good	5 crutches or worse
2 fair	T Hip-related pain at last follow-up
3 poor	1 none or unaltered from before fracture
K Gouffon screws parallel	2 pain when active
1 yes	3 pain when at rest
2 no	4 2 and 3
	U Spina-malleolus-shortening at last follow-up (cm)

chondrally in the femoral head, forming an equilateral triangle. The DHS was advanced centrally into the femoral head over a guide wire, to a position in which its trunk would be leaning against the calcar and its tip placed in the subchondral part of the femoral head. The sliding screw was fixed in a two-hole plate. The position of the implant was visualized by an image intensifier, but radiographs were not taken until the day after the operation.

Weight-bearing was allowed as soon as the patient was mobilized; in most cases after 1 or 2 days. Clinical and radiographic follow-ups were performed by one of the authors one or two days postoperatively, after three months, six months, one year, and three years.

Evaluation

The fractures and the reductions were grouped in accordance with Garden's (1961) classification. However, axial radiographs were also taken into consideration in order to avoid too rigorous a classification in the case of isolated axial dislocations. An ad latum dislocation of five millimetres or more would exclude the reduction from the group "good". The positions of the implants were defined according to

Frandsen (1986), and the classification of success or failure according to Skinner and Powles (1986). In calculating the failure rates, patients with no or few symptoms from redisplacement, non-union, or osteonecrosis were included.

Statistics

The chi-square test with Yates' correction was used as a primary tool and the logrank test (Armitage and Berry 1987) for additional confirmation because of an uneven number of deaths in the two groups.

Results (Tables 1 and 2)

Six patients treated with Gouffon screws and 14 treated with DHS died before the final follow-up. Of these 20 dead patients 3 in each group developed failure. One patient declined to complete the follow-up programme. In the Gouffon group there were 18 cases of non-union as compared to 9 in the DHS group. 7 patients in the Gouffon group developed osteonecrosis as opposed to 3 in the DHS group. After the admission of 73 patients an obvious difference in failure rate was

noticed. A chi-square test was performed to assess the status of each patient one month after surgery. The difference was found to be significant (P 0.014, 95-percent confidence limits for the difference: 0.12-0.55). Consequently, to prevent any further use of the Gouffon screws the trial was discontinued. After 3 years of follow-up, a standard chi-square test showed a significant difference (P 0.014, 95-percent confidence limits of the difference: 0.10-0.53). A log rank test confirmed the difference (P 0.019).

Discussion

No previous studies comparing the two methods of osteosynthesis of the femoral neck fracture described in the present investigation, have been published, but quite a number of studies deal with the treatment of this "unsolved fracture" (Frandsen 1986, Linde et al. 1986, Elmerson et al. 1988, Husby et al. 1989, Holmberg et al. 1990). The conclusions of the various studies are not unanimous. Both the use of multiple slender pins or screws, such as the Gouffon screws (Kofoed and Alberts 1980, Strömqvist et al. 1984, Linde et al. 1986, Madsen et al. 1987), or a sliding screw device (Nordkild and Sonne-Holm 1984, Skinner and Powles 1986) have been advocated. Bearing in mind the difficulties involved in comparing different studies of femoral neck fractures (Frandsen 1986) we found that the complication rate of the DHS sliding screw in the present study (12/35) did not differ from the failure rate of sliding screw devices in most other studies (Nordkild and Sonne-Holm 1984, Svenningsen et al. 1984, Skinner and Powles 1986, Madsen et al. 1987). Among the patients treated with Gouffon screws, 25/38 developed complications. This complication rate was unusually high for multiple pinning (Kofoed and Alberts 1980, Høeg et al. 1982, Strömqvist et al. 1984, Madsen et al. 1987, Husby et al. 1989, Lindequist et al. 1989, Rehnberg and Olerud 1989a). Poor reduction (11/38) (Kofoed and Alberts 1980, Høeg et al. 1982, Frandsen 1986), and, to a lesser degree, poor positioning of the screws (6/38) (Frandsen 1986, Skinner and Powles 1986, Rehnberg and Olerud 1989a) could be important factors. Apart from difficulties in deciding the appropriate length of the Gouffon screws intraoperatively, the method does not seem to involve any technical difficulties (Lindequist et al. 1989), but in the process of exchanging a Gouffon screw the trabecular bone in the femoral head may be damaged, thus impairing the ultimate fixation, and thereby increasing the risk of complications (Frandsen 1986, Rehnberg and Olerud 1989b).

The realization that even before the planned number of patients had entered the study there was a predominance of early failures among the Gouffon screws prompted the application of a chi-square test on the accessible data concerning failure rates (i.e. the result for each patient one month after surgery). The result turned out to be significant and the study was terminated. After 3 years of follow-up the chi-square test confirmed the difference, but since the number of deaths over the period of follow-up was unexpectedly unevenly distributed between the two groups (meaning that the difference in failure rate might wholly or partly be ascribed to patients dying before failure) it was felt prudent to supplement the chi-square analysis with a standard log rank test, which takes into account the actual number of patients at risk of failure at any time. This more sensitive test gave a significant difference of the same magnitude as the chi-square test. The conspicuous difference in mortality between the two groups could not be ascribed to any difference in age, sex, prefracture mortality, or postoperative, extra-fracture complications, factors which are actually supposed to be eliminated by the method of allocation. Neither were the methods of surgery suspected of having influenced the rate of mortality.

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