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The assessment of vertebral fractures in elderly women with recent hip fractures: the BREAK Study

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Abstract

Summary This study aimed to evaluate the prevalence of vertebral fractures in elderly women with a recent hip fracture. The burden of vertebral fractures expressed by the Spinal Deformity Index (SDI) is more strictly associated with the trochanteric than the cervical localization of hip fracture and may influence short-term functional outcomes.

Introduction This study aimed to determine the prevalence and severity of vertebral fractures in elderly women with recent hip fracture and to assess whether the burden of vertebral fractures may be differently associated with trochanteric hip fractures with respect to cervical hip fractures.

Methods We studied 689 Italian women aged 60 years or over with a recent low trauma hip fracture and for whom an adequate X-ray evaluation of spine was available. All radiographs were examined centrally for the presence of any vertebral deformities and radiological morphometry was performed. The SDI, which integrates both the number and the severity of fractures, was also calculated.

Results Prevalent vertebral fractures were present in 55.7 % of subjects and 95 women (13.7 %) had at least one severe fracture. The women with trochanteric hip fracture showed higher SDI and higher prevalence of diabetes with respect to those with cervical hip fracture, $p=0.017$ and $p=0.001$, respectively. SDI, surgical menopause, family history of fragility fracture, and type2 diabetes mellitus were independently associated with the risk of trochanteric hip fracture. Moreover, a higher SDI was associated with a higher percentage of post-surgery complications ($p=0.05$) and slower recovery ($p<0.05$).

Conclusions Our study suggests that the burden of prevalent vertebral fractures is more strictly associated with the trochanteric than the cervical localisation of hip fracture and that elevated values of SDI negatively influence short term functional outcomes in women with hip fracture.

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Introduction

Osteoporosis is a multifactorial systemic skeletal disease, characterized by low bone mass and microarchitectural deterioration of bone tissue, with a consequent increase in bone fragility and in susceptibility to fracture [1]. Osteoporotic fractures result in increased mortality, many disabilities and high economic cost. Vertebral fractures are the most common osteoporotic fractures, but only about one third of them come to clinical attention [2]. Hip fracture, the most serious complication of osteoporosis, is becoming more frequent due to the progressive aging of the world population and the annual number of hip fractures is expected to reach 4.5 million by 2050 [3, 4].

It is well established that the presence of one low trauma fracture significantly increases the risk of a further fracture [5–8].

In a systematic review carried out by Klotzbuecher et al. [5], women with a single pre-existing vertebral fracture were 4.4 times more likely to have a further vertebral fracture and 2.3 times more likely to have hip fracture than those without. In particular, Ismail et al. [7] in the European Prospective Osteoporosis Study found that prevalent vertebral deformity in women predicted future hip fracture with a risk ratio of 4.5. Moreover, it has been reported that the incidence rate of a subsequent hip fracture for women aged 80–85 years with a vertebral fracture was 6.5 % at 6 months and 4.2 % at 4 years [9].

Some studies reported that the association between vertebral deformity and hip fracture was largely independent of the severity of the vertebral compressions [10, 11]. Instead, a recent study carried out on a large Finnish population reported that severe vertebral fractures strongly predicted hip fractures, whereas mild to moderate fracture grades and the number of compressed vertebral bodies showed no prediction for hip fracture [12]. Similarly, a recent paper on the OPUS population has reported that moderate/severe vertebral compressions are likely to be true osteoporotic fractures of the spine and predict vertebral fracture risk better than mild compressions [13].

Recently, there has been a growing interest in literature regarding the hypothesis that the two main categories of hip fracture, cervical and trochanteric, may differ in pathophysiological mechanisms and consequently in predisposing factors [14]. Almost 20 years ago, Katowicz et al. reported that, in women with vertebral fracture, the risk of trochanteric hip fracture increased by 2.3 ($p <$ 0.05) and of cervical hip fracture by 1.3 (N.S.) compared with women without vertebral fracture; this indicates that trochanteric fractures may be more strongly associated with spinal osteoporosis than cervical fractures [15].

Moreover, some studies have reported that patients with trochanteric fractures were older, thinner and shorter and with lower bone mineral density (BMD) and quantitative ultrasound values than patients with cervical fractures [16–18]. However, other authors have found no difference in BMD, prevalent vertebral fractures, or risk factors between the patients with cervical fracture and those with trochanteric fracture [10, 19, 20].

Moreover, Fisher et al. [20] recently showed that elevated PTH levels increased the odds of trochanteric hip fracture, while blunted PTH response to hypovitaminosis D increased the odds of cervical fracture. Nevertheless, literature data on bone metabolism status, comorbidities, and outcomes with regard to hip fracture type in the elderly remain scant and conflicting [16, 21, 22].

The aim of the present study was twofold: firstly, to determine the prevalence and severity of vertebral fractures in a large cohort of Italian women with recent hip fracture; secondly, to assess whether vertebral fractures, comorbidities and other variables may be differently associated with trochanteric hip fractures with respect to cervical hip fractures.

Materials and methods

A total of 22 Italian centers (Departments of Orthopaedics, Rehabilitation and Geriatrics) located in both academic and nonacademic general hospitals were invited to participate in the Break Study. The general characteristics of the Break study have been reported previously [23]. In each center, between January 2009 and June 2010, experienced clinicians recruited up to 100 consecutive women, aged 60 years or over with a recent low trauma hip fracture. Low trauma fractures were either spontaneous or caused by minimal trauma (trauma equal to or less than a fall from a standing position). The pathological hip fractures due to primary or metastatic bone cancer, multiple myeloma, Paget's disease of bone, or primary hyperparathyroidism were excluded.

The women enrolled were submitted to a standardized interview. The case report included questions related to age, height and weight, lifestyle (smoking habit, alcohol consumption), patient's history (fracture after the age of 50 years, family history of fragility fracture, age and type of menopause), health status (presence of comorbidities, use of specific drugs, and pre-fracture walking ability), and the type of hip fracture. The history of previous fractures was ascertained by self-report, and no additional validation of this information was

conducted. Moreover, two radiographs of the thoracic and lumbar spine were obtained according to standardized procedures.

At each center, hip fractures were classified by experienced clinicians on preoperative radiographs and surgical reports as cervical fractures (or medial or intracapsular) and trochanteric fractures (or lateral or extracapsular). Specific training was given to all the investigators in order to avoid any discrepancies in classification of hip fracture. The participating centers completed the forms of 1,288 women of whom 1,249 were eligible for the study; however, complete X-ray evaluation of thoracic and lumbar spine was available only for 727 patients who were the object of the present study.

Study protocol was prepared according to Declaration of Helsinki and subsequent integrations.

Written consent was obtained from all participants, and the study was approved by the local Ethical Committee of each center.

Assessment of vertebral fractures

All radiographs were examined centrally (at Siena) for the presence of any vertebral deformities by two experienced clinicians (G-S and C-C) who were unaware of the patients characteristics. First, a qualitative evaluation was made to exclude vertebral deformity cause other than osteoporotic fractures and poor X-ray films. In cases of divergent opinions, consensus was reached by discussion with a radiologist. Then, the vertebrae were identified and morphometry was performed from the fourth thoracic vertebra (T4) to the fourth lumbar vertebra (L4) by marking six points in each vertebral body, corresponding to the four corners and the midpoints of the endplates. The anterior (Ha), mid-vertebral (Hm), and posterior (Hp) heights of each vertebra were measured and the three ratios, Ha/Hp, Hm/Hp, and Hp/Hp-below, were calculated.

The fractures were defined as mild, moderate, or severe based on a height ratio decrease of 20–25 %, 25–40 %, and over 40 %, respectively, according to Genant's graduation [24]. In all patients, we also evaluated the Spinal Deformity Index (SDI). SDI is an assessment tool similar to the Genant semiquantitative (SQ) approach which integrates both the number and the severity of vertebral fractures. SDI is obtained by summing up the vertebral fracture grades along the spine from T4 to L4 where SQ0 indicates absence of fracture and SQ1, SQ2, and SQ3 indicate mild, moderate, or severe fracture, respectively [25, 26]. Therefore, for each subject the SDI was calculated by summing up the SQ grade for each of the 13 vertebrae from T4 to L4 (SDI=SQT4+…+SQT12+SQL1+…+SQL4) [25].

Statistical analysis

Overall characteristics of the sample study were described by proportion or median and interquartile range (IQR), as continuous variables were not normally distributed (Kolmogorov–Smirnov test). The Wilcoxon rank-sum test or Kruskall–Wallis test were used to compare the median values, while categorical variables were assessed with the chi-square test or Fisher's exact test, as appropriate. A two-tailed $p<0.05$ was considered statistically significant.

To examine the association between the type of hip fracture and the possible predictors included in the standardized interview, an exploratory multivariable logistic regression analyses with SDI as measure of vertebral fracture status was run on the Break data, while controlling for age. The backward stepping strategy was undertaken to determine the best model, which involved variables elimination in a hierarchical manner. The same model was also used with the variable previous vertebral fracture instead of SDI. All analyses were performed with SPSS for Windows, version 16.0 (SPSS, Inc., Chicago, IL, USA).

Results

Of the 1,249 eligible women with hip fracture a complete X-ray evaluation of thoracic and lumbar spine was available for 727 patients, but 38 were discharged for inadequate X-ray quality. Therefore, the analysis was carried out on the remaining 689 patients. Of these 689 elderly women, 312 did not present any fractures, whereas 377 (=54.7 %) presented one or more vertebral fractures; of them, 95 (=13.7 %) had at least one severe vertebral fracture. The prevalence of vertebral fractures, by spinal location, is shown in Fig. 1. The distribution of vertebral fractures along the spine showed a peak prevalence at T7 and T8 levels (18.8 and 14.2 %, respectively). Another, if lower, peak prevalence was at T12 and L1 levels (11.2 and 8.6 %, respectively). In addition, the distribution of severe vertebral fractures showed a similar pattern.

The demographic, clinical, and lifestyle characteristics of the 689 elderly women with hip fracture by fracture localisation are reported in Table 1.

The proportion of SDI as well as previous vertebral fractures medians were significantly higher in women with trochanteric hip fracture with respect to those with cervical hip fracture, $p=0.017$ and $p=0.001$, respectively (Table 1). In addition, the proportion of previous severe vertebral fractures was higher in women with trochanteric than in those with cervical hip fracture, but the difference did not reach the statistical significance. Among women with trochanteric hip fracture, apart from higher proportions of diabetes (24.6 vs 15.6 %, p=0.005) and surgical menopause

Fig. 1 Prevalence of vertebral fractures in 689 elderly women with hip fractures. Results are presented as the frequency of fracture at each vertebral level
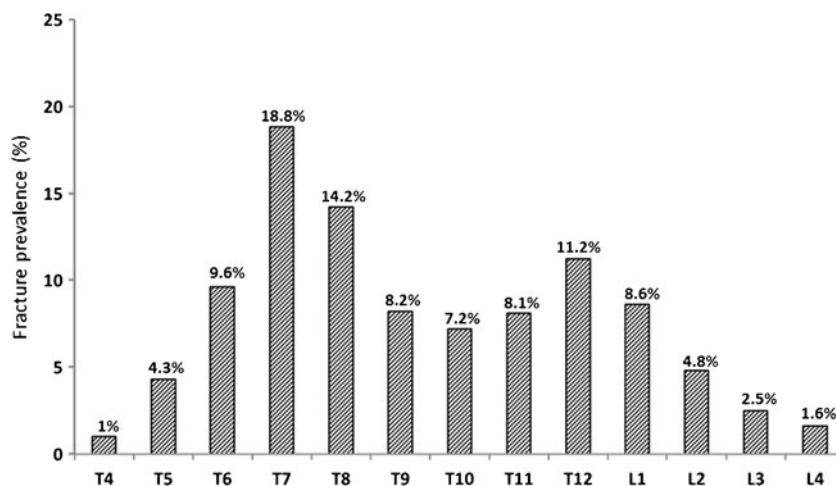
(14.0 vs 8.8 %, $p=0.049$) and a lower proportion of antidepressant users (13.4 vs 22.1 %, p=0.003), no statistically significant differences in independent variables were found. Moreover, the women with cervical hip fracture presented a BMI slightly lower with respect to those with trochanteric fracture (Table 1). No differences in prefracture walking ability were observed between the two groups (Table 2). With regard to postsurgery characteristics, significant associations with type of femoral fracture were found for postsurgery complications (32 % trochanteric vs 24.6 % cervical hip fracture, $p=0.041$) and time to weight permitted (17.3 % after more than 30 days among trochanteric vs 4.5 % cervical hip fracture, $p<0.001$). Furthermore, the length of stay in hospital was higher in women with trochanteric than in those with cervical fracture, but the difference did not reach any statistical significance (Table 2).

Table 3 shows the results of the multiple logistic regression analysis on predictors for trochanteric hip fractures. SDI, surgical menopause, family history of fragility fracture, type 2 diabetes mellitus, and use of antihypertensive and antidepressant drugs were independently associated with the risk of trochanteric with respect to the risk of cervical hip fracture.

Women who were in surgical menopause and women with family history of fragility fracture were more likely to have a trochanteric hip fracture (vs cervical hip fracture). Furthermore, the presence of diabetes was associated with an increased risk of having trochanteric hip fracture. Instead, women who used antihypertensive drugs and women who used antidepressant drugs were less likely to have trochanteric than cervical hip fracture. The fully adjusted odds ratio of trochanteric hip fracture for an increase in SDI score of one-unit was 1.10 (95 % CI, 1.3–1.16). Therefore, being the regression coefficient for SDI $b=0.088$, the adjusted odds ratio of trochanteric hip fracture was OR=1.19 for an increase in SDI score of two units and OR=1.42 for an increase of four units.

Despite the information provided by SDI being potentially more comprehensive than simple dichotomization of patients into fracture or nonfracture categories, we evaluated

the same model with the variable previous vertebral fracture, as directly measurable, instead of SDI. Similar results were found with the same predictors being selected by the stepwise method obtaining OR=1.42 (95 % CI, 1.02–1.95) for previous vertebral fracture.

The demographic and clinical characteristics of patients grouped on the basis of SDI values are reported in Table 4. As expected the patients with an elevated SDI were older and shorter with respect to those without prevalent vertebral fractures (SDI=0). Moreover, a higher SDI was associated with a higher percentage of postsurgery complications ($p=0.05$) and slower recovery ($p<0.05$).

Discussion

This study, carried out on a large cohort of elderly women with hip fracture, shows that the presence and, above all, the burden of prevalent vertebral fractures are more strictly associated with the trochanteric rather than the cervical localisation of hip fracture. Moreover, this study reveals that elevated values of SDI negatively influence functional outcomes in women with hip fracture.

In this study, 54.7 % of women with hip fracture presented vertebral fractures; however, this high prevalence is lower with respect to other similar studies carrying out spinal radiography in women with hip fracture, which reported vertebral fracture prevalence ranging from 65 to 75 % [10, 27, 28]. On the contrary, the study by Tosteson et al. [29] reported a slightly lower prevalence, but in this latter study, spinal fracture prevalence was derived from anamnesis and clinical records only. However, the prevalence of vertebral fractures in our population is markedly higher than in populations of similar age without hip fracture [27, 30]. Approximately 25 % of our hip fracture patients presented at least one vertebral fracture of severe grade. Although the majority of previous studies of a similar nature did not separately consider the severity grade of vertebral fractures,

Table 1 Distribution of demographic, clinical and lifestyle characteristics of 689 elderly women with hip fractures by hip fracture localization

Characteristics		Trochanteric fx n:382	Cervical fx n:307	P-value
With previous vertebral fractures, n/total n(%)[a]		225/382 (58.9)	152/307 (49.5)	0.017
With previous severe vertebral fractures, n/total n (%)[a]		62/382 (16.2)	33/307 (10.7)	0.050
SDI, Skeletal Deformity Index, median (IQR)[b]		2.0 (0–3.3)	0(0–2)	0.001
Surgical menopause, n/total n(%)[c]		53/377 (55.4)	27/304 (44.6)	0.04 2
Age at menopause (yrs), median(IQR)[b]		48.1 (45–52)	50.0 (47–52)	0.48 2
Age (years), median(IQR)[b]		81.5 (77–87)	81.0 (75–85)	0.219
Height (cm), median(IQR)[b]		160 (155–165)	160 (155–165)	0.521
BMI (Kg/m2), median(IQR)[b]		24.5 (22.4–27.3)	24.0 (22–26.3)	0.015
Smoking, n/total n(%)[a]		9/379 (2.4)	16/307 (5.2)	0.077
Alcohol consumption, n/total n(%)[a]		24/381 (6.3)	21/306 (6.9)	0.887
Wine consumption, n/total n(%)[a]		47/381 (12.3)	38/307 (12.4)	0.920
Family history of fragility fracture, n/total n(%)[a]		46/379 (12.1)	24/304 (7.9)	0.091
Patient's history of fracture after the age of 50 years, n/total n (%)[a]		120/380 (31.6)	88/306 (28.8)	0.474
Comorbidities	- Gastrointestinal disorders, n/total n (%)[a]	58/382 (15.2)	57/307 (18.6 %	0.280
	- Hematologic disorders, n/total n (%)[a]	9/382 (2.4)	7/307 (2.3)	0.852
	- Renal disorders, n/total n (%)[a]	24/382 (6.3)	11/307 (3.6)	0.153
	- Endocrine disorders, n/total n (%)[a]	38/382 (9.9)	25/307 (8.1)	0.494
	- Rheumatic disorders, n/total n (%)[a]	13/382 (3.4)	13/307 (4.2)	0.713
	- Diabetes, n/total n (%)[a]	94/382 (24.6)	48/307 (15.6)	0.005
	- BPCO, n/total n (%)[a]	47/382 (12.3)	28/307 (9.1)	0.226
	- Cerebrovascular diseases, n/total n (%)[a]	16/382 (4.2)	17/307 (5.5)	0.519
	- Cardiovascular diseases, n/total n (%)[a]	120/382 (31.4)	96/307 (31.3)	0.968
Medications	- Antiosteoporotic, n/total n (%)[a]	94/379 (24.8)	69/307 (22.5)	0.534
	- FANS, n/total n (%)[a]	25/382 (6.5)	21/307 (6.8)	0.880
	- Statins, n/total n (%)[a]	32/382 (8.4)	28/307 (9.1)	0.835
	- Antihypertensives, n/total n (%)[a]	267/382 (69.9)	228/307 (74.3)	0.236
	- Antiarrhythmics, n/total n (%)[a]	80/382 (20.9)	50/307 (16.3)	0.146
	- Antiplatelets, n/total n (%)[a]	94/382 (24.6)	63/307 (20.5)	0.113
	- Ansiolitics/Hypnotics, n/total n (%)[a]	72/382 (18.8)	74/307 (24.1)	0.835
	- Antidepressants, n/total n (%)[a]	51/382 (13.4)	68/307 (22.1)	0.003
	- Anticoagulants, n/total n (%)[a]	120/382 (31.4)	83/307 (27.0)	0.242
	- Thyroid hormones, n/total n (%)[a]	14/382 (3.7)	7/307 (2.3)	0.40 7
	- Glucocorticoids, n/total n (%)[a]	19/382 (5.0)	15/307 (4.9)	0.901

a Dichotomous variable, reference NO (chi-square Yates corrected test)

b Mann-Witneytest

c categorical variable (reference category, spontaneous)

our findings seem to be in agreement with a recent study carried out on a small cohort of Finnish women with hip fracture [12]. The distribution pattern of fractures along the spine was similar to that of previous studies, but in our study, the percentage of fractures at thoracic level was higher than that reported in other studies which, however, were carried out on elderly women of a lower mean age [31].

Table 2 Pre- and postsurgery characteristics of 689 elderly women with hip fracture by hip fracture localization

Characteristics	Trochanteric fracture	Cervical fracture	p value
Prefracture ambulatory capacity, n/total n (%)			0.167
Inability to walk	10/379(2.6)	7/305(2.3)	
Dipendent walking	174/379 (45.9)	119/305 (39.0)	
Indipendent walking	195/379(51.5)	179/305(58.7)	
With post-surgery complications, n/total n (%)[a]	120/375 (32.0)	75/305(24.6)	0.041
Permitted load, n/total n (%)[b]			<0.001
<10 days	150/370(40.5)	207/292(70.9)	
10–30 days	156/370(42.2)	72/292 (24.7)	
31–40 days	25/370(6.8)	4/292(1.4)	
>40 days	39/370(10.5)	9/292 (3.1)	

[a] Dichotomous variable (reference category: NO)

[b] Ordinal variable (chi-square for linear trend test)

The results of our study seem to support the hypothesis that the two main categories of hip fracture, cervical and trochanteric, differ in pathophysiological mechanisms and consequently in predisposing factors [14]. In particular, the more strict association of vertebral fractures with extracapsular hip fracture may be explained by the fact that the trochanteric structure is rather similar to that of vertebrae, involving 60 to 90 % of trabecular bone.

Baudoin et al. [32] demonstrated that the ratio of cervical to trochanteric fractures is above unity under the age of 60, but thereafter progressively decreases due to the rapid increase in trochanteric fractures with aging. Moreover, Mautalen et al. [16] in a review of literature demonstrated that previous vertebral fractures had been found twice as frequently in patients with trochanteric fracture compared with those with cervical fracture. More recently, a study carried out in the EPIDOS population

reported that all BMD measures as well as quantitative ultrasound measures were stronger predictors of trochanteric rather than cervical fractures [17]. Moreover, Gnudi et al. found that trochanteric BMD was a better predictor of trochanteric fractures than of cervical fractures, whereas proximal femur geometry played a significant role only in the prediction of cervical fracture [33]. More recently Sosa has reported that the prevalence of vertebral fractures was significantly higher in patients with non cervical than in those with cervical fractures [27]. On the contrary, other studies did not find any significant correlations between hip fracture localisation and prevalence of vertebral fractures [10]. In addition, Fox et al. [34] found that maternal history of hip fracture, body composition, and history of fracture after the age of 50 years were predictors of hip fracture but not of any one of the two types.

One of the major findings of our study is the strict association of trochanteric hip fractures with the burden of prevalent vertebral fractures. In fact, there is a growing conviction that it may be more relevant, for an adequate assessment of future fracture risk, to assess all vertebral fractures rather than to consider the spine as a binary parameter (fracture Yes/No) as in FRAX. The SDI is a summary measure of vertebral fracture status incorporating both the number and the severity of vertebral fractures [25]. Two studies have suggested that SDI may be an accurate tool for vertebral fracture prediction and that baseline SDI was predictive of the 3-year incidence of subsequent vertebral fracture regardless of BMD [25, 26].

It has also been reported that the risks of hip and any nonvertebral fractures increase with an increasing SDI [35]. This is in line with histological data showing that microarchitectural deterioration of bone is proportionally worse in women with increasing SDI values, suggesting SDI as a surrogate marker of bone fragility [36]. Thus, the evaluation of spine radiographs and the use of SDI may provide useful information for guidance for clinical decision making regarding the need for lifestyle modifications and pharmaceutical interventions [37].

Table 3 Results of backward stepwise regression models: factors associated with trochanteric hip fractures

Independent variables[c]	Trochanteric hip fracture[a]	
	OR	95 % CI
SDI	1.10	1.03–1.16
Age	1.03	1.01–1.05
Surgical menopause[b]	1.71	1.03–2.85
Family history of fragility fracture	1.96	1.13–3.40
Antihypertensive drugs	0.64	0.45–0.93
Antidepressant drugs	0.53	0.35–0.81
Diabetes	1.88	1.25–2.84

Predictors were listed in decreasing order according to the respective standardized values (p coefficient) to indicate the decreasing relative contribution to the model

[a] Reference category: cervical hip fracture

[b] Reference category: spontaneous

[c] Whole set of variables included into the models: SDI, age, BMI, high, menopause type, smoking, alcohol consumption, history of fracture after the age of 50 years, family history of fragility fracture, prefracture walking ability, comorbidities, and concomitant therapies

Table 4 Selected demographic and clinical characteristics of 689 elderly women with hip fracture grouped by Spinal Deformity Index (SDI)

Characteristics	SDI=0 (n=312)	SDI=1–2 (n=169)	SDI=3–4 (n=120)	SDI >4 (n=88)	p value
Age (years), median (IQR)[a]	81.0 (75–86)	81.0 (76–85)	82.0 (75–86)	83.0 (77–87)	0.31
Height (cm), median (IQR)[a]	161.2 (155–165)	160.0 (155–165)	160.0 (156–165)	159.0 (150–164)	0.10
BMI (kg/rn²), median (IQR)[a]	24.2 (22–27)	24.2 (22–27)	25.0 (23–27)	24.4 (22–27)	0.76
Age at menopause (years), median (IQR)[b]	50.0 (46–52)	50.0 (47–52)	50.0 (46–51)	50.0 (45–51)	0.24
Family history of fragility fracture, n/total n (%)[b]	38/309 (12.3)	13/166 (7.8)	9/120 (7.5)	10/88 (11.4)	0.47
History of fracture after 50 years, n/total n (%)[b]	86/311 (27.7)	46/167 (27.5)	36/120 (30.0)	40/88 (45.5)	0.004
Prefracture ambulatory capacity, n/total n (%)[b]					0.12
Inability to walk	10/312 (3.2)	2/169 (1.2)	3/120 (2.5)	5/88 (5.7)	
Dependent walking	129/312 (41.3)	69/169 (40.8)	56/120 (46.7)	40/88 (45.4)	
Independent walking	173/312 (55.5)	98/169 (58.0)	61/120 (50.8)	43/88 (48.9)	
With postsurgery complications, n/total n (%)[a]	85/307 (27.7)	42/167 (25.1)	35/120 (29.2)	33/86 (37.5)	0.05
Permetted load, n/total n (%)					0.045
<10 days	166/299 (55.5)	91/163 (55.8)	62/116 (53.4)	38/84 (45.2)	
10–30 days	102/299 (34.1)	52/163 (31.9)	44/116 (37.9)	30/84 (35.7)	
31–40 days	15/299 (5.0)	7/163 (4.3)	2/116 (1.7)	5/84(6.0)	
>40 days	16/299 (5.4)	13/163 (8.0)	8/116 (6.9)	11/84 (12.5)	

[a] Kruskall–WaIIis test

[b] Chi-square test

Since vertebral fractures occur at an earlier age than hip fracture, the early identification and targeting interventions for such individuals may help to reduce the burden of morbidity due to hip fracture later in life. At present, the literature data do not permit any conclusions as to whether present therapeutic strategies may have any different fracture reduction effect for cervical and trochanteric hip fractures. Concerning this point, one might speculate that osteoporosis medications may be able to reduce trochanteric hip fracture through a similar mechanism as for that of vertebral fractures by increasing (trochanteric) BMD, while the effect on cervical fracture risk may be more limited [14]. The fact that, in our population, several clinical risk factors for osteoporotic fracture, such as surgical menopause and family history of fracture, are more strictly associated with trochanteric hip fracture seems to confirm the hypothesis that this latter may represent the hip fracture type more closely connected to bone fragility.

Our data are consistent with previous observations that there are no differences between the two hip fracture types with regard to comorbidity burden [19, 20]. However, in this study, we documented a statistically significant difference between the two hip fracture groups in the prevalence of type 2 diabetes (higher among elderly women with trochanteric fracture). This finding, although not observed in previous studies, which have taken comorbidities into consideration [18, 19], may be explained by the fact that type 2 diabetes is associated with an increased bone fragility, leading to an increased risk of hip fractures especially at

trochanteric level, which have been hypothesized as being more typical of conditions of fragility [16, 38].

The concomitant therapies taken by the patients when hip fracture occurred do not present any significant associations with either of the two types of hip fracture, with the exception of antihypertensive and antidepressant drugs, which appear to be inversely associated with trochanteric hip fracture. At present, there is no literature data that are able to confirm this finding; we can only hypothesize that these drugs may influence the type and frequency of falls. Similarly, Fisher et al. [20] reported a greater association between cervical hip fracture and the presence of Parkinson's disease, which is considered a cause of frequent falls.

In the present study, short-term functional recovery was slower in elderly women with trochanteric fractures than in those with cervical fracture. However, this difference should be interpreted with caution, as it is likely to reflect differences in surgical procedures and/or rehabilitative strategies [19]. In fact, most previous studies reported similar functional outcomes in both fracture types at 6 months and at 1 year [19]. Moreover, our data seem to be in agreement with the study by Di Monaco et al. [28] who reported that SDI was negatively associated with functional outcomes in elderly women with hip fracture admitted consecutively to a rehabilitation hospital. It is possible that the positive association between functional outcomes and levels of SDI could be due to an increased probability of trochanteric hip fracture in patients with an elevated SDI, since trochanteric hip fractures are characterized by a slower recovery.

Our study has some limitations: firstly, the cross-sectional nature of the study does not allow the establishing of any causality relationships between the parameters; secondly, the lack of a comparator group of patients without hip fracture does not permit the determinations as whether the findings of hip fracture patients are different from those without hip fracture; thirdly, the fact that no information is available regarding vitamin D status, bone turnover markers, and BMD; fourthly, the fact that the classification of hip fractures was carried out at each individual center; finally, the fact that, in our patients, fall dynamics were not assessed. Nevertheless, our study presents several strong points: firstly, the large and homogeneous sample size of elderly women with hip fracture; secondly, the fact that the presence and severity of vertebral fractures was assessed by a centralized morphometric analysis on spine radiographs.

In conclusion, our study suggests that the burden of prevalent vertebral fractures is more strictly associated with the trochanteric than the cervical localisation of hip fracture and that elevated values of SDI negatively influence short term functional outcomes in women with hip fracture. This finding supports the opinion that SDI should be incorporated along with other known factors for fragility fracture risk assessment.

Recognition of the differing physiopathological features of cervical and trochanteric fracture needs to be recognized in clinical fracture risk assessment and may also open up improved strategies for prevention and therapy.

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