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Association between Osteoporotic Vertebral Compression Fractures and Age, Bone Mineral Density, and European Quality of Life-5 Dimensions in Korean Postmenopausal Women: A Nationwide Cross-sectional Observational Study

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Background: The purpose of this study was to investigate the characteristics of osteoporotic vertebral compression fractures (OVCFs) in Korean postmenopausal women and the association between OVCFs and clinical factors such as age, bone mineral density (BMD), and quality of life.

Methods: According to the population distribution in four regions in Korea, 1,281 postmenopausal female patients were recruited from nationwide orthopedic outpatient clinics. Radiologic, asymptomatic, and within 3 months of OVCF groups were analyzed based on age, fracture location, and prevalence according to BMD. In addition, BMD, T-score, body mass index, and European Quality of Life-5 Dimensions (EQ-5D) were investigated in the three groups, and the differences between groups were compared and analyzed.

Results: The prevalence of radiologic OVCFs at the T11–L1 was 3.7 times higher in the 70s group (44.0%) than in the 50s group (11.9%). Femur and total hip BMD were significantly lower in patients with thoracolumbar junction fractures than in patients with L2–5 fractures, whereas no difference was observed in lumbar spine BMD. Of the three OVCF groups, the within 3 months of OVCF group had the lowest lumbar spine T-score of –2.445. The asymptomatic OVCF group also showed significantly lower lumbar spine T-score than did the group without radiologic OVCFs ($p < 0.001$). The EQ-5D showed a significant decrease in the radiologic OVCF group ($p < 0.001$) and within 3 months of OVCF group ($p < 0.001$).

Conclusions: The prevalence of OVCFs in the thoracolumbar junction rapidly increases with old age and low BMD in Korean postmenopausal women. Femur and total hip BMD are more predictive of thoracolumbar junction fractures than lumbar spine BMD. Patients with radiologic OVCFs had a significantly lower quality of life than no OVCF group. Therefore, this study shows it is important to treat and prevent osteoporosis before an OVCF occurs.

Keywords: *Postmenopausal osteoporosis, Compression fracture, Bone density, Quality of life*

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The average life expectancy of Korean women is expected to exceed 90 years in 2030, and the frequency of osteoporosis and osteoporotic fractures is also expected to increase rapidly.[1-3] Osteoporotic vertebral compression fractures (OVCFs) are the most common type of osteoporotic fracture, but they are often neglected due to relatively

mild symptoms.[4,5] However, it has been reported that OVCFs not only increase morbidity and mortality,[6] but also affect psychosocial aspects.[7] There have been several epidemiologic studies on osteoporotic vertebral fractures in white women; however, there exist ethnic differences in the pattern and prevalence of osteoporotic fractures.[8,9] To our knowledge, there is a lack of national detailed investigation on OVCFs in postmenopausal women in Korea. There was a report of reduced quality of life (QOL) in Korean OVCF patients, but it did not reflect the population distribution;[10] besides, in other nationwide studies, there was no analysis related to bone mineral density (BMD), fracture site, or QOL.[3,11] Therefore, the purpose of this study was to investigate nationwide characteristics of OVCFs and the association between OVCFs and clinical factors such as age, BMD, fracture level, and QOL in Korean postmenopausal women who visited outpatient clinics.

METHODS

Ethics Statement

The study was conducted following the Declaration of Helsinki and approved by the Institutional Review Board of SMG-SNU Boramae Medical Center (IRB No. 06-2010-131). All patients provided written informed consent.[12-14]

Study Design

The present study is a nationwide cross-sectional observational study with a focus on postmenopausal women, who visited 62 orthopedic outpatient clinics from October 2010 to February 2011 in South Korea. Based on the assumption that the prevalence of OVCFs would be approximately 26%, the sample size was calculated as 1,183.[12-14]

To collate information on regional differences between localities, the data produced by the National Statistical Office of Korea were adopted to identify the distribution of women aged 50 years or above. The same percentage of subjects was recruited from each of the four localities including the Seoul Metropolitan, Central, Yeongnam, and Honam areas (Supplementary Table 1). The study subjects were successively recruited from each orthopedic institution. Finally, 1,281 subjects were enrolled in this study.

Inclusion Criteria

Among women aged 50 years or above who visited the orthopedic clinics, only women who had menopause were included in the study. Postmenopausal patients were defined as patients 12 months after the last menstruation at the time of enrollment and identified by history taking.[12-14]

Exclusion Criteria

Exclusion criteria included premenopausal women, women aged above 80 years, patients who experienced high-energy trauma within 3 months of study enrollment, patients with nonvertebral fractures within 6 months of study enrollment, and subjects whose normal reading of spine and femur BMD was not evaluable (due to spine instrumentation and proximal femur surgery). Subjects who could not understand the content of the survey questionnaire were also excluded based on the discretion of the investigator.[12-14]

Demographic Data

Patients were prospectively evaluated for age, postmenopausal period, comorbidities (hypertension, diabetes, hypercholesterolemia, osteoporosis, rheumatoid arthritis, hyperthyroidism, and hyperparathyroidism), degenerative osteoarthritis of the knee, foot disease, spinal diseases with claudication, and Parkinson disease based on their medical records and through an interview.[12-14]

Fracture Evaluation

Thoracic (T)-spine and lumbar (L)-spine X-rays were taken prospectively in anteroposterior and lateral positions. The available data for the past 3 months were used for analysis. The orthopedic surgeons of each orthopedic clinic confirmed the compression fracture of each T spine (T1–12) and the L spine (L1–5). Also, the surgeons checked whether the patient was aware of the fracture. If there was a fracture, it was quantitatively evaluated by comparing with the standard chart of semi-quantitative evaluation.[15] The degree of deformity was evaluated as normal (grade 0), mildly deformed (grade 1, 20%–25% of height reduction), moderately deformed (grade 2, 25%–40%), and severely deformed (grade 3, > 40%). Independent of the evaluation of fracture, tenderness of each vertebral segment was examined and recorded. The degree of deformation and tenderness of each vertebral segment was evaluated. A radiologic OVCF was defined as grade 1 or more deformation on X-ray. An asymptomatic (or neglected) OVCF was defined as a fracture found on X-ray, but the patient not remembering the previous fracture and absence of tenderness. A fracture within the last 3 months was defined as a fracture accompanied by tenderness of the same spinal segment.[16] In this study, we compared the prevalence of radiologic OVCFs, asymptomatic OVCFs, and OVCFs within 3 months according to age. Furthermore, the spinal segments were divided into T1–10, T11–L1, and L2–5, and the proportions of patients with the symptom (tenderness), fracture, and fracture and symp-

tom (fracture within 3 months) were evaluated according to age.

BMD and T-Score

Patients were subjected to BMD analysis at the L spine, femoral neck, and total hip joint using dual-energy X-ray absorptiometry prospectively. If the data measured within the past 3 months were available, the previously obtained data were used. Measurement of each area was performed according to the instructions of the manufacturer of the measuring instrument.[12,13] Patients with fractures were divided into three groups, T1–10, T11–L1, and L2–5, and compared for differences in L-spine BMD, femur BMD, and total hip BMD. We also examined the differences in BMD and T-score between the L spine, femur, and total hip according to the presence or absence of an OVCF, asymptomatic OVCF, and OVCF within 3 months.

Body Mass Index

Patients were divided into four groups according to body mass index (BMI): 18.5 kg/m^2 or less, over 18.5 to 25 kg/m^2, over 25 to 30 kg/m^2, and more than 30 kg/m^2. We compared the prevalence of OVCFs, asymptomatic OVCFs, and OVCFs within 3 months according to BMI.

History of Falls, Comorbidities, and Diseases Limiting Exercise or Gait

Patients with an OVCF, asymptomatic OVCF, and OVCF within 3 months were evaluated for a history of falls (within 1 year), comorbidities (hypertension, diabetes, hypercholesterolemia, osteoporosis, rheumatoid arthritis, hyperthyroidism, and hyperparathyroidism), diseases limiting exercise or gait (degenerative knee osteoarthritis, foot disease, spinal diseases with claudication, and Parkinson disease).

Quality of Life

The European Quality of Life-5 Dimensions (EQ-5D) instrument was used as an indicator of the QOL. The EQ-5D questionnaire was self-completed by the patient. The utility index for each patient was calculated by using the model presented elsewhere.[17] We determined the presence of difference in the EQ-5D index between patients with tenderness and without tenderness. A similar evaluation was performed for patients with fractures and fractures accompanied by tenderness. We also scored each item of the EQ-5D in patients with and without fractures on X-ray regardless of tenderness.

Statistical Analysis

In this study, continuous variables including the prevalence of OVCFs are presented as mean and standard deviation (SD) and categorical variables as frequency (percentage). The Cochran-Armitage trend test was used to compare the prevalence of fractures according to age and BMI. A *t*-test was used to compare BMD with fracture location, fracture and T-score, and fracture and BMD. A *t*-test was used to compare the differences in the EQ-5D index. Data were analyzed using SPSS ver. 18.0 (SPSS Inc., Chicago, IL, USA).

RESULTS

Demographic Data

The total number of patients included in the present study was 1,255. The mean age of the patients was 63.2 years (SD, 7.7), the mean age at the time of menopause was 48.8 years (SD, 5.2), and the mean postmenopausal period was 14.5 years (SD, 9.0).[12-14] The number of patients according to the type of fracture was 717 in the group without an OVCF, 536 in the radiologic OVCF group, 208 in the asymptomatic OVCF group, and 258 in the within 3 months of OVCF group; the average age of each group was 61.3 years (SD, 7.2), 65.8 years (SD, 7.6), 64.6 years (SD, 7.5), and 66.9 years (SD, 7.6), respectively. The average ages of all three groups with OVCFs were significantly higher than the average age of the group without an OVCF ($p < 0.05$).

Fracture Evaluation by Vertebral Segment

According to the semi-quantitative vertebral evaluation, the most frequent level of fracture was T12 (14.5%) and the fracture frequency of T11 and L1–L5 level was more than 10%. The prevalence of fractures tended to decrease in the upper T spine, and the lowest segment was identified as T1 (1.6%). Apart from the frequency of fractures, the frequency of tenderness was highest in L4 (12.8%), followed by L5 and L3 (11.3% and 9.6%, respectively). Most of the OVCFs within 3 months were observed below T10 (Table 1).

Prevalence of OVCFs by Age

The prevalence of OVCFs and OVCFs within the last 3 months exhibited a significant increase with age ($p < 0.001$). Among women in their 70s, radiologic OVCFs in the T–L spine were observed in 63% and recent OVCFs were observed in 32.7%. However, the prevalence of asymptomatic (or neglected) OVCFs was not significantly different between the different age groups (Table 2).

Table 1. Semi-Quantitative Evaluation of OVCF and Tenderness of Each Vertebral Segment in the Thoracolumbar Spine

Level	n*	Semi-quantitative grade of vertebral deformity				Tenderness	Radiologic OVCF	OVCF within 3 months
		Grade 0	Grade 1	Grade 2	Grade 3			
T1	1,250	1,230 (98.4)	20 (1.6)	0	0	15 (1.2)	20 (1.6)	5 (0.4)
T2	1,250	1,225 (98.0)	25 (2.0)	0	0	16 (1.3)	25 (2.0)	5 (0.4)
T3	1,250	1,211 (69.9)	37 (3.0)	2 (0.2)	0	27 (2.2)	39 (3.1)	10 (0.8)
T4	1,251	1,204 (96.2)	45 (3.6)	2 (0.2)	0	23 (1.8)	47 (3.8)	8 (0.6)
T5	1,251	1,201 (96.0)	44 (3.5)	3 (0.2)	3 (0.2)	23 (1.8)	50 (4.0)	6 (0.5)
T6	1,252	1,185 (94.6)	63 (5.0)	3 (0.2)	1 (0.1)	24 (1.9)	67 (5.4)	9 (0.7)
T7	1,252	1,160 (92.7)	81 (6.5)	7 (0.6)	4 (0.3)	27 (2.2)	92 (7.3)	15 (1.2)
T8	1,253	1,151 (91.9)	88 (7.0)	12 (1.0)	2 (0.2)	28 (2.2)	102 (8.1)	19 (1.5)
T9	1,253	1,141 (91.1)	99 (7.9)	9 (0.7)	4 (0.3)	42 (3.4)	112 (8.9)	28 (2.2)
T10	1,253	1,140 (91.0)	104 (8.3)	7 (0.6)	2 (0.2)	60 (4.8)	113 (9.0)	41 (3.3)
T11	1,253	1,105 (88.2)	121 (9.7)	23 (1.8)	4 (0.3)	75 (6.0)	148 (11.8)	57 (4.5)
T12	1,252	1,070 (85.5)	128 (10.2)	41 (3.3)	13 (1.0)	86 (6.9)	182 (14.5)	68 (5.4)
L1	1,252	1,082 (86.4)	117 (9.3)	42 (3.4)	11 (0.9)	89 (7.1)	170 (13.6)	67 (5.4)
L2	1,250	1,081 (86.5)	127 (10.2)	36 (2.9)	6 (0.5)	93 (7.4)	169 (13.5)	63 (5.0)
L3	1,251	1,080 (86.3)	130 (10.4)	38 (3.0)	3 (0.2)	120 (9.6)	171 (13.7)	71 (5.7)
L4	1,249	1,071 (85.7)	138 (11.0)	34 (2.7)	6 (0.5)	160 (12.8)	178 (14.3)	70 (5.6)
L5	1,252	1,093 (87.3)	127 (10.1)	30 (2.4)	2 (0.2)	141 (11.3)	159 (12.7)	51 (4.1)
Total	1,255					344 (27.4)	536 (42.7)	258 (20.6)

Values are presented as number (%).
OVCF: osteoporotic vertebral compression fracture.
*Number of subjects who underwent both vertebral deformity and tenderness assessments.

Table 2. Prevalence of OVCF by Age

Type of fracture	50s (n = 454)	60s (n = 493)	70s (n = 300)	*p*-value*
Radiologic OVCF	134 (29.5)	208 (42.2)	189 (63.0)	< 0.001
Asymptomatic (or neglected) OVCF	72 (15.9)	76 (15.4)	58 (19.3)	0.256
OVCF within 3 months	51 (11.2)	106 (21.5)	98 (32.7)	< 0.001

Values are presented as number (%).
OVCF: osteoporotic vertebral compression fracture.
*Cochran-Armitage trend test.

The increase in OVCF prevalence with aging was particularly concentrated in the T-L junction. In particular, the prevalence of radiologic OVCFs at the T12 level was five times higher in the 70s group (28.4%) than in the 50s group (5.5%) (Supplementary Table 2). The prevalence of radiologic OVCFs at the T11–L1 level was 3.7 times higher in the 70s group (44.0%) than in the 50s group (11.9%). The prevalence of T11–L1 fractures and L2–5 fractures within 3 months was estimated to be 20.0% and 20.7%, respectively, in the 70s group (Table 3).

Table 3. Prevalence of OVCF by Age and Fracture Location

Level	Symptom (tenderness)			Radiologic OVCF			OVCF within 3 months		
	50s (n = 454)	60s (n = 493)	70s (n = 300)	50s (n = 454)	60s (n = 493)	70s (n = 300)	50s (n = 454)	60s (n = 493)	70s (n = 300)
T1–T10	22 (4.8)	52 (10.5)	34 (11.3)	51 (11.2)	98 (19.9)	86 (28.7)	9 (2.0)	39 (7.9)	28 (9.3)
T11–L1	29 (6.4)	55 (11.2)	64 (21.3)	54 (11.9)	118 (23.9)	132 (44.0)	19 (4.2)	46 (9.3)	60 (20.0)
L2–L5	54 (11.9)	108 (21.9)	80 (26.7)	92 (20.3)	130 (26.4)	115 (38.3)	25 (5.5)	61 (12.4)	62 (20.7)

Values are presented as number (%).
OVCF: osteoporotic vertebral compression fracture.

Bone Mineral Density

In patients with fractures at the T–L junction, femur and total hip BMD were significantly lower than those of patients with L2–5 fractures, but there was no notable difference in L-spine BMD. There was no significant difference in all BMD between patients with T1–10 fractures and patients with T–L junction fractures (Fig. 1).

T-Score

The mean L-spine T-scores of all OVCF patients (including even the asymptomatic or neglected OVCFs) were significantly lower than the mean L-spine T-score of patients without fracture regardless of symptoms. The mean femur and total hip T-scores were also significantly lower in the fracture groups than the group without fracture (Table 4).

Body Mass Index

The prevalence of radiologic OVCFs was identified as 71% in patients with a BMI less than 18.5 kg/m^2. In the other two fracture groups, the fracture prevalence was also high in low-weight patients. However, there was no statistically significant difference in the frequency of any OVCFs according to BMI (Table 5).

History of Falls and Diseases Limiting Exercise or Gait

The history of falls was more common in radiologic OVCF patients (16%) than in patients without fracture (10.4%) (p = 0.003), and the same was true for patients with OVCFs within 3 months. In the case of asymptomatic OVCFs, only 4.3% of patients had the experience of falls (Supplementary Table 3). The prevalence of diseases limiting exercise or gait in radiologic OVCF patients was 20%, which was significantly higher than that of patients without OVCF (13.8%) (p = 0.003). However, asymptomatic fractures were not related to the diseases limiting exercise or gait (Supplementary Table 4).

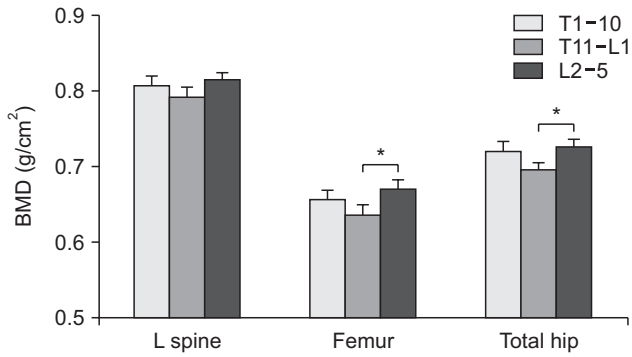

Fig. 1. Bone mineral density (BMD) with respect to fracture level. *p < 0.05.

European Quality of Life-5 Dimensions

The EQ-5D index was significantly decreased not only in patients with tenderness and OVCFs within 3 months but also in patients with radiologic OVCFs and asymptomatic OVCFs. A significant reduction in the EQ-5D was observed in patients with radiologic OVCFs, regardless of the presence or absence of tenderness (Table 6). In patients with OVCFs, the pain or discomfort dimension of the EQ-5D was the most affected: moderate to severe in 78.4% of patients. Approximately 53.0% of fracture patients complained of difficulty in mobility, and their ability to perform usual activities was also affected. Even in the presence of fractures, 75.0% or more patients reported no problem in the self-care item. In all five items of EQ-5D, the proportion of patients with some problems was higher by more than 5% in patients with fractures than in patients without fractures (Fig. 2).

DISCUSSION

In this study, the prevalence of OVCFs rapidly increased with age. Also, fractures at the T–L junction increased steeply as the age of patients increased. Therefore, it can be considered that the steep increase in T–L junction fractures led to the increase in the overall prevalence of

Table 4. Association bewteen OVCF and T-Score

Type of fracture	L-spine T-score			Femur T-score			Total hip T-score		
	n	Mean	*p*-value*	n	Mean	*p*-value*	n	Mean	*p*-value*
No radiologic OVCF	717	–1.638		706	–1.349		681	–1.028	
Radiologic OVCF	536	–2.275	< 0.001	509	–1.988	< 0.001	475	–1.663	< 0.001
Asymptomatic (or neglected) OVCF	208	–1.942	< 0.001	200	–1.686	< 0.001	202	–1.320	< 0.001
OVCF within 3 months	258	–2.445	< 0.001	241	–2.151	< 0.001	205	–1.922	< 0.001

OVCF: osteoporotic vertebral compression fracture.
*t-test.

Table 5. Prevalence of Vertebral Compression Fracture by BMI and Type of Fracture

Type of fracture	< 18.5 kg/m^2 (n = 46)	18.5–< 25 kg/m^2 (n = 776)	25–< 30 kg/m^2 (n = 364)	≥ 30 kg/m^2 (n = 49)	*p*-value*
Radiologic OVCF	33 (71.7)	312 (40.2)	157 (43.1)	20 (40.8)	0.267
Asymptomatic (or neglected) OVCF	14 (30.4)	114 (14.7)	67 (18.4)	7 (14.3)	0.896
OVCF within 3 months	17 (37.0)	148 (19.1)	75 (20.6)	11 (22.4)	0.601

Values are presented as number (%).
BMI: body mass index, OVCF: osteoporotic vertebral compression fracture.
*Cochran-Armitage trend test.

Table 6. EQ-5D Index According to OVCF

Type of fracture	EQ-5D index		
	n	Mean ± SD	*p*-value*
No radiologic OVCF	712	0.825 ± 0.139	
Radiologic OVCF	533	0.787 ± 0.153	< 0.001
Asymptomatic (or neglected) OVCF	206	0.801 ± 0.149	0.032
OVCF within 3 months	257	0.781 ± 0.156	< 0.001

EQ-5D: European Quality of Life-5 Dimensions, OVCF: osteoporotic vertebral compression fracture, SD: mean standard deviation.
*t-test.

OVCFs. It is known that traumatic and fall-related vertebral fractures predominantly occur at the T–L junction.[18] However, there are few reports about OVCFs at the T–L junction. As the age increases, thoracic or T–L kyphosis increases and BMD decreases.[19,20] It is presumed that OVCFs occur easily at the T–L junction in elderly patients even under conditions of minor trauma because the compressive force increases rapidly due to weight with an increase in the kyphosis of the T–L junction.

Indeed, in this study, the femur and total hip BMD of the group with a fracture at the T–L junction was significantly lower than those of the L-spine (L2–5) fracture group. L-spine BMD was also lower in the T–L junction fracture group, but there was no statistically significant difference. This result could be attributable to lumbar fractures generating difficulty in the measurement of BMD along with the influence of degenerative changes in osteophyte or aortic calcification.[21,22] Therefore, in the presence of a fracture of the T–L junction, underestimation of osteoporosis should be prevented by checking femur and total hip BMD.

Not surprisingly, it was apparent that a lower T-score was associated with a higher risk of a fracture within 3 months. Therefore, patients with low T-scores should be regarded as cases with an imminent risk of fracture, and aggressive treatment for osteoporosis should be considered for them. Another point to be noted is that although asymptomatic OVCF patients actually have low bone density, they are likely to remain untreated for osteoporosis due to the absence of symptoms.

According to the results of this study, it appears that the lower L spine is more susceptible to pain. The proportion of patients complaining of tenderness in the lower L spine without radiologic OVCFs was higher than that in

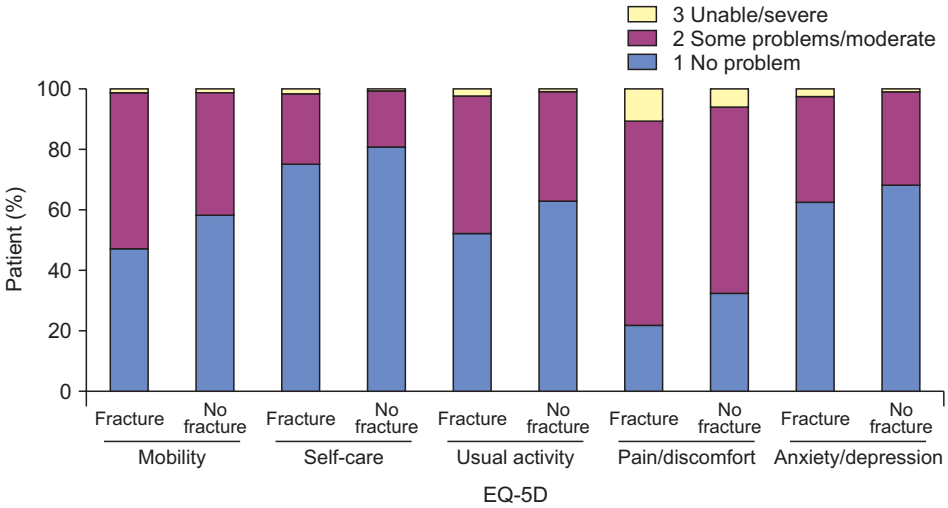

Fig. 2. European Quality of Life-5 Dimensions (EQ-5D) score with respect to the osteoporotic vertebral compression fracture.

T12. Tenderness in the lower L spine is thought to be due to a degenerative change or a fracture of an adjacent segment. If symptoms are felt even though it is not an acute fracture, this pain can be considered chronic pain. Klazen et al.[23] reported that about one-third of patients with vertebral compression fractures complained of severe pain after fracture recovery and required additional treatment, such as drug therapy or physical therapy. However, no predictor of transition from acute to chronic pain was identified.[24] Our study suggests that compression fractures of the lower lumbar location may be a risk factor for chronic pain.

Low BMI has been known as a risk factor of osteoporotic hip fractures and shows nonlinear correlations, but the effect of BMI on OVCFs was not identified.[25] In our study, there was no difference in fracture frequency in the group with BMI below 22 kg/m^2 compared with other groups. However, the group with a BMI less than 18.5 kg/m^2 showed a very high prevalence of fractures (more than 70%), which was even higher than the overall prevalence of 42.7%. Even if we could not prove statistical significance due to the small number of patients, this implies that in Koreans, low BMI could be a risk factor of fracture.

Osteoporotic vertebral fractures and QOL appear to be closely related.[26] Among the osteoporotic fractures, QOL reduction is reported to be more severe in hip and vertebral fractures than in wrist fractures.[27] A report revealed that the QOL fell even in osteoporosis without fracture.[28] Osteoporotic vertebral fractures are reported to be worse in all 5 domains of EQ-5D and VAS.[10] According to a study in Japan, QOL was recovered at 6 months for wrist fractures, at 1 year for vertebral fractures, and at 1 year for hip fractures. In Sweden, vertebral fractures were reported to be more associated with QOL reduction than hip fractures were.[29] In the present study, the EQ-5D score was reduced in patients with radiologic OVCFs, but not in patients with OVCFs within 3 months. Therefore, it is important to prevent fractures through the treatment of osteoporosis, as it decreases EQ-5D, as well as remaining painful. Several studies have reported the causes of QOL reduction. Back muscle strength and mobility of the vertebrae have been reported to affect the QOL in postmenopausal women.[30,31] Patients with vertebral fractures generally have back muscle weakness, and it is understood that wearing a brace or bed rest reduces mobility of the patients.

This study has some limitations. As it is a cross-sectional study, it was impossible to explain the causal relationship between OVCFs and other clinical factors. Postmenopausal women who could not visit the outpatient clinics were excluded from the study, so there might have been a selection bias. Confounding factors such as age was not controlled with analysis of BMI, history of falls, and chronic illness. Also, osteoporosis treatment history was not included in the analysis of OVCFs. Nevertheless, the significance of this study can be found in the fact that it is a nationwide cross-sectional study of orthopedic outpatients with multifaceted analysis of osteoporotic vertebral fractures in Korean postmenopausal women.

OVCFs of the T–L junction increase rapidly in Korean postmenopausal women with increasing age. Femur and total hip BMD are more predictive of OVCFs than L-spine BMD. Osteoporotic compression fractures cause discomfort even after healing of the fracture and eventually cause QOL degradation. This study underscores the importance of preventing and treating osteoporosis before an OVCF occurs.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

SUPPLEMENTARY MATERIAL

Supplementary material is available in the electronic version of this paper at the CiOS website, www.ecios.org.

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