



Prevalence of bone mineral density testing and osteoporosis management following low- and high-energy fractures

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Objective: The aim of this study was to report the prevalence of post-fracture bone mineral density (BMD) testing and osteoporosis treatment in patients admitted to the orthopedic department for low-energy or high-energy fractures and to identify factors affecting prevalence of post-fracture BMD testing and osteoporosis treatment.

Methods: A total of 265 patients aged 45 years or older admitted with low-energy or high-energy fractures were reviewed between January 2010 and May 2011. Information regarding age, gender, fracture site and history of post-fracture BMD testing and osteoporosis treatment, including data reporting experiences of attending orthopedists (young: <10, senior: >10 years of experience) were recorded.

Results: Of the 265 patients (175 female, 90 male), 259 (97.7%) patients had low-energy fractures and 6 (2.3%) suffered high-energy fractures. Of 259 low-energy fractures, 99 (38.2%) underwent BMD testing and had mean total T-scores of -2.04 ± 1.01 (proximal-femur) and -2.12 ± 1.27 (lumbar-spine). Only one high-energy fracture patient (16.7%) underwent BMD testing, with a T-score of -1.1 (proximal-femur) and -2.7 (lumbar-spine). Eighty-six (32.5%) patients (85 low-energy fractures; 1 high-energy fracture) with diagnosis of osteopenia/osteoporosis from BMD testing were treated with calcium, vitamin D, and bisphosphonates. Bone mineral density testing was significantly higher in low-energy fracture patients who were treated by a young orthopedist, a common fracture site (proximal-femur, distal-radius, vertebrae) or were female ($p < 0.05$).

Conclusion: Bone mineral density investigation and treatment rates are currently suboptimal. The current gap in adequate care necessitates multidisciplinary intervention in order to lessen the incidence of future fractures, particularly in patients over the age of 45.

Key words: Fracture; high-energy; low-energy; management; osteoporosis.

Low-energy fractures, such as stress fractures or fractures resulting from falls, are a growing public health concern in several regions in the world.^[1] Incidence of this type of fracture is increasing in line with an aging population.^[2] Additionally, low-energy fractures are a crucial risk factor for osteoporosis and are recognized as a related indi-

cator of bone quality.^[3] However, in some areas in the world, studies have reported insufficient osteoporosis care following low-energy fractures.^[4,5] Therefore, it is important to identify the adequacy of current post-fracture osteoporosis assessment and treatment in patients who suffer from low-energy fractures in an effort to

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decrease the incidence and burden of subsequent fractures.^[3]

There is still a lack of data describing the osteoporosis care gap in patients following hospitalization for low-energy fracture in several regions in the world. The incidence of osteoporosis has also been increasingly reported in middle-aged and elderly patients with high-energy fractures.^[6,7] Similar to low-energy fractures, little is known about the incidence of osteoporosis and its management in patients with high-energy fractures in routine clinical practice.

The present study aimed to determine the calculated frequency of osteoporosis management, including bone mineral density (BMD) measurements and osteoporosis treatment implementation, following hospitalization for low- and high-energy fractures in current practice. The factors affecting the rate of post-fracture osteoporosis management were also studied.

Patients and methods

This study included 265 patients (175 females, 90 males) aged 45 years or older. Medical records and radiographic data for all patients admitted between January 2010 and May 2011 were reviewed. Patients sustaining low-energy fracture as a result of minimal trauma (e.g., fall from a standing height or lower) or no recognizable trauma^[8] or with a high-energy fracture as a result of a major trauma (e.g., traffic accident or fall from a greater than standing height)^[7] were included. Patients who sustained fractures due to pathological causes (e.g., primary or secondary tumor, other metabolic bone diseases, etc.), obtained previous diagnosis and treatment for osteoporosis, or sustained fractures to the skull and/or ribs were excluded. The study protocol was approved by the Institutional Review Board of our institution.

Patient baseline characteristics were obtained from medical records. Demographic data including age, gender, mechanism of injury (low-energy or high-energy trauma), fracture site and osteoporosis treatment were recorded.

The experience of the attending physician was recorded for each patient. The attending physicians were classified into two categories: young physician (less than 10 years' work post orthopedic board certification) and senior physician (more than 10 years' work post certification).

Radiographic diagnoses were confirmed by one orthopedist and one radiologist. The fracture site of each patient was recorded. The history of post-fracture BMD investigation for each patient was reviewed from medical records, including the computerized Picture Archiving and Communication System (PACS) database. The history of the post-fracture BMD investigation was counted

as positive if patients were tested with dual-energy X-ray absorptiometry (DXA) during their hospital stay or within 6 to 12 weeks after discharge from hospital. Dual-energy X-ray absorptiometry of the lumbar spine (L2-L4), the non-fractured proximal femur and/or the distal radius were performed. The results of DXA in each patient were classified as recommended by the World Health Organization (WHO) as follows: normal, T-score \geq -1; osteopenia, -1>T-score \geq -2.5; or osteoporosis, T-score<-2.5.^[9]

Differences in quantitative data were analyzed using the Student's t-test for normally distributed data and the Mann-Whitney U test for non-normally distributed data. Differences in categorical data (gender, experience of the attending physician, absence/presence of post-fracture DXA, and fracture site) between low-energy and high-energy fracture groups were analyzed using the Fisher's exact test. The effect of each factor on the rate of post-fracture osteoporosis management was investigated using univariate and multivariate analyses. Potential factors that showed a significant relationship with post-fracture osteoporosis management on univariate analysis were included in the multivariate models, which expressed the results as odds ratios (ORs) with 95% confidence intervals (CIs). A p value of <0.05 was considered statistically significant. Statistical analysis was performed using IBM SPSS software version 20 (SPSS Inc., Chicago, IL, USA).

Results

A total of 265 patients were assessed between January 2010 and May 2011. One hundred seventy-five patients were female (mean age: 72.45 \pm 11.84 years) and 90 male (mean age: 70.98 \pm 12.73 years). Demographic data of the low-energy and high-energy fractures are summarized in Table 1.

Low-energy fractures were sustained by 259 (97.7%) patients and high-energy fractures by 6 patients (2.3%). The most common fracture sites in patients with low-energy fracture were the proximal femur (60.3%), distal radius (9.3%), proximal humerus (6.9%), and ankle

Table 1. Demographic characteristics of the patients.

	Low-energy fracture (n=259)	High-energy fracture (n=6)	p
Age in years (Mean \pm SD)	71.01 \pm 13.11	73.5 \pm 10.24	0.106
Gender			
Male	87 (33.6%)	3 (50%)	0.411
Female	172 (66.4%)	3 (50%)	
Attending physician			
Young physician	139 (53.7%)	5 (83.3%)	0.224
Senior physician	120 (46.3%)	1 (16.7%)	

(3.5%); and the calcaneus (33.3%), pelvis (16.7%), and other sites in the lower extremities (50%) in patients with high-energy fractures. There was a significant difference in the distribution of fracture sites between low- and high-energy fractures ($p<0.001$) (Table 2).

Bone mineral density measurements were taken in 99 (38.2%) of the 259 patients in the low-energy fracture group using DXA during their hospital stay or within 6 to 12 weeks following discharge (Table 3). One patient (16.7%) in the high-energy fracture group underwent post-fracture DXA. There was no significant difference in the prevalence of post-fracture DXA between groups ($p=0.414$).

Eighty-two (82.8%) low-energy fracture patients who underwent DXA had common or well-known sites of low-energy fractures (proximal femur, wrist, vertebral), and 17 (17.2%) had other sites of fracture. There was no patient with multiple regions of low-energy fracture. Mean lumbar spine and femoral neck T-scores were -2.12 ± 1.27 and -2.04 ± 1.01 , respectively. The mean distal radius T-score was -4.14 ± 1.29 (Table 3). There were significantly higher rates of DXA use in female patients (OR=1.22; 95% CI=1.03-1.44; $p=0.025$), patients with a common fracture site (OR=1.25; 95% CI=1.08-1.44; $p=0.004$) or who received in-patient care by a young attending physician (OR=1.59; 95% CI=1.28-1.98; $p<0.001$). Logistic regression analysis also demonstrated that receiving in-patient care by a young attending physician was a significant predictor post-fracture DXA (OR=2.71; 95% CI=1.58-4.66; $p<0.001$), followed by common fracture sites (OR=2.11; 95% CI=1.12-4.00; $p=0.022$) and female gender (OR=1.82; 95% CI=1.02-3.23; $p=0.042$).

For the one high-energy fracture patient who underwent post-fracture DXA, the total T-score was -1.1 and -2.7 at the proximal femur and lumbar spine, respectively. A subgroup analysis however, could not be performed.

Of the 99 patients with low-energy fractures who underwent DXA, 85 (85.9%) patients were diagnosed with osteopenia or osteoporosis from the DXA assessment and started on supplemental calcium (1 g/day) and vitamin D (0.5 μ g of alfacalcidol (1-alpha-hydroxyvita-

Table 2. Distribution of fracture sites.

	Low-energy fracture (n=259)	High-energy fracture (n=6)	p
Proximal femur	156 (60.2%)	-	<0.001*
Subtrochanteric femur	4 (1.5%)	-	
Pelvis	1 (0.4%)	1 (16.7%)	
Femoral shaft	4 (1.5%)	-	
Distal femur	7 (2.7%)	-	
Vertebrae	8 (3.1%)	-	
Tibial plateau	2 (0.8%)	-	
Tibial shaft	3 (1.2%)	1 (16.7%)	
Ankle	9 (3.5%)	1 (16.7%)	
Calcaneus	4 (1.5%)	2 (33.3%)	
Metatarsal	3 (1.2%)	1 (16.7%)	
Proximal humerus	18 (6.9%)	-	
Elbow	3 (1.2%)	-	
Hand (metacarpal, phalanges)	5 (1.9%)	-	
Distal radius	24 (9.3%)	-	
Others (clavicle, humeral shaft, forearm, patella, tibial plafond)	8 (3.1%)	-	

*Significant difference

min D3)/day) during the hospital stay in combination with bisphosphonate therapy (alendronate or risedronate or ibandronic acid; at the 7th week after fracture treatment). The remaining 14 (14.1%) patients had normal T-scores and were started with supplemental calcium and vitamin D in the same concentrations during the hospital stay. The sole high-energy fracture patient (16.7%) who underwent DXA was supplemented with calcium and vitamin D during the hospital stay in combination with bisphosphonate therapy (at the 7th week after fracture treatment). The 5 high-energy fracture patients (83.3%) who did not obtain DXA assessment received calcium and vitamin D supplements without bisphosphonate therapy.

Discussion

Patients who sustain low-energy fractures commonly receive orthopedic medical treatment. Several studies have revealed that post-fracture osteoporosis management is rarely achieved, indicating the need for increased

Table 3. Bone mineral density results according to WHO definitions.^[9]

	Region of interest (number of assessed patients)	Normal T-score \geq -1	Osteopenia -2.5 \leq T-score<-1	Osteoporosis T-score<-2.5
Low-energy fracture (n=99)	Femoral neck (n=95)	14 (14.7%)	46 (48.4%)	35 (36.8%)
	Lumbar spine (n=96)	18 (18.8%)	43 (44.8%)	35 (36.5%)
	Distal radius (n=8)	-	1 (12.5%)	7 (87.5%)
High-energy fracture	Femoral neck (n=1)	-	1 (100%)	-
	Lumbar spine (n=1)	-	-	1 (100%)
	Distal radius (n=0)	-	-	-

awareness among physicians of the importance of conducting bone status assessments in patients with low-energy fractures.^[10-13] Dual-energy X-ray absorptiometry is recommended for the majority of these patients.^[9] When DXA results demonstrate osteoporosis (T-score < -2.5) or osteopenia ($-2.5 \leq \text{T-score} < -1$), proper medical treatment should then be prescribed.^[9] However, low-energy fracture patients are not the only patients reported to have low BMD. Lofthus et al. demonstrated that patients with hip fractures have a significantly lower BMD than control patients, irrespective of trauma energy,^[7] raising the question about the current gap in post-fracture osteoporosis care for patients with high-energy fractures.

The present study included patients admitted for low- or high-energy fractures. We found a low rate of BMD testing or DXA scanning in both groups. Only 38.2% and 16.7% of patients with low- and high-energy fractures, respectively, underwent DXA testing for osteoporosis during their hospital stays or in the 6 weeks following fracture. This suggests that many patients who experience low-energy or high-energy fractures are not assessed for osteoporosis as a preventative strategy against subsequent fractures. To the best of our knowledge, the current study is one of few evaluating the rates of BMD testing and osteoporosis management in both low- and high-energy fracture patients post-fracture. Despite differences in regions, our results are almost equivalent to the frequencies of 0 to 32%^[14] and 1 to 32%^[15,16] found in other review studies of low-energy fractures. We found no significant differences between rates of BMD testing in low- and high-energy fracture patients.

Factors affecting the prevalence of BMD testing were identified in the present study. In low-energy fracture patients, in-patient care by a young attending physician was a significant predictor of post-fracture DXA, followed by the occurrence of fracture at a common fracture site (proximal femur, vertebrae, and wrist) and female gender. Castel et al. proposed that many physicians do not recognize osteoporosis as a metabolic condition and thus fail to correlate it with other medical conditions.^[13] Suarez-Almazor et al. revealed that physician attitudes were vital factors in decisions about screening and treatment of osteoporosis.^[17] In our study, we used an indirect approach to explore physicians' attitudes toward the management of patients with low-energy or high-energy fractures, and found that awareness of osteoporosis and compliance with management guidelines in patients with newly diagnosed low-energy fractures were significantly lower in senior physicians than in young physicians. Future studies should address specific problems with physicians' views about a condition or its management practices; their views may account for a deficiency in a certain situation.

In terms of common fracture sites acting as a predictor for the use of DXA, we found that well-known sites of low-energy fracture were more likely to be examined using BMD testing than less-common fracture sites. However, Levasseur et al. point out that low-energy fracture sites are not confined to the common fracture sites, and can occur in the pelvis, ribs, tibia, fibula, elbow, knee, patella, and calcaneus, etc.^[9] Future research and educational approaches should include strategies to make physicians aware of fracture site bias in post-fracture screening for osteoporosis and outline the current lack of rational decision making for BMD testing and the confusion associated with its management.^[18]

The third predictor for the use of DXA scanning was female gender. Female patients were more likely than male patients to receive BMD testing after a low-energy fracture. Castel et al. posited that this bias might be due to the misapprehension that osteoporosis was a 'female's problem' only.^[13] Improved communication between orthopedic surgeons, specialists and involved physicians with respect to evidence-based medicine may help to reduce the gap between fracture occurrence and osteoporosis management in both genders.

The prevalence of medical treatment for osteoporosis and osteopenia were almost comparable with the rates of BMD testing in the present study. Of the 259 low-energy fracture patients, 99 patients had BMD testing, and 85 of these 99 patients (32.8% of low-energy fracture patients) had a diagnosis of osteoporosis/osteopenia. All 85 patients received bisphosphonates, supplemental calcium, and vitamin D. The same treatment, minus bisphosphonates, was given to the remaining 14 (5.4%) who had T-scores in the normal range and to the other 160 (61.8%) patients of the original cohort who did not receive BMD testing. While the prevalence rate of proper medical treatment appears good when compared with previous papers,^[10,19-21] it may be suboptimal as BMD testing was not performed in 61.8% of the low-energy fracture patients. We cannot predict how many patients in the untested group would have benefitted from the inclusion of bisphosphonates in their treatment plan. Although the diagnosis of osteoporosis following low-energy fracture is crucial, it is only effective in preventing future fractures if a treatment plan is in place and maintained. A previous study reported that the proportion of postmenopausal patients receiving osteoporosis treatment increased from 15.2 to 63.3% following a diagnosis of low BMD with bone densitometry.^[22] Patients with hip fracture in Canada diagnosed with osteoporosis post-fracture were more likely to obtain treatment.^[19] Moreover, those who had a diagnosis of osteoporosis were more likely to receive bisphosphonates than those who suffered fractures but had not been diagnosed with osteo-

porosis.^[23] These reports underline the importance of a diagnosis of osteoporosis for the prevention of subsequent fractures in patients who have suffered a low-energy fracture.

The present study was somewhat limited by its low number of high-energy fracture patients, and as such, could not investigate the effects of physicians' attitude, fracture sites and gender towards the prevalence of osteoporosis diagnosis and treatment. Further studies with more patients would be necessary to identify the barriers in the diagnosis and management of osteoporosis in high-energy fracture patients.

In conclusion, BMD investigation and treatment rates are currently suboptimal. Factors affecting the prevalence of post-fracture testing and management include treatment by a younger attending physician, female gender and presence of a fracture in a well-known site. The gap in care between the occurrence of a fracture and the diagnosis and treatment of osteoporosis necessitates multidisciplinary intervention to lessen the incidence of future fractures.

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Conflicts of Interest: No conflicts declared.

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