

# Sliding screw-plate for fixation of femoral neck fracture

Ninety-eight fractures of the femoral neck treated with a sliding screw-plate system were followed from 6 to 65 months. Two cases developing deep infection and four cases of primary technical failure were reoperated. Union was encountered in 80/92 of the fractures; 13/80 of the united fractures developed necrosis of the femoral head. Serious complications were thus encountered in 31/98 of the fractures, and 27 of these were reoperated. On the basis of comparison with reports on other methods for internal fixation, the sliding screw-plate method is recommended for fixation of femoral neck fractures.

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The predominant technical problem in fractures of the femoral neck is the high incidence of necrosis of the femoral head and, to a minor degree, non-union. In this study the results of a series of 110 fractures of the femoral neck treated with a sliding screw-plate system are presented.

## Patients and methods

This study included patients with fractures of the femoral neck and an age of less than 70 years or with a high level of physical activity treated in the orthopaedic departments at Gentofte Hospital from January 1978 to April 1982. Patients over 70 years and in poor general condition were treated with a Moore prosthesis. Patients with fractures of Garden's Stage 1 were generally not operated. Patients with basocervical fractures were included, whereas patients with pathological fractures due to malignancy were excluded from the study. Nineteen patients randomly allocated to sliding nailplate in a prospective study between sliding nail-plate and sliding screw-plate were also excluded. There were 110 patients, 74 women with a median age of 65 (50-91) years and 36 men with a median age of 65 (19-89) years.

The fractures were classified according to Garden (1961), and further divided into subcapital, transcervical and basocervical fractures.

The operation was not performed as an emergency but as soon as possible and not later than 48 h after admission. In one case a Stage 1 fracture was operated 10 days after admission due to secondary dislocation.

The implant was a sliding screw-plate manufactured from a cobalt-chromium-molybdenum alloy (Howmedica).

On admission to the hospital, traction was applied in all dislocated fractures. The operations were carried out by surgeons of various experience. The patient was placed on the fracture table in the supine position and final reduction was made under general/spinal anaesthesia with the aid of an image intensifier. The sliding screw was inserted through a lateral incision. As steep an angle as possible was attempted with calcar support. An attempt was made to place the proximal end of the screw in the central third of the femoral head in the frontal as well as the lateral view, and between 0.5 and 1 cm from the articular surface of the femoral head. Postoperatively, mobilisation was started within a few days.

## Follow-up

Twelve patients were not available for follow-up, usually because they died within a few months. Ninety-eight patients were followed for a median period of 27 (6-65) months. The follow-up included a radiographic examination of the hip in the frontal and lateral views. Six patients had died during the period of the survey. The 27 patients who were reoperated before follow-up were not examined. One patient was in a psychiatric ward, due to severe senile dementia, and was not examined.

## Radiographic examination

All radiographs were examined by both authors. The pre- and postoperative radiographs and those obtained at the final follow-up were examined. The last

films obtained prior to death or reoperation were also examined. The *reduction* of the fracture was rated good if the angle between the medial trabeculae and the medial femoral cortex in the frontal view was between 155 and 165 degrees, and the femoral head was positioned within  $\pm 5$  degrees from the erect position in the lateral view. Acceptable reduction was defined as the femoral head being dislocated in only one view, and non-acceptable reduction as the femoral head being dislocated in both views. The *position of the tip of the sliding screw* in the femoral head was good when it was placed in the central third in both views, and non-acceptable when placed in the upper and/or anterior third of the femoral head. The remaining positions were acceptable. It was recorded whether the tip of the screw had perforated the articular surface. The group without *screw perforation* was divided into two groups, according to whether the tip was closer than 1 cm or more than 1 cm from the articular surface. The *fixation index*, defined as the length of the part of the screw positioned in the capital fragment in relation to the length of the capital fragment, was recorded as good  $> 0.8$ , acceptable 0.6–0.8, or non-acceptable  $< 0.6$ . The *telescoping effect*, from comparison of the postoperative films and the latest radiographs obtained, was estimated with correction for different enlargement of the films, and recorded as less than 1 cm, between 1 and 2 cm, and more than 2 cm. *Migration* of the sliding screw, *osteolysis* (defined as a zone of rarefaction of more than 1 mm around the sliding screw), *varus* of more than 10 degrees, and *failure of cortex screws* were noticed. *Necrosis of the femoral head* was noted (Martel & Sitterley 1969), when at least one of the following changes was observed: 1) subtle diffuse mottling of the bone, 2) isolated patches of sclerosis, 3) irregular discrete rarefaction with fuzzy marginal sclerosis, 4) subchondral cortical depression, 5) generalised subchondral fragmentation, or 6) periosteal bone apposition along the femoral neck.

## Statistical methods

The chi-square test and Cochran's three-way test were used for the statistical analysis.

## Results

Postoperative complications occurred in 16 patients. Deep infection resulted in reoperation in two cases. Four patients were reoperated due to primary technical failure. In two of these cases, severe migration of the sliding screw caused dislocation of the femoral head.

Table 1. Incidence of late complications in 92 fractures of the femoral neck operated with sliding screw-plate

	No. of patients	Femoral head necrosis <sup>a</sup>	p-value
<b>Age (years)</b>			
<50	9	2	<0.025 <sup>b</sup>
51–60	20	6	
61–70	43	3	
71–80	13	2	
>80	7	0	
<b>Garden Stage<sup>c</sup></b>			
1	8	0	<0.05 <sup>b</sup>
2	9	0	
3	56	8	
4	14	5	

a. Number of united fractures developing necrosis.

b. Chi-square test, d.f. 1.

c. In five fractures the preoperative radiographs were not available at follow-up.

In one case unintended severe telescoping of the screw led to dislocation of the femoral head. In the fourth case the screw did not telescope, and an increasing gap between the femoral fragments resulted in reoperation.

In 80 of the remaining 92 patients the fractures united with radiographically visible trabeculation across the fracture line. Non-union developed in 12 fractures, 11 of which were reoperated. In the last case, reoperation was likewise indicated, but was not attempted because of the general status of this old patient. In four of the cases with non-union, femoral head necrosis was found as well.

Thirteen of the 80 united fractures developed femoral head necrosis with a median interval of 21 (5–57) months. Ten of these patients were reoperated because of pain. One patient died just after the diagnosis was established, and reoperation was postponed in the last two patients, who were not troubled by pain.

The frequency of femoral head necrosis and non-union was related to the preoperative variables (Table 1). The incidence of necrosis was relatively high in young patients, but non-union was not related to age.

In the non-dislocated fractures and in the extracapsular or basocervical fractures, no complications were encountered. There was a cor-

Table 2. Incidence of late complications in 66 fractures<sup>a</sup> operated with sliding screw-plate

	No. of patients	Femoral head necrosis <sup>b</sup>	p-value
Distance from articular surface			
<1 cm	48	4	<0.0005 <sup>c</sup>
>1 cm	13	7	
Perforation	5	2	
Fixation index			
good	46	6	<0.05 <sup>c</sup>
fair	18	5	
non-acceptable	2	2	

a. 21 fractures of Garden's stage 1 and 2, basocervical fractures and 5 fractures, where the preoperative roentgenograms were not available at follow-up, were excluded from this table.

b. Number of united fractures developing necrosis.

c. Chi square test, d.f. 1.

relation of dislocation with necrosis but not with non-union. The small differences in the incidence of late complications in relation to the location of the fracture were not significant.

The small differences in rate of complications between quality of reduction and screw position were not significant, although there was a tendency to a lower rate of necrosis with a better reduction. The incidence of femoral head necrosis but not non-union in relation to the position of the screw was highly significant (Table 2).

During the period of follow-up we encountered three cases with secondary perforation of the femoral head, five cases with migration of the lag screw, 27 cases of osteolysis and one case of secondary variation of more than 10 degrees, all without femoral head necrosis or non-union. In two cases, one or two of the three cortex screws were broken. Secondary fracture of the femur did not occur.

## Discussion

The radiographic signs of necrosis of the femoral head listed by Hulth (1961) and Frangakis (1966) are somewhat vague, and we have therefore tried to apply the broad but more

thorough descriptions by Martel & Sitterley (1969). We found one or more of four of their signs in more than half of our necrosis cases. In order of importance, we encountered subchondral cortical depression, generalised subchondral fragmentation, isolated patches of sclerosis or subtle diffuse mottling of the bone, but also periosteal bone apposition along the femoral neck and irregular discrete rarefactions with fuzzy marginal sclerosis. In this series we found necrosis of the femoral head in only 13 of the 80 united fractures. However, it must be emphasized that this number should be regarded as a minimum, since the median time of follow-up was 2 years. On the other hand, this figure was based strictly on a radiographic diagnosis, and not on a combination of pain and radiographic changes. Another explanation for our results could be the relatively lesser damage to the circulation of the femoral head following screwing as compared to nailing, as recently stated by Strömquist (1983).

Analysing the preoperative variables, we found a significant relation between necrosis and dislocation, between age and dislocation ( $p < 0.025$ , chi-square test), and between necrosis and age. When taking into account, however, the uneven Garden stage distribution in relation to age, the relation between necrosis and age, disappeared ( $p < 0.3$ , Cochran's three-way test). A possible explanation could be that the severity of the initial trauma, capable of breaking the femoral neck, is much higher in young people than in the elderly, and so severe that it often results in a dislocated fracture, as also stated by Zetterberg et al. (1982).

Garden (1971) and Barnes et al. (1976) have pointed out that of the postoperative variables, the exact reduction was of the utmost importance in determining the end result. Although we found that a good reduction seemed to have a better prognosis, this was not significant in our study. This might be due to a wrong acceptance of the nil-hypothesis. Instead, we found the position of the sliding screw to be highly significant. The relationship between necrosis and screw position was not explained by a skew distribution of Garden stage among the two groups of screw position ( $p < 0.03$ , Cochran's three-way test).

In our study the rate of non-union was 12/92.

Only a few authors, notably Johansson (1964) reporting on nailing with Nyström nails and McCutchen & Carnesale (1983) testing the Calandruccio/Deyerle devices, have reported an equally low incidence of non-union.

We conclude from our study that the method of internal fixation with the sliding screw-plate described here may be recommended in the fixation of fractures of the femoral neck.

## References

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