Acta orthop. scand. *53*, 427–435, 1982

FEMORAL NECK FRACTURES IN YOUNG ADULTS

CARL H. ZETTERBERG[1], LARS IRSTAM[2] & GUNNAR B. J. ANDERSSON[1]

[1]Department of Orthopaedic Surgery I and [2]Department of Diagnostic Radiology, Sahlgren Hospital, Göteborg, Sweden

A total of 110 fractures of the neck of femur were studied in 108 patients 17 to 50 years old. The aims were to analyze why these fractures occur in young adults, and what results can be expected after internal fixation.

Severe trauma caused about half of the fractures. In the remaining group chronic and disabling disorders were usually present at the time of injury. Seventeen patients were known to abuse alcohol. Aseptic necrosis with late segmental collapse occurred in 41 per cent of the hips (45/110), comparatively more often in patients who were 45 years or younger. Only 16 of the 73 patients who were seen at follow-up (22 per cent) had a perfect result.

It is concluded that femoral neck fractures in patients younger than 45 years occur because of significant trauma in a healthy subject, or minor trauma in a subject with predisposing disease. The incidence of late segmental collapse is greater than in elderly patients with femoral neck fractures. A less satisfactory result can therefore be expected.

Key words: femoral fractures; femoral neck fractures; femur head necrosis; femur neck

Accepted 20.viii.81

About 5 per cent of all femoral neck fractures occur in young patients (Mårtenson 1962). There are differences in character between this group of fractures and the majority of femoral neck fractures, which occur in elderly patients; there are differences in sex distribution, in fracture trauma, and in treatment results.

Alffram (1964) and Mårtensson (1962) found that femoral neck fractures in young adults were more common in men than in women, while the reverse is the case in the elderly patient. It has also been suggested that the fracture trauma is greater in the young patient (Askin & Bryan 1976, Colonna 1929, Cooper 1824, Kay & Hall 1971, McDougall 1961, Mårtensson 1962, Protzman & Burkhalter 1976, Ratliff 1974).

The result of treatment seems to be poorer in young patients. Askin & Bryan (1976) followed 17 patients, 15 to 40 years old. Only 6 revealed a normal hip at follow-up. Protzman & Burkhalter (1976) reported similar poor results in 22, 20- to 50-year-old patients. Aseptic necrosis occurred in 86 per cent (19/22), and non-union in 59 per cent (13/22). Whether the poor result was related to the fracture trauma, the type of fracture, the patient's age, or the treatment method, is not clear from these studies.

Although some interest has been devoted to this particular group of fractures, there are no large series of consecutive fractures in which the cause of the fracture and the results after treatment have been analyzed. The purpose of this study is twofold; *first* to answer the question: why do femoral neck fractures occur in young adults? To that purpose we consider the type of injury leading to the fracture and the patient's medical

0001-6470/82/030427-09 $02.50/0

and social situation at the time of the accident; *second* to answer the question: what are the results of treatment after fractures of the femoral neck in young adults? To that purpose we consider the long-term medical and social results in relation to the age and sex of the patients, the cause of injury, the type of fracture, and the preoperative, peroperative, and postoperative management.

PATIENTS AND METHODS

The study included all femoral neck fractures, sustained by patients 17 to 50 years of age, admitted during the years 1960–1975 in the city of Göteborg, Sweden, the population of which is 450,000.

There were 110 fractures in 108 patients (base material). Fifty-four patients were women and 54 men. Age and sex distribution is demonstrated in Figure 1. A male dominance was found up to age 47, after which the fractures occurred more often in women. Multiple fractures were present in 14 patients, 8 of whom had been injured in traffic accidents. Sixty-four fractures were located in the left femur, 46 in the right. The hospital charts, records and radiographs were obtained for all patients, together with data from the national health insurance office. The material thus accumulated

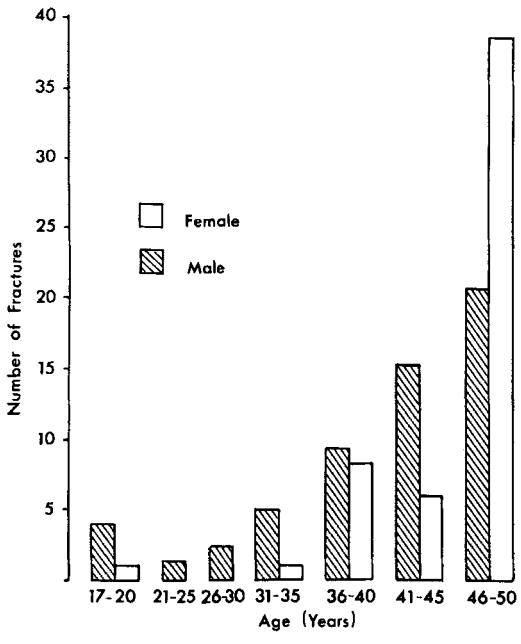

Figure 1. Age and sex at the time of injury.

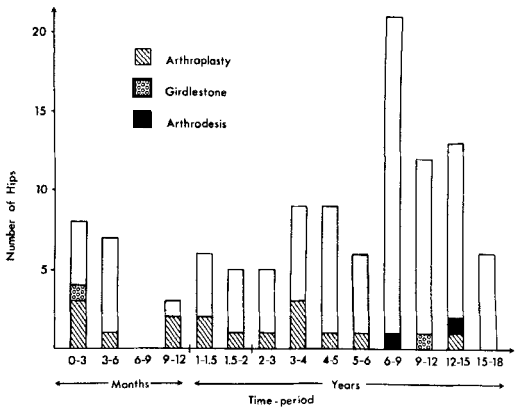

Figure 2. Radiographic follow-up period. Reoperated hips are included, as well as the time interval between injury and revision.

was used to analyze the fracture trauma, and the patient's medical and social situation at the time of injury.

Seventy-four fractured hips with the nails still in place in 73 patients were available for re-examination at the time of follow-up (follow-up material). Of the remaining 36 fractures (in 35 patients) there were 12 in 11 patients who had died; 16 in 16 reoperated patients with a hip prosthesis (2 of whom had died); 2 in 2 reoperated patients with an arthrodesis; and 2 in 2 reoperated patients with an excision arthroplasty. Six patients with 6 fractures could not be persuaded to participate. The times at which the reoperations were performed are given in Figure 2. Thus the follow-up was attended by 68 per cent (73/108) of the base material, or 92 per cent (73/79) of living patients in whom arthroplasty and arthrodesis had not been performed.

The clinical and radiological follow-up was performed 2 to 17 years after injury (mean 9 years). The patient's pain, range of hip joint motion, and ability to walk, was evaluated according to Charnley's modification (Charnley 1972) of D'Aubigné's and Postel's assessment scale (D'Aubigné & Postel 1954), giving a maximum of 18 points as the best result. This assessment was supplemented by an additional functional analysis and evaluation of work capacity and social situation (Table 1).

All available (preoperative, peroperative, and postoperative) radiographs were examined and classified according to Garden's fracture scale and alignment index (Garden 1961, Nieminen & Satokari 1975). The nail location in a 30-degree sector in the femoral head was classified in the antero-posterior view as high (H), central (C), or low (L) and in the lateral view as anterior (A), central (C), or posterior (P).

The radiographic follow-up was from immediately postoperatively to 18 years postoperatively (mean 6.6 years) (Figure 2). Available radiographs of the reoper-

Table 1. Hip assessment. A person with a healthy hip would get a maximum of 27 points (6 + 6 + 6 + 3 + 3 + 3 and Category A)

Grade	Pain	Movements	Walking
1.	Severe and spontaneous	0–30 degrees	Few yards or bedridden. Two sticks or crutches
2.	Severe on attempting to walk. Prevents all activity	60 degrees	Time and distance very limited with or without sticks
3.	Tolerable, permitting limited activity	100 degrees	Limited with one stick (less than one hour). Difficult without a stick. Able to stand long periods
4.	Only after some activity. Disappears quickly with rest	160 degrees	Long distances with one stick. Limited without a stick
5.	Slight or intermittent. Pain on starting to walk but getting less with normal activity	210 degrees	No stick but a limp
6.	No pain	260 degrees	Normal

	Put on shoes and stockings	Walk up and down stairs	Bath in a tub
1.	No	No	No
2.	With difficulty	With difficulty	With difficulty
3.	Yes	Yes	Yes

Category

A. One hip diseased. No other condition interferes with walking.
B. Both hips diseased. No other condition interferes with walking.
C. Other, not primarily hip-related factor, interferes with normal locomotion.

ated patients and the patients who had died were studied for healing, pseudarthrosis or late segmental collapse and included as such in the evaluation. The primary postoperative radiographs could not be evaluated in 10 patients; in 5 the radiographs were missing, in 1 an excision arthroplasty was performed, and 4 were not treated with a nail.

Aseptic necrosis was defined as late segmental collapse (LSC), i.e. collapse or incongruency of the articular surface, often associated with sclerosis and radiolucent areas in the femoral head. Pseudarthrosis was defined as the absence of bony trabeculae crossing the fracture line after 1 year.

Statistical analysis was performed at the 5 per cent level of significance using the Chi-square test with Yate's continuity correction when applied to the comparison of two independent proportions. Student's *t*-test was used for comparison of two independent means. Variables which fell out univariate were not considered to influence one another with the exception of age and sex, and multivariate analysis was not performed.

RESULTS

Primary series (base material)

Falls were responsible for 78 fractures (71 per cent), traffic accidents for 22 (20 per cent), while "other causes" were found in the remaining 10 (9 per cent). A difference in the severity of the accident trauma was found between patients in different age groups. Traffic accidents and "other causes" were responsible for 48 per cent of the fractures in patients 40 years and younger, com-

Table 2. The cause of the fracture divided according to the sex of the patient

Type of accident	No. of fractures Male	Female	Total
Fall, same level	25	41	66
Fall, from height	7	5	12
Traffic	16	6	22
Other	8	2	10
Total	56	54	110

pared to 22 per cent in the 41 to 50 year age group (Table 2). Differences in fracture trauma were also found between men and women as traffic accidents and falls from a height were responsible for 41 per cent (23/56) of fractures in men and 20 per cent (11/54) in women ($P < 0.05$). Falls on the same level caused 76 per cent (41/54) of the fractures in women compared to 45 per cent (25/56) of the fractures in men (Table 2).

Thirty-eight per cent of the patients (41/108) had a concomitant chronic or disabling disorder at the time of the accident (Table 3). Twenty-three suffered from neuromuscular disorders, 12 from musculoskeletal diseases or injuries, and 6 from mental disorders. Two patients with mental disorders had in addition diabetes mellitus, and another 2 had had a gastric resection. Three of the patients with chronic diseases used cortisone daily, while 6 were on diphenylhydantoin treatment. All 6 patients with mental disorders used drugs known to negatively influence muscle strength.

Table 3. Diseases and disabilities at the time of the fracture

Disease or Disability	Number
Epilepsy	8
Mental disorder	6
Poliomyelitis	3
Neurological disease with paresis	12
Fracture (under treatment)	3
Rheumatoid arthritis	6
Osteoarthritis (lower limb)	3
Total	41

Seventeen patients were known by the health and social authorities to abuse alcohol (15 per cent). The above-mentioned predisposing social and medical factors were not present in the 4 patients in the 17 to 19 years group but were otherwise evenly distributed with respect to age and sex.

The occupations of the patients at the time of injury were; 17 housewives, 27 blue-collar workers, 34 white-collar workers, and 5 social workers. In 4 patients work classification was not possible, 6 were sick-listed, and one unemployed. Fifteen patients (14 per cent) had a disability pension; 14 a full pension, and one a 50 per cent pension.

Internal fixation was performed on 105 hips. Four fractures were treated non-operatively and one with an excision arthroplasty. Fifty-five hips were nailed with a Sven Johansson nail, 44 with a hook nail (Rydell 1964) (Figure 3), and 6 with

Figure 3. The hook-nail (Rydell) in place.

various flanged nails. The time interval between injury and operation and the type of fixation device used did not statistically significantly influence the end result.

All patients survived the first half year postoperatively. The 11 deaths in this series occurred 6 months to 10 years postoperatively (mean 6.9 years). The cause was arteriosclerosis in 4, liver cirrhosis in 2, uremia in 2, multiple sclerosis, ileus and drowning in the remaining 3.

Twenty primary complications occurred (18 per cent, 20/110) (Table 4). Eleven of these were directly related to technical problems. Only 3 fractures with a technical complication healed satisfactorily.

Table 5 shows the fracture stage of the 105 patients in which the radiographs could be evaluated, and the development of LSC in relation to the fracture stage. No stage I fractures were found. The proportion of LSC was less in the 8 stage II fractures than in the stage III and IV fractures. The reduction of the fracture was acceptable in 53 hips, poor in 42, and impossible to evaluate in 11. It appears from Table 6 that the position of the nail could be evaluated in 100 hips. Neither the reduction nor the nail placement could be shown to statistically significantly influence the end result.

Late segmental collapse occurred in 41 per cent of the hips (45/110). Thirty-four per cent occurred during the first 2 years, and 7 per cent

Table 4. Primary complications. n = 20

Complications related to internal fixation	*n*
Femoral head fracture	4
Re-osteosynthesis at operation	5
Fracture dislocation	1
Lateral slipping of nail	1
Total	11
General complications	
Wound infection (superficial)	4
Clinical thromboembolism	2
Pneumonia	2
Hematemesis	1
Total	9

Table 5. Garden's fracture stage and the frequency of late segmental collapse (LSC)

Stage	*n*	Healed	LSC	(%)
I	0			
II	8	6	2	(25)
III	44	22	18	(41)
IV	53	20	25	(47)
Total	105	48*	45*	

* In 12 hips late segmental collapse and healing was not evaluated because of too short a follow-up period.

Table 6. The nail location (100 hips)

Antero-posterior view	Central	Anterior	Posterior
Central	45	21	9
High	6	–	2
Low	5	8	4

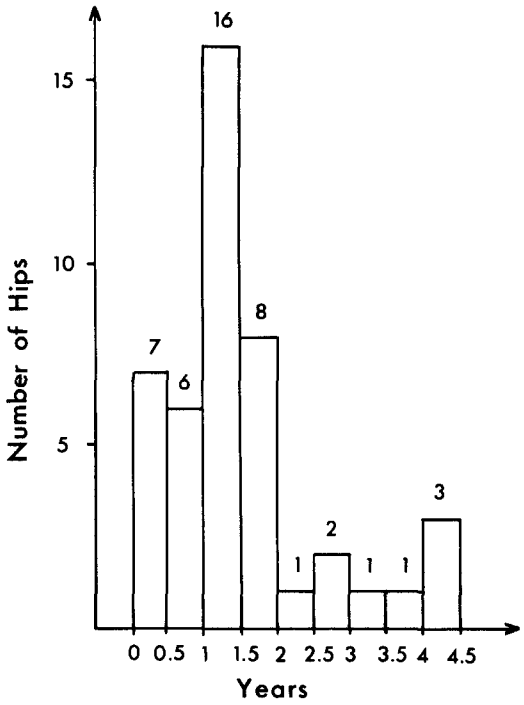

Figure 4. Time-period postoperatively when late segmental collapse was diagnosed.

(8/110) at later periods (Figure 4). Pseudarthrosis was found in one patient only.

Follow-up series

The radiographic result differed between age groups and between men and women. There was a higher proportion of LSC in younger patients of both sexes. This was especially true for younger women who significantly more often developed late segmental collapse than did younger men, ($P < 0.05$; Table 7). Neither predisposing disease nor the fracture trauma could be shown to have a statistically significant influence on the occurrence of late segmental collapse, although a greater proportion of the patients with greater magnitude of the trauma developed LSC. The frequency of LSC was significantly lower in the latter half of the period studied ($P < 0.05$).

The clinical results according to the Charnley Assessment Scale are given in Table 8. The majority of patients did well, but a perfect result (6, 6, 6) was obtained in 22 per cent only (16/74). These 16 were well reduced, and healed without sign of LSC. The patients' ability to walk, put on shoes and socks, to take a bath, and to walk up and down stairs is given in Table 9.

Figure 5 shows the functional results when the Charnley Scale was combined with the three functional assessments. Patients with LSC did significantly poorer than those with no LSC ($P < 0.001$). Nineteen patients in whom the fracture

Table 7. Radiographic results related to the age and sex of the patients

Age-group (years)	Sex	Number of fractures	Results		% LSC	Not evaluated
			Healed	LSC		
17–19	M	3		1		2
	F	1	1		52	
20–40	M	18	8	7		3
	F	9	1	8		
41–45	M	15	8	4	38	3
	F	6	1	4		1
46–50	M	20	10	6	36	4
	F	38	20	15		3
Total		110	49	45		16

Table 8. Results at follow-up. n = 74. H denotes healed, LSC late segmental collapse. The pain situation could not be assessed in 3 patients. No radiographs were obtained in 3 patients at follow-up

Grade	Pain		Movement		Walking	
	H	LSC	H	LSC	H	LSC
1				4		
2				1		3
3	1	6		6	4	4
4	8	9	5	8	3	8
5	7	8	16	3	12	9
6	27	2	24	4	26	2
n	43	25	45	26	45	26
Mean	5.4	4.2	5.4	3.7	5.3	4.1
S.D.	1.04	0.93	0.69	1.57	0.95	1.14
P	<0.05		<0.01		<0.05	

Table 9. Results at follow-up. n = 74. H denotes healed, LSC late segmental collapse. Two hips not included

Score	Put on shoes and stockings		Walk up and down stairs		Bath in a tub	
	H	LSC	H	LSC	H	LSC
3	39	10	36	14	38	14
2	5	16	9	13	6	10
1	1	1			1	3
n	45	27	45	27	45	27
Mean	2.8	2.3	2.8	2.5	2.8	2.4
S.D.	0.42	0.55	0.57	0.51	0.44	0.70
P	<0.05		not significant		<0.05	

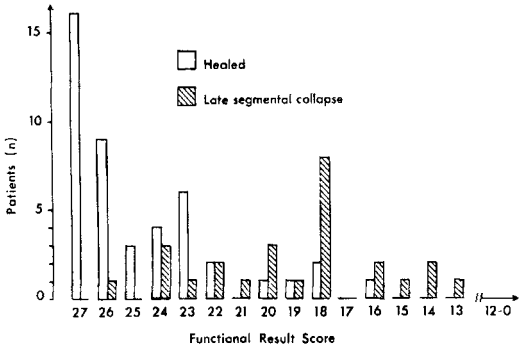

Figure 5. Clinical result at the time of follow-up. For result-score, see text.

healed without LSC had a functional loss of more than 1 point. In 13 of these the loss was primarily due to other disabilities.

The ability to work changed as a result of the fracture. Eighty-six per cent (93/108) of the patients worked at the time of injury. At follow-up 3 patients had reached their normal pension age, and another 14 had received a pre-retirement pension. Thus, of the 73 patients seen at follow-up, 48 worked (66 per cent), 44 per cent (21/48) of these having reduced working capability compared to the pre-fracture state.

DISCUSSION

The study shows that there are two main reasons for femoral neck fractures in young adults; either a significant trauma in a healthy subject, or a comparatively minor trauma in a subject with a predisposing disease.

The significance of the trauma, particularly in the younger age-groups is in agreement with the literature (Askin & Bryan 1976, Cooper 1824, Protzman & Burkhalter 1976, Mårtensson 1962). The importance of concomitant disease, medication or alcoholism has not been stressed previously. Thirty-seven per cent of the subjects had neurological or skeletal diseases or injuries, and alcohol intoxication was frequent at the time of the accident. Two of the 8 patients with epilepsia sustained their fractures during seizures. The fact that these patients were treated with diphenylhydantoin and had osteomalacia may also have contributed (Wallöe 1979).

The results of treatment were less satisfactory than in series of fractures dominated by elderly patients. The less satisfactory results were largely due to the more frequent occurrence of LSC, which presumably is the result of mechanical stress on a femoral head with vascular disturbance. Several contributing factors have been identified in elderly patients, e.g. the degree of fracture dislocation, the accuracy of reduction, the type of fixation device and its placement, the duration of the operation, and the time interval between the accident and the operation (Barnes et al. 1976). In this study of 110 fractures, the use of fluoroscopy gave a statistically significantly reduced duration of operation ($P < 0.01$), because it facilitated reduction of the fracture and positioning of the nail. The use of fluoroscopy also reduced the bleeding peroperatively. This was

probably one of the reasons why significantly better results were obtained in the latter half of the period studied ($P < 0.05$).

The frequency of late segmental collapse was clearly age-related, occurring more often in the younger than in the comparatively older patients. This is in agreement with previous observations on other groups of patients. A high frequency of avascular necrosis is usually reported among children after femoral neck fractures (Canale & Bourland 1977, Ingram & Bachynski 1953, Kay & Hall 1971, McDougall 1961, Mitchell 1936, Pförringer & Rosemeyer 1977, Ratliff 1974), while in the elderly patient LSC occurs in about 30 per cent (Barnes et al. 1976, Öhman et al. 1969). The young adults apparently constitute an intermediate group with better results than children but poorer results than elderly patients. The reason why the younger patients run a greater risk of developing LSC can be the fracture trauma. A comparatively greater trauma was found in the younger patients (Table 2) confirming the existing literature reports (Askin & Bryan 1976, Mårtensson 1962, Protzman & Burkhalter 1976). Another possibility is a difference in femoral head circulation. In children and adults differences are known to exist (Trueta & Harrison 1953, Tucker 1949), and these have been implicated as the reason for the higher incidence rate of LSC in children (McDougall 1961, Ratliff 1974). In the present material there is a difference in results below and above 45 years of age. This makes the circulation theory less probable.

There may be several reasons for the fact that the quality of reduction and the position of the nail did not statistically significantly influence the final result. One reason certainly is that the material is small when divided with respect to fracture stage, accuracy of reduction and position of the nail. Another reason may be that other factors are more important in these young patients, so that the influence of quality of surgery was obscured. During the 15 years studied several changes in treatment occurred; the fixation device was changed, fluoroscopy was introduced, and the general care of the patients was altered with a different method of anesthesia and deep vein thrombosis prophylaxis. All these changes together contributed to a better end result. The results therefore only indicate that surgery in the present series was of an acceptable quality.

Only one patient with pseudarthrosis was found in the material. This is low compared to elderly patient groups but in accordance with results in children (Canale & Bourland 1977, Colonna 1929, Ingram & Bachynski 1953, Kay & Hall 1971, McDougall 1961, Mitchell 1936, Pförringer & Rosemeyer 1977, Rydell 1964).

The choice of treatment in the young adult is, in our opinion, still internal fixation. To get as good a result as possible it seems important to operate early and reduce the fracture as exactly as possible preferably with the aid of fluoroscopy. The patients should be informed that late complications are frequent. Social and rehabilitation measures are often indicated.

ACKNOWLEDGMENTS

Supported by Grants from Ulla and Gustaf af Ugglas' Foundation. Skilled secretarial work was provided by Ingrid Melkersson, Kerstin Månsson, Ingela Törnqvist, and Birgitta Benzow.

REFERENCES

Alffram, P.-A. (1964) An epidemiologic study of cervical and trochanteric fractures of the femur in an urban population. *Acta Orthop. Scand.*, Suppl. 65.

Askin, S. R. & Bryan, R. S. (1976) Femoral neck fractures in young adults. *Clin. Orthop.* **114**, 259–264.

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

Canale, S. T. & Bourland, W. L. (1977) Fracture of the neck and intertrochanteric region of the femur in children. *J. Bone Joint Surg.* **59**-A, 431–443.

Charnley, J. (1972) The long-term results of low-friction arthroplasty of the hip performed as a primary intervention. *J. Bone Joint Surg.* **54**-B, 61.

Colonna, P. C. (1929) Fracture of the neck of the femur in children. *Am. J. Surg.* **6**, 793–797.

Cooper, A. (1824) Treatise on dislocations and on fractures of the joints. London.

D'Aubigné, M. & Postel, M. (1954) Functional results of hip arthroplasty with acrylic prosthesis. *J. Bone Joint Surg.* **36**, 451.Garden, R. S. (1961) Low-angle fixation in fractures of the femoral neck. *J. Bone Joint Surg.* **36**, 451.

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

Ingram, A. J. & Bachynski, B. (1953) Fractures of the hip in children. *J. Bone Joint Surg.* **35**-A, 867.

Kay, S. P. & Hall, J. E. (1971) Fracture of the femoral neck in children and its complications. *Clin. Orthop.* **80**, 53–71.

McDougall, A. (1961) Fracture of the neck of femur in childhood. *J. Bone Joint Surg.* **43**-B, 16–28.

Mitchell, J. I. (1936) Fracture of the neck of the femur in children. *JAMA* **107**, 1603.

Mårtensson, L. (1962) Is Swedish hospital planning adequate? *Läkartidningen* **59**, 3185–3200 (In Swedish).

Nieminen, S. & Satokari, K. (1975) Classification of medial fractures of the femoral neck. *Acta Orthop. Scand.* **46**, 775–781.

Öhman, U., Björkegren, N.-Å. & Fahlström, G. (1969) Fracture of the femoral neck; A five year follow-up. *Acta Chir. Scand.* **135**, 27–42.

Pförringer, W. & Rosemeyer, W. E. (1977) Schenkelhalsfracturen bei Jugendlichen. *Arch. Orthop. Unfallchir.* **90**, 169–185.

Protzman, R. R. & Burkhalter, W. E. (1976) Femoral neck fractures in young adults. *J. Bone Joint Surg.* **58**-A, 689–695.

Ratliff, A. H. C. (1974) Fractures of the neck of the femur in children. *Orthop. Clin. North Am.* **5**, 903–924.

Rydell, N. (1964) Osteosynthesis of medial collum fractures with the "spring-loaded nail". *Acta Orthop. Scand.* **35**, 149–157.

Trueta, J. & Harrison, M. H. M. (1953) The normal vascular anatomy of the femoral head in adult men. *J. Bone Joint Surg* **35**-B, 442–461.

Tucker, F. R. (1949) Arterial supply to the femoral head and its clinical importance. *J. Bone Joint Surg.* **31**-B, 82–93.

Wallöe, A. (1979) *Bone disease in epileptics.* University of Lund, Sweden. (Thesis).

Correspondence to: Carl H. Zetterberg, M.D., Department of Orthopaedic Surgery, Sahlgren Hospital, S-413 45 Göteborg, Sweden.