

Redisplacement of nailed femoral neck fractures

4-year follow-up of 110 cases

Paul Eliasson, Johan Kärrholm and Lars Ingvar Hansson[†]

In 110 femoral neck fractures, we measured the articulothrochanteric distance and the anteroposterior position of the femoral head, preoperatively, postoperatively, and at a minimum follow-up of 2 years. In displaced fractures the size of the displacement could not be used to predict future incidence of fracture redisplacement or femoral head necrosis.

We have previously measured the preoperative displacement of femoral neck fractures in the proximal-distal and anteroposterior directions (Eliasson et al. 1988). Meaningful differences were found only if the Garden (1961) classification was condensed to two groups; one consisting of Stages I and II (undisplaced fractures) and the other of Stages III and IV (displaced fractures).

The purpose of this study was to measure the fracture compression after reducing and nailing femoral neck fractures and to evaluate whether the size of the preoperative displacement influenced the final result.

Patients and methods

Between 1977 and 1980, 314 consecutive patients were admitted to our hospital because of a femoral neck fracture. All the 100 cases treated with Nyström nails 1979-80 were primarily excluded. The remaining 214 patients were all traced. Totally, 104 fractures were excluded: 9 were primarily treated with a hip prosthesis and 1 with a sliding screw; 56 patients died within 2 years, and 38 patients were too disabled, refused to participate, or lived abroad.

Thus, 110 cases (29 men, 81 women) fulfilled the inclusion criteria: von Bahr or Nyström nailing with

a minimum follow-up of 2 years or radiographically verified healing complications. Prosthetic replacement because of redisplacement, nonunion, or segmental collapse was performed in 29 cases 11 months (4 days-4 years) after the fracture. A further 21 cases with healing complications were not reoperated on, and they were examined at a mean follow-up time of 4 years. The mean follow-up in 60 fractures that healed uneventfully was 5 (2-8) years.

Preoperative, postoperative (mean 6, range 1-14 days after nailing), and follow-up radiographs were examined, and the articulothrochanteric distance (ATD) and anteroposterior position (APP) of the femoral head was recorded (Eliasson et al. 1988). In cases of collapse the circumference of the femoral head was reconstructed before measuring the ATD (Figure 1). To correct for errors caused by varying magnification, the diameter of the femoral head was measured on each radiograph and the recorded values of ATD and APP were adjusted using a femoral head diameter of 59 mm. To make a comparison with a normal material (Eliasson et al. 1988), the measurements in the normal material were also adjusted to a femoral head diameter of 59 mm. In addition, all the fractures were classified according to Garden (1961).

The displaced fractures were treated with closed reduction before nailing. No attempt at reduction of the undisplaced fractures was performed. Three Nyström nails (58 fractures) or 2-3 von Bahr screws (52 fractures) were used to stabilize the fractures. Thirty-five surgeons performed the operations. None of the surgeons performed both of the methods. The postoperative and follow-up results (ATD, APP, fre-

[†]Department of Orthopedics, Umeå University Hospital, S-901 85 Umeå, Sweden

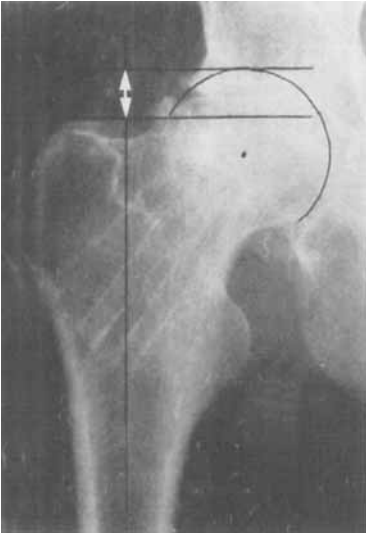


Figure 1. Reconstruction of the circumference of the femoral head, which has developed segmental collapse.

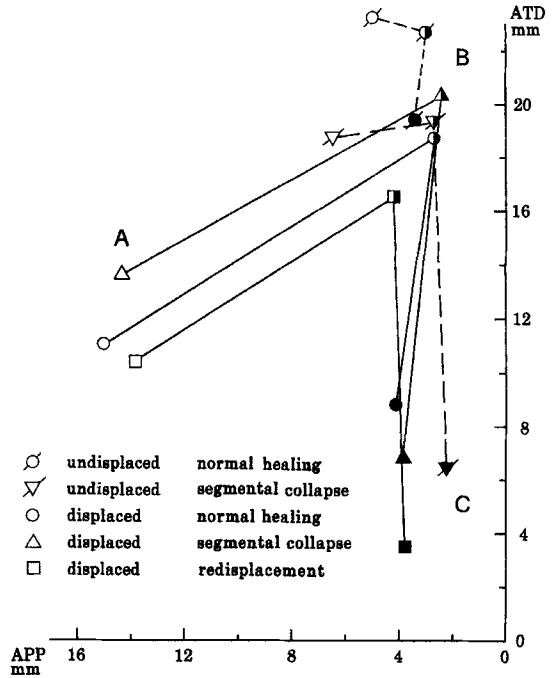


Figure 2. Mean values of articular-trochanteric distance (ATD) and anteroposterior position (APP) of the femoral head from fracture to follow-up in 110 fractures.

A (white) preoperative.
 B (black and white) postoperative.
 C (black) follow-up.

quency of healed fractures, segmental collapse, and redispacement) did not differ between the two types of osteosynthesis.

The Student's *t*-test, the Mann-Whitney *U*-test, chi-square with Yates' correction, and the Fisher exact probability test were used.

Results

Undischanced fractures (Figure 2)

The preoperative ATD and APP did not differ between fractures which subsequently healed without any complications and those which developed segmental collapse (Table 1). With the exception of displacement of one fracture, nailing of the 29 undischanced fractures did not result in any change of the position of the femoral head.

During the course of uncomplicated healing, the ATD decreased 3.3 mm. The corresponding de-

crease of ATD in cases with femoral head necrosis at follow-up was higher (12.9 mm, $P < 0.001$), indicating a more pronounced fracture compression. The APP did not change in either of the two groups.

Displaced fractures (Figure 2)

On the preoperative radiographs, the average proximal displacement of the femoral shaft did not differ between cases that subsequently developed segmental collapse (n 19) and those (n 37) whose fractures healed without any complications. The preoperative APP was also the same in the two groups (Table 1).

Redispacement or nonunion was recorded in 25 cases 5 months (4 days to 2.5 years) after fracture. The preoperative ATD and APP did not differ from the values of those fractures that healed uneventfully or with segmental collapse.

Measured on the first postoperative films, the average ATD had increased about 6-8 mm and the APP had decreased 10-12 mm after reduction. No

difference was recorded between the three groups (healed with or without segmental collapse, redisplacement). Compared with a normal material (Eliasson et al. 1988), the postoperative position of the femoral head did not differ in the proximal-distal direction, but a small posterior displacement (mean value 3.1 mm, $P < 0.001$) remained.

Between the postoperative examination and follow-up, the ATD decreased about 10 mm in those fractures that healed uneventfully. The anteroposterior position of the femoral head did not change; the 3-4 mm posterior displacement remained at healing compared with normal hips ($P < 0.001$). Redisplacement of the fracture implied more pronounced proximal displacement of the femoral shaft at follow-up ($P < 0.05$) but no change of the anteroposterior position of the femoral head compared with those fractures that healed without complications.

The frequency of segmental collapse was rather evenly distributed between Garden III and IV fractures ($P < 0.22$). Redisplacement occurred more often after Type IV fractures ($P < 0.034$).

Analysis of the total material and the three separate subgroups of end results (healing with or without segmental collapse, nonunion) did not reveal any significant differences as regards the postoperative or follow-up ATD or APP between Garden Types I and II or Types III and IV fractures.

Discussion

It has been suggested that in femoral neck fractures there is a correlation between the displacement and the extent of injury to the blood supply of the femoral head (Calandruccio and Anderson 1980). Classifications of femoral neck fractures have focused on the anatomy of the fracture line (Pauwels 1935, Garden 1961) and a semiquantitative assessment of the fracture displacement (Garden 1961). Further, the accuracy and the value of the Garden classification have been questioned because of difficulties in separating the different stages in this classification (Johansson et al. 1986, Frandsen et al. 1988).

Spontaneous compression in displaced femoral neck fractures of about 4 mm during the immediate postoperative period and before weight bearing has previously been demonstrated using roentgen stereophotogrammetric analysis (Ragnarsson et al. 1989). In this study the postoperative radiographs were made at various delays after operation, indicating a change of the position of the femoral head before the first radiographic examination was performed.

Table 1. Articulo-trochanteric distance (ATD; mm) and anteroposterior position (APP; mm) in 110 femoral neck fractures. Mean SD

	Undisplaced fractures					
	A		B		C	
n	23		5		1	
ATD I	23.2	5.6	18.7	4.3	14.2	
II	22.7	4.9	19.3	4.5	7.4	
III	19.4	5.3 ^a	6.4	2.3	-10.5	
APP I	5.0	5.1	7.5	12.0	15.6	
II	3.0	4.5	2.7	4.3	12.0	
III	3.0	3.2	2.2	3.6	.a	
	Displaced fractures					
	A		B		C	
n	37		19		25	
ATD I	11.0	5.8	13.6	9.4	10.4	7.9
II	18.7	7.0	20.3	8.2	16.5	9.2
III	8.8	8.3	6.9	9.3	3.5	10.0
APP I	15.0	6.5	14.3	7.0	13.8	6.4
II	2.7	5.3	2.4	8.7	4.1	7.0
III	4.1	4.1 ^b	3.8	6.8 ^a	3.8	8.6 ^a

A Healed without complications.

B Segmental collapse

C Redisplacement, nonunion.

I Preoperative examination.

II Postoperative examination.

III Follow-up examination.

^a One radiograph missing.

^b Two radiographs missing.

Nevertheless, at the postoperative examination the ATD did not differ when compared with a normal material, possibly because the fracture displacements were overcompensated or the initial movements were too small to be detected in conventional radiographs.

During normal healing the proximal displacement of the femoral shaft was about 3 mm in undisplaced and 1 cm in displaced fractures, whereas the APP only changed minimally. More pronounced comminution at the fracture site in the displaced fractures may be of importance. We believe that localized reduction of the blood supply may be another important factor, because radiographic signs of necrosis implied pronounced compression even in undisplaced fractures. If this apparently obligate shortening of displaced fractures can be influenced with a more stable osteosynthesis remains to be investigated.

Redisplacement did not imply a significant change of the APP, but probably a rotatory displacement, although this could not be evaluated in our study. Healing of the posterior capsule at the time of redisplacement might have prevented a posterior dislocation.

The predictive value of the Garden classification concerning healing complications has been questioned (Strömqvist et al. 1983), and neither this classification nor measurements of ATD or APP could be used in our study to predict femoral head necrosis. However, the Garden classification was of some value in predicting nonunion.

References

- Calandruccio R A, Anderson W E. Post-fracture avascular necrosis of the femoral head: correlation of experimental and clinical studies. *Clin Orthop* 1980; (152): 49-84.
- Eliasson P, Hansson L I, Kärrholm J. Displacement in femoral neck fractures. A numerical analysis of 200 fractures. *Acta Orthop Scand* 1988; 59(4): 361-4.
- Frandsen P A, Andersen E, Madsen F, Skjodt T. Garden's classification of femoral neck fractures. An assessment of inter-observer variation. *J Bone Joint Surg (Br)* 1988; 70(4): 588-90.
- Garden R S. Low angle fixation in fractures of the femoral neck. *J Bone Joint Surg (Br)* 1961; 43: 647-63.
- Johansson A, Strömqvist B, Bauer G, Hansson L I, Pettersson H. Improved operations for femoral neck fracture. A radiographic evaluation. *Acta Orthop Scand* 1986; 57(6): 505-9.
- Pauwels F. Der Schenkelhalsbruch, ein mechanisches Problem. *Z Orthop (Beil.h.)* 1935; 63.
- Ragnarsson J I, Hansson L I, Kärrholm J. Stability of femoral neck fractures. A postoperative roentgen-stereophotogrammetric analysis. *Acta Orthop Scand* 1989; 60(3): 283-287.
- Strömqvist B, Hansson L I, Palmer J, Ceder L, Thorngren K G. Scintimetric evaluation of nailed femoral neck fractures with special reference to type of osteosynthesis. *Acta Orthop Scand* 1983; 54(3): 340-7.