Risk factors for osteoporosis are common in young and middle-aged patients with femoral neck fractures regardless of trauma mechanism

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Background and purpose There have been few prospective studies examining young and middle-aged patients with hip fracture. We therefore investigated background data, risk factors, and the trauma mechanism in young and middle-aged patients with femoral neck fracture.

Patients and methods 185 patients, 27 young (20–49 years old) and 158 middle-aged (50–69 years old) were prospectively included in a multicenter study lasting 3 years. Background data and risk factors for osteoporosis and fracture were obtained, and the type of injury was classified as low-energy trauma, high-energy trauma, or sports injury.

Results In the young age group, the fracture occurred because of low-energy trauma in two-fifths of patients and because of sport injury in two-fifths of patients. The rest occurred because of high-energy trauma. The corresponding proportions for the middle-aged group were four-fifths, one tenth, and one tenth (p < 0.001). There was a higher proportion of men (19/27) in the young group than in the middle-aged group (69/158) (p = 0.001). One fifth of the young patients were smokers as compared to two-fifths in the middle-age group (p = 0.04). One quarter of the patients reported high-volume alcohol drinking, with no difference between the two groups. Furthermore, three-quarters of the young patients and four-fifths of the middle-aged patients had one or more risk factors for osteoporosis and fracture.

Interpretation A minority of patients in each age group had high-energy trauma as the cause of their femoral neck fracture. Lifestyle factors and other non-trauma-related risk factors appear to have been important contributors to the occurrence of femoral neck fracture in both age groups.

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Only 3% of all patients with hip fracture are less than 50 years of age (Robinson et al. 1995, Cheng et al. 2009). The hip fracture population is usually classified as elderly patients (≥ 70 years of age) and young patients (< 50 years of age) (Rogmark and Johnell 2006, The Swedish National Hip Fracture Registry). Middle-aged patients (50–69 years old) are seldom studied as a specific age group, and they are often combined with older, more frail patients (Nguyen et al. 2005, Thorngren et al. 2005).

The epidemiology of femoral neck fractures in the elderly has been extensively investigated but there have been few prospective studies on young patients with femoral neck fracture. Studies on the mechanism of injury in young patients with hip fracture have given contradictory results. Some studies have shown that hip fractures in patients less than 50 years of age result from high-energy trauma (Askin and Bryan 1976, Swiontkowski et al. 1984, Cheng et al. 2009) while others have found the opposite (Zetterberg et al. 1982, Boden et al. 1990, Robinson et al. 1995, Lofthus et al. 2006). The majority of elderly patients with femoral neck fracture have risk factors for osteoporosis and fracture, but only a few studies have examined this issue in young and middle-aged patients (Holmberg et al. 2005, Lofthus et al. 2006).

We investigated background data, explored risk factors for osteoporosis and fracture, and recorded the mechanism of trauma in young and middle-aged patients with femoral neck fracture.

Patients and methods

In this prospective multicenter study, we included 185 consecutive patients between 20–69 years of age with femoral neck fracture (ICD-10 code S7200). The 4 centers were Stockholm Söder Hospital (n = 91), Danderyd Hospital (n = 41), Karolinska University Hospital at Solna (n = 23), and Karo-

linska University Hospital, Huddinge (n = 30), all in Stockholm, between September 2002 and May 2006. We included patients who lived independently and those who were able to walk before the fracture. We did not include patients with a severe psychotic disease or cognitive impairment according to the Short Portable Mental Status Questionnaire (SPMSQ < 3), simultaneous fracture of the lower extremity, or a fracture older than 48 h before admission. Also, we did not include patients with a previous pathology in the fractured hip, patients with chronic renal failure, or those with hyperparathyroidism. All patients were operated with internal fixation. The femoral neck fractures were classified by consensus—by 3 orthopedic surgeons—into undisplaced fractures (Garden 1–2) and displaced fractures (Garden 3–4).

All assessments except the American Society of Anaesthesiologists (ASA) classification and fracture classifications were performed by specially trained research nurses. At inclusion, the following variables were registered: age, sex, living condition before fracture, walking ability, activities-of-daily-living (ADL) status, ASA score, number of comorbidities, health-related quality of life before the fracture (EuroQol), alcohol consumption, smoking, previous history of falling during the previous year, previous fractures for patients and their parents, and the mechanism of trauma.

The mechanism of trauma was classified as low-energy trauma (fall at the same level), sports injury (bicycling, iceskating), or high-energy trauma (traffic accident, riding accident, and fall from a height). Cognitive function was classified according to SPMSQ (Pfeiffer 1975) as follows: severe cognitive impairment if 0–2 correct answers; moderate cognitive impairment if 3–5 correct answers; mild cognitive impairment if 6–7 correct answers; and intact cognitive function if 8–10 correct answers. ADL status was assessed according to Katz et al. (1963), i.e. independence or dependence in bathing, dressing, going to the toilet, mobilitiy, continence, and feeding. ADL index A indicates independence in all 6 functions and index B indicates independence in all but 1 of the 6 functions. Indices C to G indicate dependence in bathing and at least 1 more function. The ASA score was assessed by the attending anesthesiologist.

The health-related quality of life (HRQoL) was rated using the EQ-5D, and patients were asked to rate their HRQoL the week before the fracture. We used the preference scores (EQ-$5D_{index}$ scores) generated from a large UK population (UK EQ-5D index Tariff) (Dolan et al. 1996) when calculating the scores of our study population. An EQ-$5D_{index}$ score of 0 indicated the worst possible health state and a score of 1 indicated full health.

Alcohol consumption was evaluated using the Alcohol Use Disorder Identification Test (AUDIT), which is a validated instrument for identification of hazardous and harmful alcohol use and also possible dependency (Saunders et al. 1993). Nonsmokers and ex-smokers were coded as non-smokers while current smokers were coded as smokers. The following variables were registered as risk factors for osteoporosis and fracture (Kanis et al. 2008): smoking, high alcohol AUDIT score, hypogonadism, early menopause, anti-epileptic use, corticosteroid use or use of psychopharmaca, previous low-energy fracture in adult life for patients or their parents, chronic disabling liver, lung disease or neuromuscular disease, diabetes mellitus, rheumatoid arthritis, and underweight (BMI < 18.5).

The study was performed according to the Helsinki Declaration and the protocol was approved by the local ethics committee (Dnr. 01-427).

Statistics

Normally distributed variables were tested for differences with Student's t-test. Medians were used instead of means for non-normally distributed variables and the Kruskal-Wallis test was used for comparisons. Contingency tables were tested for differences using the chi-square test and the Fisher's exact test was used if one or more of variables has an expected frequency of five or less. Any p-value of < 0.05 was considered statistically significant. The software used was SPSS version 19.0 for Windows.

Results

Age and gender distribution

There were 27 patients (19 men) in the young group (20–49 years) and 158 patients (69 men) in the middle-aged group (50–69 years). 131 patients (71%) had a displaced fracture (Table 1).

The middle-aged group had a higher number of comorbidities, higher ASA score, more frequent use of medications, and a higher rate of smoking (Table 1). There was male predominance until the age of 50. The mean EQ-5D index in the young patients was 0.92 (SD 0.2) and it was 0.81 (SD 0.3) in the middle-aged patients. Women had higher use of psychopharmaca than men and their fractures more often occurred after low-energy trauma (Table 1). However, there were no statistically significant differences between sexes regarding ASA score, number of comorbidities, alcohol AUDIT, and smoking habits (Table 1).

The mean B-hemoglobin value for the whole study population was 134 (SD 14) g/L (missing, n = 1), mean S-albumin was 35 (SD 5) g/L (missing, n = 24), and mean S-creatinine was 72 (SD 22) µmol/L (missing, n = 10).

Risk factors

20 of the 27 young patients (7 out of 10), and 130 of the 158 middle-aged patients (8 out of 10) had 1 or more risk factors for osteoporosis and fracture. One fifth of the young patients (6/22) were smokers, as compared to two-fifths (68/158) of the middle-aged patients (p = 0.04). A quarter of the patients reported high-volume drinking according to AUDIT, with no difference between the two age groups (Table 1).

Table 1. Characteristics of the study population

	All patients	Young (20–49 years)	Middle-aged (50–69 years)	p-value	Men	Women	p-value
Age mean (SD)	57 (9)	41 (8)	60 (5)	–	56 (9)	58 (8)	0.03
Number (%)	185 (100)	27 (15)	158 (85)	–	88 (48)	97 (52)	–
Age distribution, n (%)							
15–49 y	27 (15)	–	–	–	19 (22)	8 (8)	0.01
50–69 y	158 (85)	–	–	–	69 (78)	89 (92)	
Sex n (%)							
men	89 (48)	19 (70)	69 (44)	0.01	–	–	–
women	158 (52)	8 (30)	89 (56)		–	–	–
ASA score [a], n (%)							
1	67 (37)	18 (67)	49 (32)	0.004	31 (36)	36 (38)	0.7
2	79 (44)	8 (29)	71 (46)		38 (44)	41 (44)	
3	30 (17)	0	30 (20)		14 (16)	16 (17)	
4	4 (2)	1 (4)	3 (2)		3 (4)	1 (1)	
Comorbidities, n (%)							
0	84 (45)	20 (74)	64 (41)	0.01	36 (41)	48 (50)	0.1
1	50 (27)	2 (7)	48 (31)		21 (24)	29 (30)	
2	35 (19)	3 (11)	32 (20)		22 (25)	13 (13)	
≥3	16 (9)	2 (8)	14 (9)		9 (10)	7 (7)	
Medications, n (%)							
None	80 (43)	19 (70)	61 (39)	0.002	40 (46)	40 (41)	0.4
Corticosteroids	2 (1)	0	2 (1)	0.7	1 (1)	1 (1)	–
Anti-epileptics	10 (5)	0	10 (6)	0.3	9 (10)	1 (1)	0.007
Psychopharmaca	17 (9)	1 (4)	17 (11)	0.2	3 (4)	14 (14)	0.01
Cardiovascular	31 (17)	2 (7)	29 (18)	0.1	15 (17)	16 (17)	0.9
Anti-diabetics	19 (10)	1 (4)	18 (11)	0.2	11 (12)	8 (8)	0.3
Others	27 (15)	4 (15)	22 (14)	0.5	11 (12)	16 (17)	0.5
Alcohol AUDIT [a], n (%)							
High	47 (26)	7 (27)	40 (26)	0.9	23 (27)	24 (25)	0.7
Low	133 (74)	19 (73)	114 (74)		62 (73)	71 (75)	
Smoking	74 (40)	6 (22)	68 (43)	0.04	33 (37)	41 (43)	0.4
Trauma mechanism, n (%)							
Low-energy	139 (75)	12 (44)	127 (80)	< 0.001	58 (66)	81 (84)	0.009
Sports injury	32 (17)	11 (41)	21 (13)		23 (26)	9 (9)	
High-energy	14 (8)	4 (15)	10 (7)		7 (8)	7 (7)	
Fracture type, n (%)							
Displaced	131 (71)	20 (74)	111 (70)	0.6	69 (78)	62 (64)	0.03
Undisplaced	54 (29)	7 (26)	47 (30)		19 (22)	35 (36)	
Living alone [a], n (%)							
Yes	71 (38)	9 (35)	62 (40)	0.6	38 (43)	33 (36)	0.3
No	109 (59)	17 (65)	92 (60)		50 (57)	59 (64)	
ADL Katz [b], n (%)							
A	175 (95)	27 (100)	148 (95)	0.7	86 (98)	89 (94)	0.4
B	6 (3)	0	6 (4)		2 (2)	4 (4)	
C	2 (1)	0	2 (1)		0	2 (2)	

ASA: American Society of Anaesthesiologists classification; AUDIT: Alcohol Use Disorders Identification Test.
[a] Missing, n = 5.
[b] Missing, n = 2.

Trauma mechanism

In the young age group, the femoral neck fracture occurred as a result of low-energy trauma in two-fifths of cases, as a result of sports injury in two-fifths of cases, and as a result of high-energy trauma in one fifth of cases. The corresponding values for middle-aged group were four-fifths, one tenth, and one tenth, respectively (p < 0.001). Of the 127 middle-aged patients with low-energy trauma, 79 (two-thirds) fell indoors. The corresponding value in the young group was 6 of 12 patients.

There were several differences regarding comorbidities, smoking, and drinking habits in those who had experienced low-energy trauma and in those who had had other trauma mechanisms (Table 2). Furthermore, these patients more often reported that they had had a previous fall during the year before the fracture (Table 2).

Discussion

In the present study, high-energy trauma was the cause of

Table 2. Patient characteristics according to the mechanism of trauma

	Young patients			Middle-aged patients		
	Low-energy trauma	Sports injuries/ high-energy trauma	p-value	Low-energy trauma	Sports injuries/ high-energy trauma	p-value
Age mean (SD)	43 (6)	40 (9)	0.4	61 (5)	58 (5)	0.03
EuroQol mean (SD)	0.89 (0.2)	0.96 (0.1)	0.3	0.80 (0.27)	0.88 (0.19)	0.1
No. (%)	12 (44)	15 (56)		127 (80)	31 (20)	
Sex, n (%)						
Men	7 (58)	12 (80)	0.4	51 (40)	18 (58)	0.07
Women	5 (42)	3 (20)		76 (60)	13 (42)	
ASA score [a], n (%)						
1	6 (50)	12 (80)	0.2	31 (25)	18 (60)	0.004
2	5 (42)	3 (20)		61 (50)	10 (33)	
3	0	0		28 (23)	2 (7)	
4	1 (8)	0		3 (2)	0	
Comorbidities, n (%)						
0	7 (58)	13 (87)	0.8	47 (37)	17 (55)	0.2
1	2 (17)	0		39 (31)	9 (29)	
2	1 (8)	2 (13)		28 (22)	4 (13)	
≥ 3	2 (17)	0		13 (10)	1 (3)	
Comorbidities, n (%)						
Cardiovascular disease	0	1 (7)	0.6	46 (36)	7 (23)	0.2
Cerebrovascular lesion	0	1 (7)	0.6	7 (6)	3 (10)	0.4
Lung disease	2 (17)	0	0.2	16 (13)	1 (3)	0.2
Diabetes mellitus	1 (8)	0	0.4	17 (13)	1 (3)	0.1
Epilepsy	0	0	–	9 (7)	1 (3)	0.7
Parkinson disease	0	0	–	2 (2)	0	0.6
Hypothyroidism	1 (8)	0	0.4	4 (3)	3 (10)	0.1
Malignancy	0	0	–	8 (6)	1 (3)	0.7
Lever disease	1 (8)	0	0.4	9 (7)	1 (3)	0.7
Neuromuscular disease	1 (8)	0	0.4	5 (4)	0	0.6
Hypogonadism	1 (8)	1 (7)	0.9	1 (1)	0	0.9
Alcohol AUDIT [a], n (%)						
High	4 (33)	3 (21)	0.6	34 (27)	1 (3)	0.005
Low	8 (67)	11 (79)		90 (73)	29 (97)	
Smoking	5 (42)	1 (7)	0.03	59 (47)	9 (29)	0.08
Previous fall last year before fracture [b], n (%)	7 (58)	3 (20)	0.04	48 (41)	6 (21)	0.05
Risk factor for osteoporosis and fracture, n (%)	11 (92)	9 (60)	0.09	110 (87)	20 (65)	0.004

ASA: American Society of Anaesthesiologists classification; AUDIT: Alcohol Use Disorders Identification Test.
[a] Missing, n = 5.
[b] Missing, n = 13.

femoral neck fracture in the minority of young patients. This contrasts with what has mostly been reported in the literature—by Askin and Bryan (1976) with 17 patients included, by Swiontkowski et al. (1984) with 27 patients included, and by Cheng et al. (2009) with 42 patients included. This lack of concordance could have several explanations, such as the fact that the frequency of traffic accidents, a major cause of high-energy trauma, varies between countries. Another reason could be the variation in the prevalence of osteoporosis throughout the world (Kanis 1997). A third explanation could be that sports injuries have been considered to be high-energy trauma in some studies (Robinson et al. 1995). We chose to consider femoral neck fractures after a sports injury as a separate group, since fractures during sports activity have not been considered before as an important cause of a femoral neck fractures.

Femoral neck fractures due to a fall during sports activity were more frequent in young patients than in middle-aged patients, in whom the fractures most often occurred after low-energy trauma. Similar results have been reported by other authors (Jonsson et al. 1993, Holmberg et al. 2005). It is possible that the differences in trauma mechanisms are caused by increased osteoporosis with increasing age and/or by reduced lean body mass, which might increase the tendency to fall in middle-aged patients. Likewise, most of the young patients had good physical health according to their ASA score, in contrast to the middle-age group who had higher morbidity and several medications, e.g. anti-epileptic, cardiovascular, and anti-diabetic drugs—factors that have all been related to increased risk of hip fracture (Holmberg et al. 2005, Lofthus et al. 2006).

Our study confirms findings by others that femoral neck fracture is more common in men of younger age (Boden et

al. 1990, Lofthus et al. 2006). The HRQoL in our study was similar to that in a normal Swedish age-matched reference population (Burstrom et al. 2001). Tidermark et al. (2002) reported similar findings in patients over 65 years of age who had a femoral neck fracture. The distribution of displaced and undisplaced fractures in the present study is similar to that in the elderly population (Tidermark et al. 2003).

We found a high rate of smoking in the middle-aged group, which was high compared to the average for a Swedish middle-aged population (20%) (The Swedish National Board of Health and Welfare 2009). This is consistent with earlier findings implicating smoking as a risk factor for hip fracture in the middle-aged population (Holmberg et al. 2005). Smoking is associated with adverse lifestyle-related behavior such as low nutritional intake, malabsorption, and low peak bone mass; a recent meta-analysis showed that smokers have an increased risk of sustaining any kind of fracture, and the highest risk was seen for hip fracture (Kanis et al. 2005b).

In the present study, both age groups had higher alcohol consumption than in the general Swedish population (13%) (The Swedish National Board of Health and Welfare 2009). Several authors from different countries have reported high alcohol consumption in young patients with hip fracture (Jonsson et al. 1993, Robinson et al. 1995, Lofthus et al. 2006, Cheng et al. 2009). Excessive consumption of alcohol is also a well-recognized cause of secondary osteoporosis, particularly in men (Kanis et al. 2005a).

Our results indicate that the greater part of young and middle-aged subjects with femoral neck fracture have 1 or more risk factors for osteoporosis and fracture, regardless of the trauma mechanism, which has also been reported by others (Boden et al. 1990, Lofthus et al. 2006). Hip fractures in young subjects may be a result of early osteoporosis leading to fractures even after only moderate trauma (Boden et al. 1990, Lofthus et al. 2006).

The present study had some limitations that should be considered. The lack of a control group without femoral neck fracture and possible recall bias in reporting falls are 2 such limitations. Not all risk factors for osteoporosis were registered, such as low calcium intake and low physical activity. Furthermore, our sample was not representative of all young and middle-aged patients with a femoral neck fracture. To determine how representative our study group was, registrations of all femoral neck fracture patients were done over 1 year. The analysis showed that four-fifths of young patients and half of all middle-aged patients with such fractures were included in the study. 2 patients were excluded because of a simultaneous fracture in the lower extremity (high-energy trauma). The study population appeared to be healthier, with better ASA and EQ-5D scoring, a higher ADL index, and less use of walking aids than the patients who were not included. This discrepancy was probably due to the fact that we did not include patients from institutions (i.e. nursing home and residential care home), those with severe cognitive impairment, or those who had been unable to walk before the fracture.

In summary, high-energy trauma was the cause of femoral neck fracture in a minority of both young and middle-aged patients. It appears that lifestyle factors and other non-trauma-related risk factors are main contributors to femoral neck fracture in both age groups.

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