

Factors predicting healing complications in femoral neck fractures

138 patients followed for 2 years

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We have previously studied the radiographic outcome of femoral neck fracture osteosynthesis with either two hook-pins or a four-flanged nail performed by a small group of surgeons with special interest in the methods. In 138 femoral neck fractures a backwards stepwise logistic regression analysis was used to study the significance of preoperative fracture-related factors, intraoperative factors and the osteosynthesis. The development of non-union/redisplacement and segmental collapse of the femoral head was influenced by fracture displacement (P 0.001) and method of osteosynthesis (P 0.007). The postoperative scintimetric ratio was influenced by the method of osteosynthesis (P 0.0003), fracture dis-

placement (P 0.004) and by the presence of a posterior fragment (P 0.03).

Reduction of the fracture and positioning of the osteosynthesis were to a large extent within the accepted limits. This may explain why the previously well documented negative effects of malpositioning of the osteosynthesis and inferior reduction were not demonstrated to influence the rate of healing-complications. We conclude that neither patient age, sex nor preoperative fracture variables, with the exception of the extent of fracture displacement, can be used to predict radiographic healing-complications in femoral neck fractures.

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A number of factors have been thought to predict healing-complications. Factors such as the choice of fixation device, reduction of the fracture and performance of the osteosynthesis are in the hands of the surgeon, while other factors, such as age, sex and fracture displacement, are beyond their influence.

In a prospective series of femoral neck fractures we studied whether a small group of surgeons could improve the technical results and thus disclose fracture-related factors predicting healing complications.

177 patients, 39 patients died without known complication within 2 years of fracture. A complete radiographic follow-up was thus obtained in 138 patients with an age of 77 (32–96) years at the time of fracture. The woman/man ratio was 2.3:1. Scintimetric and 2-year radiographic results for these patients have been published previously (Strömqvist and Hansson 1984, Strömqvist et al. 1992).

Methods

To minimize the effects of differences in surgical skill, a group of 6 surgeons was constituted to perform all the primary surgery on femoral neck fractures. Demographic data, such as sex and age, were recorded (Table 1).

Preoperative radiographic factors studied by an independent radiologist were displacement (Garden 1961), slope (Pauwels 1935) and posterior fragmentation of the femoral neck (Scheck 1980). Postoperative reduction-related factors were angulation between the fragments in the AP and lateral planes (Garden 1971), fracture-diastasis (Frandsen and Andersen Jr. 1981) and the articulo-trochanteric distance (Edgren 1965).

Patients

Femoral neck fracture patients admitted to our hospital 1981 to June 1983 and followed for 2 years or until the fracture complication were included. During the first year all femoral neck fracture patients born on an uneven date were operated with two hook-pins (Strömqvist et al. 1983), while those born on an even date were operated on with a four-flanged nail (Rydell 1964). The four-flanged nail was abandoned during the following year, and during the last 2 years of the study only hook-pinned patients were included. No primary prosthetic replacement was performed. Out of

Table 1. Factors studied as potential risk factors for femoral neck fracture complication following closed reduction and osteosynthesis. As complication (C) is designated non-union/redisplacement and collapse of the femoral head. Normal healing (H) is absence of these signs after a follow-up of 2 years

		Undisplaced ^a		Displaced ^a	
		H	C	H	C
Age (SD)		73 (17)	70 (22)	75 (11)	77 (10)
Sex	Man	9	1	14	14
	Woman	23	2	44	31
Method	Rydell	9	1	8	18
	LIH	23	2	50	27
Pauwels (1935) angle	< 55	28	3	43	34
	≥ 55	4	0	15	11
Posterior fragment (Scheck 1980)	No	28	2	28	27
	Yes	4	1	30	18
Rep. AP 160-185 (Garden 1971)	Yes	30	3	54	38
	No	2	0	4	7
Rep. lat ≤ 5 (Garden 1971)	Yes	32	3	48	34
	No	0	0	10	11
Diastasis ≥ 5 mm (Frandsen and Andersen 1981)	No	31	2	45	31
	Yes	1	1	13	14
ATD decrease ≥ 10mm (Edgren 1965)	No	30	3	53	36
	Yes	2	0	5	9
Medial support (Frankel 1960)	Yes	31	3	51	39
	No	1	0	7	6
Nail end-joint line < 10mm (Frandsen 1979)	Yes	32	3	52	40
	No	0	0	6	5
Nail penetration (Kalén 1968)	No	31	3	55	41
	Yes	1	0	3	4
Central nail (Frandsen 1979)	Yes	19	1	41	25
	No	13	2	17	20
Scintimetric ratio (Strömqvist 1983)	≥ 1.0	30	0	45	10
	< 1.0	1	3	10	33

^a Garden 1961

Osteosynthesis-related factors studied were cortical pin support (Frankel 1960), pin position in the femoral head, pin end—joint distance (Frandsen 1979) and nail penetration of the femoral head (Kalén 1968).

The femoral head ratio fractured/intact side as determined by Tc-MDP scintimetry within 3 weeks from the operation (Strömqvist 1983) also was included. In a first analysis factors predicting overall healing complications (redisplacement, non-union and collapse of the femoral head) were studied.

In a second analysis only factors predicting redisplacement and non-union, thought to correlate with inferior osteosynthesis, were studied. Thus, collapse of the femoral head was not included.

In a third analysis, factors predicting a low scintimetric ratio (Strömqvist 1983) were studied; a low ratio has previously been demonstrated to predict healing complications. Furthermore, more traumatic methods of osteosynthesis have been demonstrated to cause a low ratio.

Statistical analysis was performed with a backwards stepwise logistic regression.

Results

Two factors were found to influence the overall rate of radiographic healing complications. A four-flanged nail vs hook-pin fixation had a Risk Ratio (RR) (95% confidence interval) of 3.6 (1.5-8.6; *P* 0.007) and displaced fracture vs undisplaced fractures a RR of 10 (2.7-37; *P* 0.001). Three factors were found to influence the postoperative scintimetric ratio. A four-flanged nail vs hook-pin fixation had a RR 5.1 (2.2-12; *P* 0.0003), displaced fracture vs undisplaced fracture a RR 4.7 (1.7-13; *P* 0.004), and the presence of a posterior fragment a RR 2.6 (1.1-5.7; *P* 0.03).

Three factors were found to influence redisplacement and non-union. Displaced fractures had a very high Risk Ratio (due to division by zero). Posterior fragment had a RR 2.8 (1.1-7.2; *P* 0.02) and ATD decrease >10 mm a RR 5.3 (1.5-18; *P* 0.003). There was a strong intercorrelation between displacement and posterior fragment. We found no difference between the displaced Garden Types III and IV in the rate of radiographic healing complications, the postoperative scintimetric ratio or redisplacement/non-union.

Discussion

The purpose of the logistic regression analyses was to identify factors that influenced the appearance of healing complications. Stepwise performance of the analyses enables (from a probabilistic viewpoint) the most important factor to be determined. The importance of these factors is expressed as their relative risk for healing complications. Logistic regression performed in a backwards stepwise manner excludes independent variables in a stepwise manner and estimates with each step the coefficients for logistic regression.

In agreement with other studies, the age and the sex of the patient did not correlate to the rate of radiographic healing complications (Nilsson et al. 1988, Alberts and Jervaeus 1990, Alho et al. 1991, Strömquist et al. 1992).

The method of osteosynthesis and the fracture displacement according to Garden (1961) were found to influence the rate of healing complications. In agreement with a previous study (Strömquist and Hansson 1984) the postoperative scintimetric ratio was to a large extent influenced by the method of osteosynthesis and the fracture displacement. More unexpected was the correlation between a posterior fragment and the postoperative scintimetric ratio, especially since the posterior fragment was not demonstrated to be correlated to healing complications. Thus, the posterior fragment may be a result of a larger energy absorption or displacement of the fragments at the time of fracture.

No preoperative factor in our study, with the exception of fracture displacement, was a predictor of healing complications. Whether other factors, such as operative delay, social circumstances, bone mineral content, medical conditions, etc., influence the rate of healing was not studied. The significance of the reduction and of the technical performance of the osteosynthesis on the healing rate have been demonstrated beyond doubt in previous studies, and the absence of their predictive value in this study shows that improved surgical skill may reduce the complication rate. Thus, our study indicates that the surgeon can influence the rate of healing complications mainly by choice of method and performance of the osteosynthesis.

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