Acta orthop. scand. 48, 57–62, 1977

OSTEOSYNTHESIS OF MEDIAL FRACTURES OF THE FEMORAL NECK BY SLIDING NAIL-PLATE FIXATION

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Sliding-nail-plate osteosynthesis of displaced medial fractures of the femoral neck was carried out in 65 consecutive cases. The appliance presented here differs from other sliding-nail plates as it has no fixed angle between the nail and the plate. Immediate postoperative weight-bearing was permitted. The average follow-up period was 2.2 years. Union of the fractures was seen in 74 per cent and avascular necrosis in 21 per cent. Complications were few, which we attribute to the early mobilization of the patients.

Key words: early weight-bearing; medial fractures of the femoral neck; sliding-nail-plate osteosynthesis

Accepted 22.xi.76

In patients with displaced medial fractures of the femoral neck an osteosynthesis sufficiently solid to permit immediate weight-bearing is desirable, but of course without increasing non-union or avascular necrosis.

It is generally agreed that in medial fractures of the femoral neck, full reduction of the fracture and rigid apposition of the fracture surfaces are of particular importance, but there is no agreement as to which sort of internal fixation satisfies these aims best.

Sliding-nail-plate osteosynthesis was earlier reported by Pugh (1955), Massie (1958), and Brown & Abrami (1964). The purpose of this study is to present the findings of a consecutive series of 65 displaced medial fractures of the femoral neck treated with sliding-nail-plate osteosynthesis and with immediate postoperative weight-bearing.

MATERIAL AND METHODS

This study includes all patients with displaced medial fractures of the femoral neck treated in the Orthopaedic Department Ø, Odense University Hospital between March 1972 and March 1974. There were 65 patients, 51 women and 14 men. The average age was 74.1 years, ranging from 48 years to 93 years. The age distribution is given in Table 1.

The fractures have been divided according to Garden's (1961) classification: 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 fractures in stage 3 and stage 4 have been considered in this series. Pathological fractures have been excluded.

Operation was performed at the first opportunity, but not as an emergency. After admission to hospital, 16 patients were operated within 24 hours, 10 patients between 24 hours and 48 hours, and 13 patients between 48 hours and 72 hours. On admission to hospital, traction (usually without internal rotation) was applied through the tibial tubercle. Final adjustment of

Table 1. Age distribution of 65 patients with medial fracture of the femoral neck and number of deaths before the follow-up.

Age	40–49	50–59	60–69	70–79	80–89	90–	Total
Number of patients	1	4	15	16	21	8	65
Number of deaths before follow-up	–	–	1	2	7	2	12

the reduction was made under general anaesthesia on the fracture table with fluoroscopy and image intensifier.

The appliance which is illustrated in Figure 1 consists of a partial trifin nail sliding in a circular barrel. The telescopic property of the nail allows progressive impaction as resorption occurs at the fracture site, without any risk of the nail penetrating the articular surface of the femoral head. The compressed nail is inserted over a guide pin, and with a special driver the trifin nail is driven into position to 0.5 cm below the articular surface of the femoral head. The nail should be placed at as steep an angle as possible, resting on the femoral calcar and a little posterior and inferior to the centre of the femoral head. Lastly, the nail is connected to a three-hole plate by a topbolt (Figure 2 a and b).

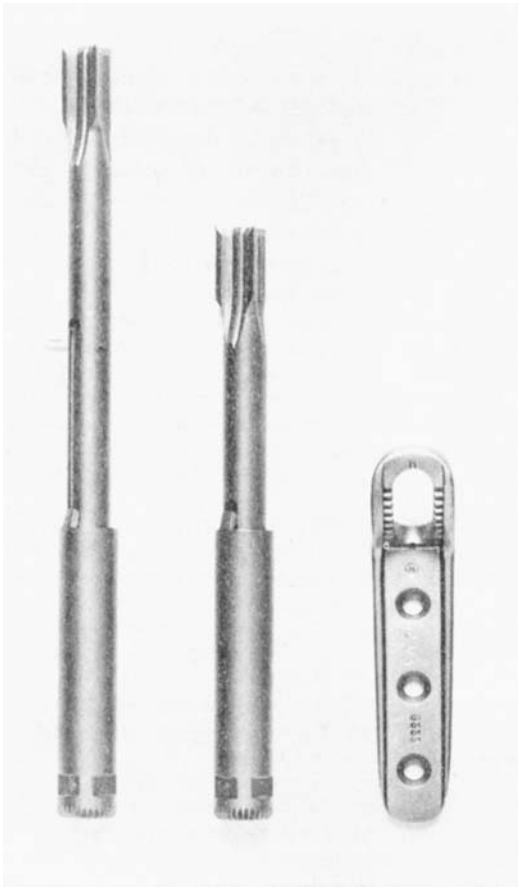


Figure 1. The sliding-nail-plate material. The nail component is shown in its longest and shortest position.

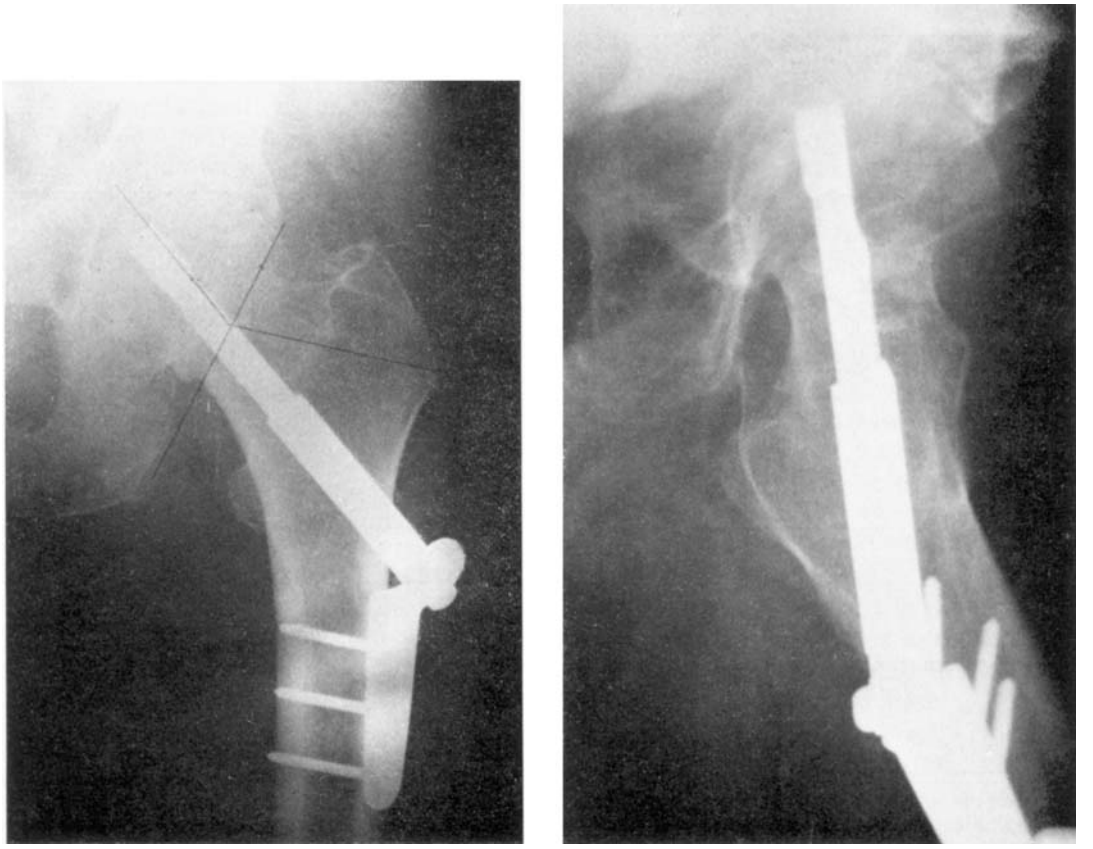
In the postoperative treatment we aimed at an early mobilization. If there were no contraindications, the patient would sit in a chair the day after the operation, and on the second or third day, the patient was permitted to walk with elbow crutches. Weight-bearing on the operated leg up to the threshold of pain was allowed. The patients have been followed with clinical and radiographic examination until either union of the fracture or failure was manifest.

At the follow-up, 12 (18 per cent) patients had died. Six patients refused to come to hospital for radiographic examination and one patient was an American tourist. They have all been excluded from the results. In the remaining 46 patients, clinical and radiographic examinations were made at the follow-up. The average follow-up period was 2.2 years, ranging from 1.2 years to 3.5 years.

RESULTS

The results were divided into three groups:

1. Union was seen in 34 patients (74 per cent), and this implies bone union of the fracture with radiographic visible trabeculation across the fracture line.
2. Failure was seen in 10 patients (22 per cent). This implies recurrence of the fracture deformity. This group also includes two cases of failure of the applicance. This group does not include avascular necrosis.



a. antero-posterior position. *b. lateral position.*

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

3. Doubtful union. At the follow-up there were two patients (3 per cent) with no clear evidence of bone union, but there were no signs of failure either.

Avascular necrosis was seen in seven patients (21 per cent) who had all previously shown bone union. Union was found in stage 3 fractures in 94 per cent, and in stage 4 fractures in 61 per cent (Table 2).

In 38 cases with good reduction of the fracture, 76 per cent united (Table 3). In 26 cases with good position of the sliding nail 82 per cent united (Table 4).

Postoperative complications were found in 21 patients as listed in Table 5. In one case we had to remove the appliance one year after the operation because of a deep infection. There were no signs of phlebothrombosis or pulmonary embolism. Prophylactic anti-coagulation was not used in the series.

In 10 cases, the osteosynthesis failed. Two cases showed poor reduction of the fracture as well as a poor position of the sliding nail. Within the first three months, another two patients had a new trauma with redisplacement of the fracture. In a further two cases, the sliding nail telescoped out of the femoral head, and in three patients no obvious explanation was found.

In the last of the failures, the femoral head tilted when the nail was inserted

Table 2. Results of the follow-up related to degree of fracture displacement.

Displacement	Number of patients	Union	Failed	Doubtful union	Avascular necrosis
Stage 3	18	17	–	1	4
Stage 4	28	17	10	1	3
Total	46	34	10	2	7

Table 3. Results of the follow-up related to the quality of reduction.

Reduction	Number of patients	Union	Failed	Doubtful union	Avascular necrosis
Good	38	29	7	2	7
Fair	6	5	1	–	–
Poor	2	–	2	–	–
Total	46	34	10	2	7

Good: Reduction is anatomical or slightly in valgus without any rotation.
Fair: Reduction is anatomical or slightly in valgus with some rotation.
Poor: Reduction is in varus or with severe rotation.

Table 4. Results of the follow-up related to the position of the sliding nails.

Position of sliding nail	Number of patients	Union	Failed	Doubtful union	Avascular necrosis
Good	26	23	3	–	2
Fair	12	8	4	–	4
Poor	8	3	3	2	1
Total	46	34	10	2	7

Good: The nail is placed in the centre or in the lower posterior quadrant of the femoral head.
Fair: The nail is placed in the lower anterior quadrant or in the superior posterior quadrant of the femoral head.
Poor: The nail is placed in the superior anterior quadrant of the femoral head, penetrating the femoral head, or more than one centimetre below the cortex of the femoral head.

and the fracture surfaces could no longer be brought into contact.

DISCUSSION

The present sliding-nail-plate osteosynthesis differs in only one major respect from other appliances (Pugh 1955, Massie 1958, Brown & Abrami 1964, Ainsworth 1971), it has no fixed nail-plate angle. The fact that the nail is connected by a topbolt to the side plate increases the possibility of obtaining an optimal position of the nail. Backman (1957) showed that the weight-bearing forces which act on the proximal end of the femur are almost vertical, and accordingly we aim at the steepest possible position of the nail resting on the calcar

and definitely not above or anterior to the midpoint of the articular surface of the capital fragment. This steep position of the nail also minimizes the strain on the junction between the nail and the plate, and thus we have only seen failure of the appliance in two (3 per cent) cases where the nail slid back into the barrel followed by redisplacement of the fracture. Neiminen (1975) reported sliding outwards of the nail in 29.2 per cent and collapse of the junction between nail and side-plate in 8.9 per cent in a series of patients treated with early weight-bearing.

Table 5. Postoperative complications in 65 patients operated with sliding-nail-plate osteosynthesis for medial fracture of the femoral head.

Complications	Number of patients
Death within one month	3
Cardiac diseases	5
Pulmonary diseases	7
Phlebothrombosis	0
Decubital ulcer	4
Miscellaneous	7
Deep infection	1
Total	27

If a patient had more than one complication, each complication is listed separately. All together there were 21 patients with postoperative complications.

In the present study of elderly patients we aimed at a very early mobilization. As reported earlier (Brown & Abrami 1964, Graham 1968, and Neiminen 1975) weight-bearing 2 weeks after the operation does not deteriorate the final result. On the contrary, results indicate that early weight-bearing improves the final result compared with late weight-bearing (after 12 to 14 weeks). Investigations by Skipper (1975) show that the first days after the operation the patients only put a little of their body weight on the operated leg, but within a week the ability to bear weight increases rapidly in patients with medial fractures of the femoral neck. After an average period of 53 days the patients put full weight on the operated leg.

One might expect that the early mobilization with weight-bearing would be followed by an increased incidence of nonunion of the fracture and avascular necrosis of the femoral head. This has not been the case. We found that the rate of union was 94 per cent in stage 3 fractures and 61 per cent in stage 4 fractures.

As seen in Table 6, these figures do not differ from results reported earlier (Garden 1961, Brown & Abrami 1964, Graham 1968, Nieminen 1975). Further, they are also in agreement with reports from Odense University Centre (Jensenius

Table 6. Survey of 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
Garden 1961 (1)	93	57	29	12
Brown & Abrami 1964	90	65	21	30
Graham 1968	85	71	28	28
Nieminen 1975 (2)	66	65	16	26
Present study	94	61	24	18

(1) Low-angle Küntscher nail.
(2) Smith-Petersen nail with or without side plate.

1956, Frederiksen et al. 1967). It also appears from Table 6 that the rate of avascular necrosis in our material was 24 per cent in stage 3 fractures and 18 per cent in stage 4 fractures, and even here the results do not differ.

Furthermore, it is evident from Table 6 that there is a high rate of union in stage 3 fractures and a considerably lower rate of union in stage 4 fractures. On the other hand, there is no connection between avascular necrosis and the fracture stage.

In the present study there was no clinically observed phlebothrombosis or pulmonary embolism, which, together with the low mortality (three patients within 30 days), we attribute to the early mobilization of the patients.

As stated by Spotoft (1944) and Garden (1961, 1971, 1974), an exact reduction of the fracture is the basis of a high rate of union (Table 3). That an optimal internal fixation is also of importance in this respect can be seen from Table 4.

The conclusion made from this study can only be of a tentative nature due to the small number of patients, but the advantages already mentioned together with the high rate of acceptable results make it an attractive method of internal fixation of medial fractures of the femoral neck.

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