Acta orthop. scand. *50*, 443–449, 1979

OSTEOSYNTHESIS OF DISPLACED FRACTURES OF THE FEMORAL NECK

A Comparison Between Smith-Petersen Osteosynthesis and Sliding-Nail-Plate Osteosynthesis – A Radiological Study

PETER A. FRANDSEN

Departments of Orthopaedic Surgery O and Ø, University Hospital, Odense, Denmark

Smith-Petersen osteosynthesis has been compared with sliding-nail-plate osteosynthesis in a prospectively planned, randomized, follow-up study of 197 cases of displaced medial fractures of the femoral neck. A total of 131 patients were followed for more than 2 years. After Smith-Petersen osteosynthesis 66 per cent of the fractures united and after sliding-nail-plate osteosynthesis 77 per cent united. The results showed that the choice of fixation devices is of minor importance compared with exact reduction of the fracture and optimal positioning of the nail.

Key words: choice of fixation devices; displaced medial fracture of the femoral neck; osteosynthesis

Accepted 26.xi.78

Since 1931 when Smith-Ptersen et al. introduced the trifin nail in the treatment of femoral neck fractures, this method has been widely used in the Scandinavian countries. During the last 20 years many new methods of osteosynthesis have appeared and one of these is the sliding-nail-plate osteosynthesis.

The report presents the results of a randomized, prospectively planned, follow-up examination of displaced medial fractures of the femoral neck, in which we have compared the Smith-Petersen osteosynthesis and the sliding-nail-plate osteosynthesis.

METHOD

On admission to hospital, traction (usually without internal rotation) was applied through the tibial tubercle. Final adjustment of the fracture was made under general anaesthesia on the fracture table with fluoroscopy and 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 aim was to place the nail as steeply as possible, so that it rested on the femoral calcar and was a little posterior and inferior to the centre of the femoral head (Figure 3).

In the postoperative treatment early mobilization was encouraged. If there were no contraindications, the patient sat in a chair the day after the operation. On the second or third day, the patient was allowed to walk with elbow crutches. 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.

PATIENTS

This study includes all patients with displaced medial fractures of the femoral neck treated in the

0001–6470/79/040443–07$02.50/0

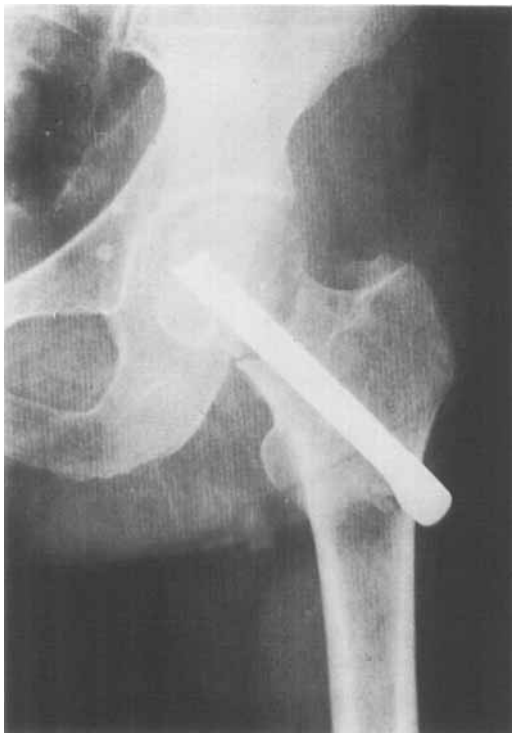

Figure 1. Radiograph of the Thornton nail in a femoral neck fracture.

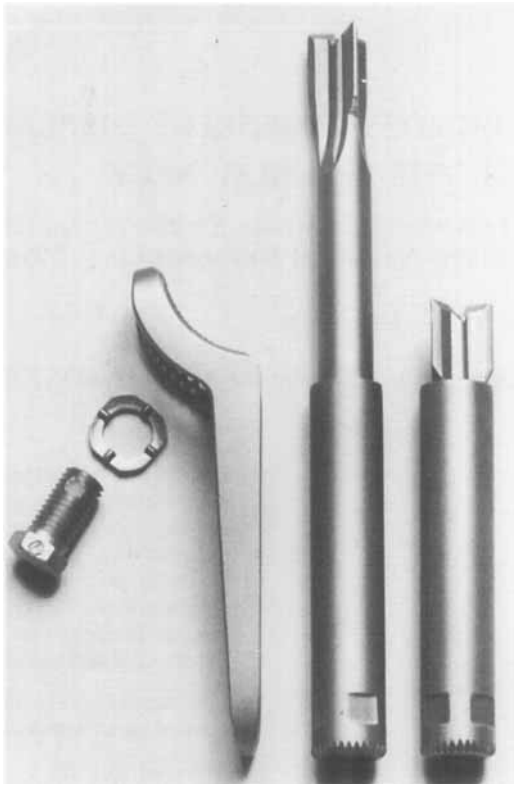

Figure 2. The sliding-nail-plate. A nail is shown in its longest and shortest position.

Orthopaedic Departments O and Ø between March 1972 and May 1975.

The fractures have been divided according to Garden's classification (1961): Stage 1: incomplete fracture (impacted valgus fracture); Stage 2: complete fracture without displacement; Stage 3: complete fracture with partial displacement; Stage 4: complete fracture with full displacement. Only stage 3 and stage 4 fractures have been considered in this series.

The two orthopaedic departments receive emergency admissions on alternating days and the patients have been randomized according to this. To a large extent the operations were performed by the same doctors in both departments, because all doctors except the chief surgeons rotate between the two departments for periods of 1 year.

From March 1972 to May 1975, 205 patients with 207 displaced medial fractures of the femoral neck were admitted to the hospital. The following 10 patients were excluded from the study: three patients with pathological fractures; three patients who died before the operation was performed; one patient with a fracture at least 4 weeks old and surgery was not indicated; one patient in whom the fracture could not be reduced and therefore a Moore prosthesis was inserted instead; and two patients due to age – both 28 years old.

Smith-Petersen osteosynthesis was performed in 100 cases and sliding-nail-plate osteosynthesis in 97 cases. The age distribution is given in Table 1. In the Smith-Petersen group the average age was 78 years (range: 51–96 years). In the sliding-nail-plate group the average age was 76 years (range: 48–93 years). Thirty-eight patients in the Smith-Petersen group and 24 patients in the sliding-nail-plate group died before the 2 year follow-up period was over. Four patients (one was an American tourist) – all in the sliding-nail-plate group – were lost to follow-up.

For those fractures that united the average follow-up period in the Smith-Petersen group was 31 months (range: 24–65 months) and in the sliding-nail-plate group 34 months (range: 24–56 months).

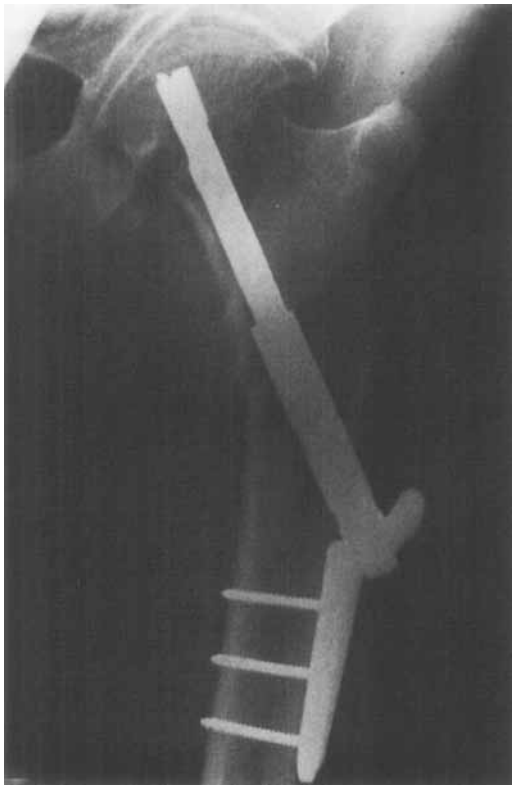

Figure 3. Radiograph of the sliding-nail-plate in a femoral neck fracture.

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. A group was planned as: Position holding, but union doubtful. This implied that bone union was not visible, although the fracture maintained its position. After 2 years follow-up no patients were left for this group.

The overall results are listed in Table 2. In the Smith-Petersen group 66 per cent united and in the sliding-nail-plate group 77 per cent united. The frequency of avascular necrosis was about 20 per cent in both groups. In Table 3 the results are analysed according to Garden's classification.

At the end of each operation – the patient still under general anaesthesia – radiographic pictures both in the frontal and lateral view were taken. The analysis 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) between the central axis of the medial group of trabeculae in the capital fragment and the line of the medial femoral cortex was used. This angle is normally 160–165 degrees (Figure 4). 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 fracture 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.

The position of the tip of the fixation appliance was analysed according to three segments of the femoral head in both frontal

Table 1. Age distribution of 197 cases of displaced medial fracture of the femoral neck

Age	40–49	50–59	60–69	70–79	80–89	90–	Total
Smith-Petersen nail	—	7	16	34	35	8	100
Sliding-nail-plate	1	5	19	33	31	8	97

Table 2. Results of the follow-up

Type of osteosynthesis	Number of patients	Union	Failure	Avascular necrosis
Smith-Petersen	62	41 (66 %)	21	8 (20 %)
Sliding-nail-plate	69	53 (77 %)	16	11 (21 %)

$0.20 > P > 0.10$; Chi square test.

Table 3. Results of the follow-up related to the degree of fracture displacement

Type of osteosynthesis	Displacement	Number of patients	Union	Failure	Avascular necrosis
Smith-Petersen	Stage 3	33	26 (79 %)	7	6 (23 %)
	Stage 4	29	15 (52 %)	14	2 (13 %)
Sliding-nail	Stage 3	35	32 (91 %)	3	6 (19 %)
	Stage 4	34	21 (62 %)	13	5 (24 %)

In both groups, fractures in stage 3 healed significantly better than fractures in stage 4 ($P < 0.05$, 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	31	25 (81 %)	6	5
	Fair	20	15 (75 %)	5	3
	Poor	11	1 (9 %)	10	—
Sliding-nail	Good	41	36 (88 %)	5	7
	Fair	19	14 (74 %)	5	2
	Poor	9	3 (33 %)	6	2

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	36	28 (78 %)	8	6
	Fair	14	10 (71 %)	4	1
	Poor	12	3 (25 %)	9	1
Sliding-nail	Good	39	36 (92 %)	3	7
	Fair	21	15 (71 %)	6	3
	Poor	9	2 (22 %)	7	1

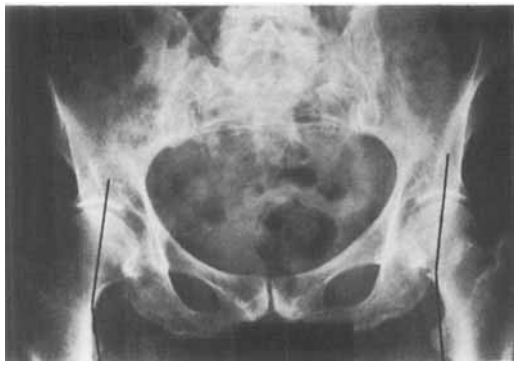

Figure 4. Radiograph illustrating the Garden angle in a normal (right side) and a fractured femoral neck (see text for details).

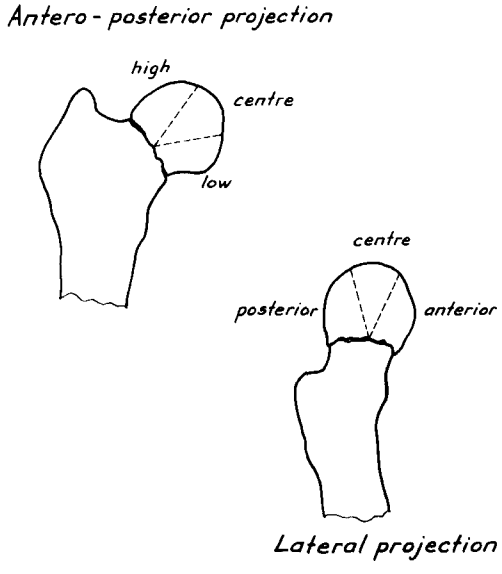

Figure 5. Diagrams illustrating the different areas of the femoral head in which the various positions of the nails were recorded.

and lateral radiographs (Figure 5), and divided into three groups accordingly. Good: central in both views. Fair: posterior and/or inferior. Poor: anterior and/or superior. If the tip of the nail was not within 1 cm of the articular surface of the femoral head, the position of the fixation appliance was degraded one group. Furthermore, a few cases with the nail placed in the inferior and/or posterior position were classified as

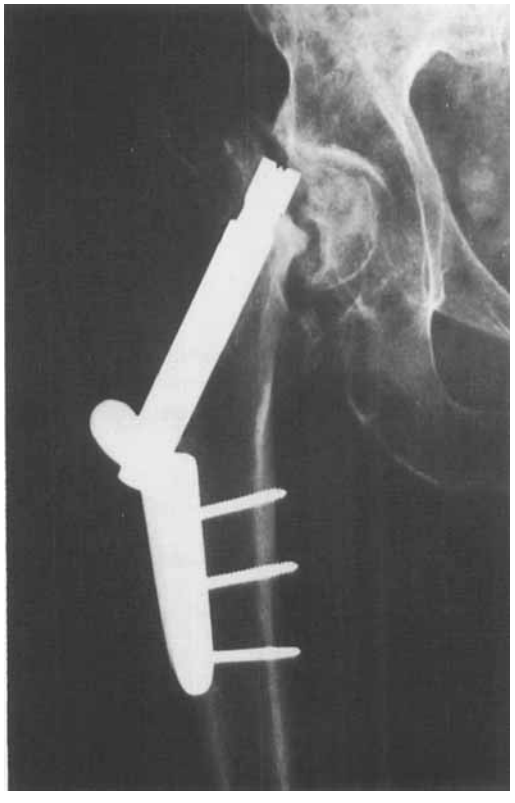

Figure 6. Radiograph showing that the sliding-nail has telescoped across the fracture line followed by redisplacement of the fracture.

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.

In the Smith-Petersen group 21 cases did not unite. In 12 (19 per cent) of these cases the nail slid out of the capital fragment. In six cases (9 per cent) in the sliding-nail-plate group the nail telescoped across the fracture line, allowing redisplacement of the fracture (Figure 6).

The frequency of certain postoperative complications are listed in Table 6.

DISCUSSION

From Table 7 it can be seen that the results in this study do not differ a great deal from

Table 6. Postoperative complications in 197 patients operatively treated for a displaced medial fracture of the femoral neck

Complications	Smith-Petersen	Sliding-nail-plate
Death within 1 month	14	7
Cardiac diseases	2	3
Pulmonary diseases	15	9
Pulmonary embolism	5	3
Phlebothrombosis	3	1
Deep infection	1	2
Decubital ulcer	8	6
Number of patients with complications	34	25

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

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
SLIDING-NAIL-PLATE				
Brown & Abrami (1964)	90	65	21	30
Graham (1968)	85	71	28	28
Barnes et al. (1976)	75	70	—	—
Present study	91	62	19	24
SMITH-PETERSEN				
Nieminen (1975)	66	65	16	26
Barnes et al. (1976)	58	49	—	—
Present study	79	52	23	13

Only studies using Garden's classification have been included in Table 7.

results reported earlier. Barnes et al. (1976) found in a prospective, non-randomized, multi-centre trial that the failure rate was consistently about 20 per cent higher after Smith-Petersen nailing compared to other fixation devices, including sliding-nail-plate, crossed screws, low angle screws and low angle nails (Table 7). However, their results have not been confirmed in the present series, which showed that the rate of union was only about 10 per cent higher in the sliding-nail-plate group than in the Smith-Petersen group.

From Tables 4 and 5 it is evident that both an exact reduction of the fracture and a centrally placed nail are the most important factors in obtaining a good result. Furthermore, it can be seen that there is a high rate of union in stage 3 fractures and a low rate of union in stage 4 fractures. This implies that Garden's classification (1961) to some extent can be used to pick out those patients most suited for a primary prosthetic replacement.

The frequency of postoperative complications was a little higher after Smith-Petersen nailing than after sliding-nail-plate osteosynthesis. We can offer no explanation for this, in as much as both the preoperative and the postoperative treatment were exactly the same in the two departments. The

average age, which was a little higher in the Smith-Petersen group, seems insufficient to explain the difference.

The conclusion drawn from this study is that the choice of fixation devices is of minor importance compared with an exact reduction of the fracture and an optimal positioning of the nail.

REFERENCES

Barnes, R., Brown, J. T., Garden, R. S. & Nicoll, E. A. (1976) Subcapital fractures of the femur. *J. Bone Jt Surg.* **58**-B, 2–24.

Brown, J. T. & Abrami, G. (1964) Transcervical femoral fracture. *J. Bone Jt Surg.* **46**-B 648–663.

Graham, J. (1968) Early or delayed weight-bearing after internal fixation of transcervical fracture of the femur. *J. Bone Jt Surg.* **50**-B, 562–569.

Garden, R. S. (1961) Low-angle fixation in fractures of the femoral neck. *J. Bone Jt Surg.* **43**-B, 647–663.

Nieminen, S. (1975) Early weight-bearing after classical internal fixation of medial fractures of the femoral neck. *Acta orthop. scand.* **46,** 782–794.

Smith-Petersen, M. N., Cave, E. F. & Vangorder, G. W. (1931) Intracapsular fractures of the neck of the femur. *Arch. Surg.* **23,** 715–759.

Correspondence to: Peter A. Frandsen, Engvej 11, Dk-5230 Odense M, Denmark.