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TREATMENT OF DISPLACED FRACTURES OF THE FEMORAL NECK

Smith-Petersen Osteosynthesis versus Sliding-Nail-Plate Osteosynthesis

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In a prospectively planned follow-up study 383 cases of displaced medial fractures of the femoral neck were allocated either to Smith-Petersen osteosynthesis or to sliding-nail-plate osteosynthesis. Two hundred and forty-nine cases were followed for more than 2 years. The two differently treated groups were alike. The results showed that sliding-nail-plate osteosynthesis was significantly superior to Smith-Petersen osteosynthesis. We recommend that Smith-Petersen osteosynthesis be abandoned.

Key words: femoral neck fractures; fracture fixation

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Since the introduction of the trifin nail in the treatment of medial fractures of the femoral neck (Smith-Petersen et al. 1931), a considerable number of reports have been presented concerning the treatment of these fractures. Different methods of osteosynthesis have been recommended by several authors, but to the best of our knowledge no randomized study comparing the different types of osteosynthesis has been published so far.

This series is a continuation of a preliminary report presented earlier (Frandsen 1979). It presents the results of a randomized, prospectively planned, follow-up examination of displaced medial fractures of the femoral neck, in which Smith-Petersen osteosynthesis has been compared with sliding-nail-plate osteosynthesis.

METHOD

On admission to hospital traction through the tibial tubercle was applied. Final adjustment of the fracture was made under general anaesthesia on the fracture table using fluoroscopy with an image intensifier. Operation was performed at the earliest opportunity, but not as an emergency.

A Thornton nail was used in the Smith-Petersen osteosynthesis (Figure 1). The appliance shown in Figure 2 was used in the sliding-nail-plate osteosynthesis. In both osteosyntheses the intention was to place the nail as steeply as possible, resting on the femoral calcar and a little posterior and inferior to the centre of the femoral head.

In the postoperative treatment early mobilization was encouraged. If not otherwise contraindicated, the patient was out of bed sitting in a chair on the day after the operation. On the second or third day the patient was allowed to walk with elbow crutches. In all but the younger patients weight-bearing on the operated leg up to the threshold of pain was allowed. As avascular necrosis of the femoral head most often occurs between 1 and 2 years after the operation, it was decided to make the follow-up period no less than 2 years, unless failure was evident earlier.

The two orthopaedic departments at the University Hospital in Odense receive emergency admissions on alternating days, and the patients have been allocated to treatment according to this. The operations were performed largely by the same doctors in both departments, because all doctors except the chief surgeons

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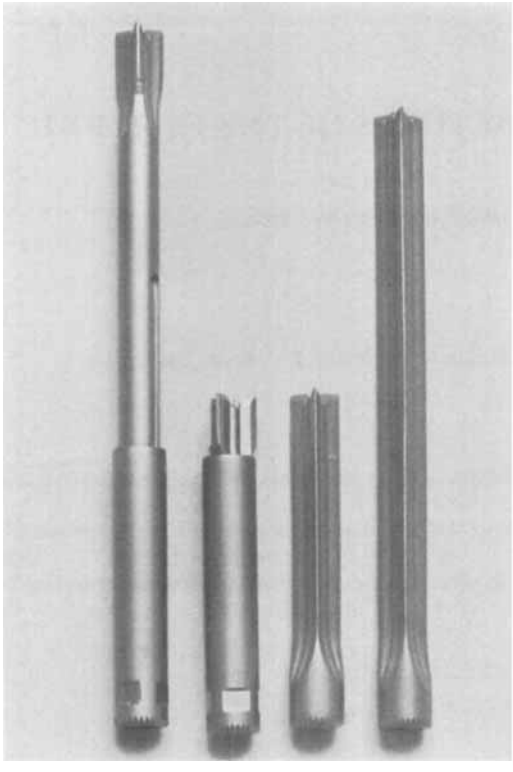

Figure 1. The long and short Thornton nail (right) and sliding nails in their longest and shortest position (left).

Figure 2. Radiograph of the sliding-nail-plate in a femoral neck fracture.

rotate between the two departments for periods of 1 year.

PATIENTS

This study includes all patients with displaced medial fractures of the femoral neck treated in the Orthopaedic Departments O and Ø, Odense University Hospital, between March 1972 and August 1977. After that time no new patients were admitted to the study in order to provide 2 years of postoperative observation.

The fractures were divided according to Garden's classification (1961). Only displaced fractures, i.e. stage 3 and stage 4 fractures have been considered in this series.

During the study 402 cases of displaced medial fractures of the femoral neck were admitted to hospital. The following 19 patients were excluded: three had pathological fractures; three died before the operation was performed; seven presented old fractures in which surgery was not indicated; two with old fractures and two in whom the fractures could not be reduced were treated with a Moore prosthesis; one refused operation on religious grounds; and one patient could not be followed up as she was an American tourist.

Smith-Petersen osteosynthesis was performed in 196 cases and sliding-nail-plate osteosynthesis in 187 cases. The age distribution is given in Table 1. Eighty-six of the patients were males, giving a ratio of females to males of 3.45. Table 1 also separates the patients with and without 2 years of postoperative observation. The median age was: in the Smith-Petersen group 78 years (range: 28–96 years) and in the sliding-nail-plate group 77 years (range: 22–95 years). One hundred and thirteen patients died without 2 years follow-up, and 21 patients refused to participate in the follow-up (Table 1). Thus 249 patients with a follow-up period of at least 2 years were available for analysis.

For those fractures that united the median follow-up period was 25 months (range: 24–65 months) in the Smith-Petersen group and 32 months (range: 24–62 months) in the sliding-nail-plate group.

Table 1. Age distribution of 383 cases of displaced medial fractures of the femoral neck in relation to: 1) treatment and 2) length of follow-up (more than or less than 2 years)

Age		–49	50–59	60–69	70–79	80–89	90–	Total
Smith-Petersen								
Follow-up: ≥ years	Union	2	11	18	26	23	3	83
	Failure	–	1	8	22	16	1	48
	Total	2	12	26	48	39	4	131
Follow-up: < 2 years	Union	–	1	–	1	4	3	9
	Holding	–	1	5	18	25	7	56
	Total	–	2	5	19	29	10	65
Sliding-nail								
Follow-up: ≥ 2 years	Union	4	12	25	28	18	2	89
83 (63%)	Failure	–	1	3	12	9	4	29
	Total	4	13	28	40	27	6	118
Follow-up: < 2 years	Union	–	–	3	10	6	1	20
	Holding	–	–	2	16	22	9	49
	Total	–	–	5	26	28	10	69

RESULTS

The results were divided into three groups:

1. Union, which implied bone union of the fracture with radiographically visible trabeculation across the fracture line.
2. Failure, which implied any recurrence of the fracture deformity including all cases in which the appliance failed. Avascular necrosis is not included in this group.
3. One group was planned as: Position holding, but union doubtful. This implied that bone union was not visible, although the fracture retained its position. After 2 years follow-up no patients were left in this group.

The overall results are listed in Table 2. In the Smith-Petersen group 63 per cent of the fractures united. In the sliding-nail-plate group 75 per cent united, which is a significantly better result ($P < 0.05$, Chi square test). The frequency of avascular necrosis was the same in both groups.

In Table 3 the results are evaluated according to Garden's classification. At the end of each operation – with the patient still under general anaesthesia – radiographic pictures were taken both in the frontal and lateral view. The figures in Tables 4 and 5 are based on these pictures. The reduction of the fracture was measured both in the frontal and lateral view. In the frontal view the Garden angle (1961) was used, i.e. the angle between the central axis of the medial group of

Table 2. Results of the follow-up

Type of osteosynthesis	Number of patients	Union	Failure	Avascular necrosis
Smith-Petersen	131	83 (63%)	48	17 (20%)
Sliding-nail	118	89 (75%)	29	19 (21%)

Chi square test; $P < 0.05$.

Table 3. Results of the follow-up related to the degree of fracture displacement (Garden's classification)

Type of osteosynthesis	Displacement	Number of patients	Union	Failure	Avascular necrosis
Smith-Petersen	Stage 3	71	52 (73%)	19	12 (23%)
	Stage 4	60	31 (52%)	29	5 (16%)
Sliding-nail	Stage 3	62	53 (85%)	9	9 (17%)
	Stage 4	56	36 (64%)	20	10 (28%)

In both groups, stage 3 fractures healed significantly better than stage 4 fractures ($P < 0.025$, Chi square test).

Table 4. Results of the follow-up related to the quality of reduction

Type of osteosynthesis	Reduction	Number of patients	Union	Failure	Avascular necrosis
Smith-Petersen	Good	79	58 (73%)	21	12
	Fair	34	19 (56%)	15	4
	Poor	18	6 (33%)	12	1
Sliding-nail	Good	58	52 (90%)	6	12
	Fair	41	32 (78%)	9	4
	Poor	19	5 (26%)	14	3

trabeculae in the capital fragment and the line of the medial femoral cortex. This angle is normally 160–165 degrees. In the lateral view the anterior or posterior angulation of the head was measured by the angle between a line drawn from the midpoint of the fracture surface of the distal fragment to the centre of the femoral head and a line through the central axis of the neck of the femur. The reduction of the fractures was divided into: *Good:* Frontal angle: 160–179 degrees; lateral angle: less than 15 degrees. *Fair:* frontal angle: either 150–159 degrees or 180–189 degrees; lateral angle: 15–25 degrees. *Poor:* frontal angle: either less than 150 degrees or more than 190 degrees; lateral angle: more than 25 degrees. The results are listed in Table 4.

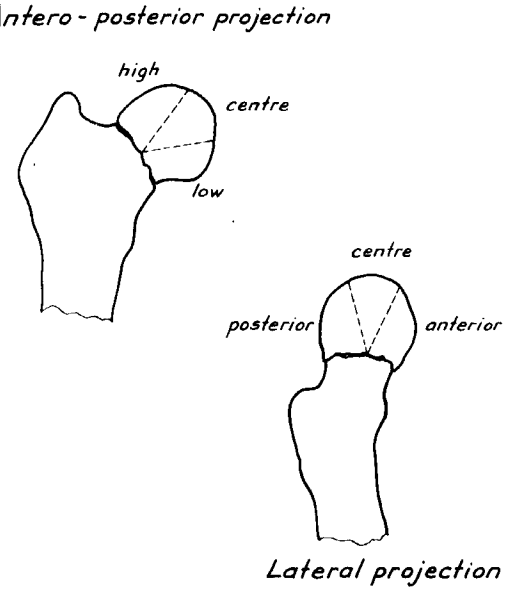

Figure 3. Diagrams illustrating the different areas of the femoral head in which the various positions of the nails were recorded.

The position of the tip of the fixation appliance was determined in relation to the three segments of the femoral head both in the frontal and the lateral radiographs (Figure 3), and divided into three groups accordingly. *Good:* central position in both views. *Fair:* posterior and/or inferior position. *Poor:* anterior and/or superior position. Furthermore, a few cases with the nail placed in the inferior and/or posterior position were classified as poor, because the position of the nail was so peripheral that it was outside the neck and/or the head of the femur. The results are listed in Table 5.

Table 5. Results of the follow-up related to the position of the nail

Type of osteosynthesis	Position of the nail	Number of patients	Union	Failure	Avascular necrosis
Smith-Petersen	Good	74	55 (74%)	19	11
	Fair	29	16 (55%)	13	3
	Poor	28	12 (43%)	16	3
Sliding-nail	Good	55	48 (87%)	7	10
	Fair	34	28 (82%)	6	8
	Poor	29	13 (45%)	16	1

Table 6. Postoperative complications in 383 cases of displaced medial fracture of the femoral neck

Complications	Smith-Petersen	Sliding-nail
Death within 1 month	18	13
Cardiac disease	6	8
Pulmonary disease	22	24
Pulmonary embolism	10	5
Phlebothrombosis	6	7
Deep infection	3	2
Decubital ulcer	10	12
Number of patients with complications	53	56

If a patient had more than one complication, each complication is listed separately.

In the Smith-Petersen group 48 fractures did not unite. In 28 of the cases this was due to the nail sliding out of the capital fragment. In 15 cases in the sliding-nail-plate group the nail telescoped across the fracture line, allowing redisplacement of the fracture.

The frequency of some postoperative complications is listed in Table 6.

DISCUSSION

For decades the frequency of failure has been a major problem in the treatment of displaced medial fractures of the femoral neck. To prevent failure, many types of osteosyntheses have been designed and tested, but in no previous study has there been a random allocation of patients to different types of osteosynthesis.

In the present series the patients were allocated to two different kinds of osteosynthesis according to the day of admission to hospital. This type of randomization has some weak points compared with randomization by odd and even numbers. However, these weak points are minimized or eliminated by the following: it is a study of an acute disease; the preoperative and the postoperative treatment is the same in both departments; and the surgeons – except the chief surgeons – rotate between the two departments. Because of these circumstances the statistical analyses are valid.

The results show that fractures treated with sliding-nail-plate osteosynthesis united significantly better than those treated with Smith-Petersen osteosynthesis ($P < 0.05$). These results do not differ from what has been found in consecutive series (Table 7).

Table 3 shows that there was exactly the same distribution of stage 3 and stage 4 fractures in both groups. Furthermore, within each group the union of stage 3 fractures was significantly better than that of stage 4 fractures ($P < 0.025$, Chi square test).

Tables 4 and 5 show that both the reduction of the fracture and the position of the nail were a

Table 7. Survey of published follow-up studies after operative treatment of medial fractures of the femoral neck

	Union (per cent)		Avascular necrosis (per cent)	
	Stage 3	Stage 4	Stage 3	Stage 4
Smith-Petersen				
Nieminen (1975)	66	65	16	26
Barnes et al. (1976)	58	49	–	–
Present study	73	52	23	16
Sliding-nail				
Brown & Abrami (1964)	90	65	21	30
Graham (1968)	85	71	28	28
Barnes et al. (1976)	75	70	–	–
Present study	85	64	17	28

little better in the Smith-Petersen group compared with the sliding-nail-plate group, and that both these parameters are of major importance in the treatment of displaced medial fractures of the femoral neck.

Due to the comparability of the two differently treated groups of patients, the following conclusions can be drawn from this study:

1. Sliding-nail-plate osteosynthesis is superior to Smith-Petersen osteosynthesis in the treatment of displaced medial fractures of the femoral neck. Smith-Petersen osteosynthesis should therefore be abandoned.
2. Medial fractures of the femoral neck with complete displacement (stage 4) have a significantly higher rate of failure than those which are only partially displaced (stage 3).
3. Exact reduction of the fracture and an optimal position of the nail are still of major importance in the treatment of displaced medial fractures of the femoral neck.

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