JBM J Bone Metab 2022;29(1):43-49
https://doi.org/10.11005/jbm.2022.29.1.43
pISSN 2287-6375 eISSN 2287-7029

Original Article

Prevalence and Risk Factors of T-Score Spine-Hip Discordance in Patients with Osteoporotic Vertebral Compression Fracture

Byung-Ho Yoon*, Ho Won Kang*, Su Min Kim, Young Do Koh

Department of Orthopedic Surgery, Ewha Womans University, College of Medicine, Mokdong Hospital, Seoul, Korea

Corresponding author
Young Do Koh
Department of Orthopedic Surgery, Ewha Womans University Mokdong Hospital, 1071 Anyangcheon-ro, Yangcheon-gu, Seoul 07985, Korea
Tel: +82-2-2650-5890
Fax: +82-2-2642-0349
E-mail: ydkoh@ewha.ac.kr

Received: January 31, 2022
Revised: February 14, 2022
Accepted: February 14, 2022

*Byung-Ho Yoon and Ho Won Kang equally contributed to this work and should be considered co-first author.

Background: T-score discordance between the spine and hip is commonly observed when dual energy X-ray absorptiometry (DXA) is used to diagnose osteoporosis. However, information is scarce regarding the prevalence and risk factors for this problem in Korea. This study evaluated the prevalence of major/minor discordance and associated risk factors in elderly Korean patients with osteoporotic vertebral compression fractures (OVCFs). **Methods:** This study included 200 patients (37 men, 163 women) treated for thoracic or lumbar compression fractures between January 2015 and August 2021. DXA was performed to examine T-scores and determine the prevalence of discordance, defined as a difference between the T-score categories of the femur and spine in the same individual. The *t*-tests, χ^2 tests, and regression analyses were used to assess the associated risk factors of T-score discordance among the subjects. **Results:** T-score concordance, minor discordance, and major discordance were observed in 137 (68.5%), 59 (29.5%), and 4 (2%) patients with OVCFs, respectively. The spinal T-score was lower than the femoral T-score in all major discordance and 81.3% (48/59) of minor discordant cases. Overall, the only factor related to T-score discordance was the age at fracture (odds ratio, -0.01; $P=0.014$). **Conclusions:** The results of this study showed that a significant number of subjects (31.5%) showed spine-hip discordance, even with a mean age in their 80s. More attention should be paid to the appropriate evaluation and management of elderly patients with OVCFs. Moreover, a longitudinal study is necessary to verify the clinical importance of T-score discordance in this population.

Key Words: Absorptiometry, photon · Bone density · Fractures, compression · Osteoporosis · Spinal fractures

INTRODUCTION

Bone mineral density (BMD) assessed by dual energy X-ray absorptiometry (DXA) is used to diagnose osteoporosis, assess fracture risk, and monitor changes in BMD over time.[1,2] The International Society for Clinical Densitometry (ISCD) has recommended that BMD should be measured for the purpose of diagnosing osteoporosis at 2 preferred skeletal sites, the hip and lumbar spine.[3,4] ISCD also recommended osteoporosis would be diagnosed on the basis of the lowest T-score for BMD found at the spine, total hip, and femoral neck.[5] However, clinicians commonly conflict the discordance of T-score category at the 2 different skeletal

sites (lumbar spine and hip), which can complicate the diagnosis of osteoporosis and therapeutic plan.[6,7]

Discordance in diagnosis of osteoporosis is defined as the presence of different categories of T-scores in 2 skeletal sites of an individual patient.[8,9] This phenomenon can be divided into 2 types. Minor discordance refers to a difference of at least 1 category and if the difference is more than one diagnostic class (osteoporosis at one site and normal at the other site), it is referred to as major discordance.[6,10,11]

According to previous literatures, the prevalence of major T-score discordance is between 2.7% and 4.3%, whereas minor discordance is between 35% and 41%.[12,13] Various studies have analyzed the prevalence and impact of T-score discordance on the management of osteoporosis. The offset was found to significantly affect fracture risk with a hazard ratio of 1.12, independent of the fracture risk assessment tool (FRAX) probability.[14] However, studies on the prevalence and factors of T-score discordance in Korea are lacking, especially in patients with osteoporotic vertebral compression fractures (OVCFs).

Thus, we aimed to determine the prevalence and risk factors of discordance between hip and spine BMD using DXA among patients with OVCFs.

METHODS

1. Included patients

We carried out a retrospective review of patients diagnosed with OVCFs under the official approval of the Institutional Review Board (IRB; IRB no. EUMC 2021-10-031). From January 2015 to August 2021, Between 2011 and 2020, patients aged >65 years who were admitted for surgery due to acute

The 48 hip fracture were eligible for this study we identified 296 patients who were treated with spine compression fracture. We excluded women who were treated with significant glucocorticoid or aromatase inhibitor exposure (>90 days) in whom management differs from the general population.

A fracture was defined as a case in which the anterior or median height of the vertebra was decreased by more than 20% compared to the posterior height.[15,16] When it was difficult to differentiate from old fracture, it was diagnosed after magnetic resonance imaging evaluation. The OVCFs were properly treated based on current treatment principles including conservative treatment and surgical treatment. For these patients, systemic disease and fractures were checked with the medical records, and after reviewing the radiology department, 7 patients who had pathologic vertebral fractures and 66 patients were without DXA were excluded from the list, and 200 patients were finalized (Fig. 1).

There were 75 Thoracic compression fractures (37.5%), 114 Lumbar compression fractures (57%), 11 were thoracic and lumbar compression fractures (5.5%). There were 162 single compression fractures (81%) and 38 multiple compression fractures (19%). Twenty-five patients (12.5%) had

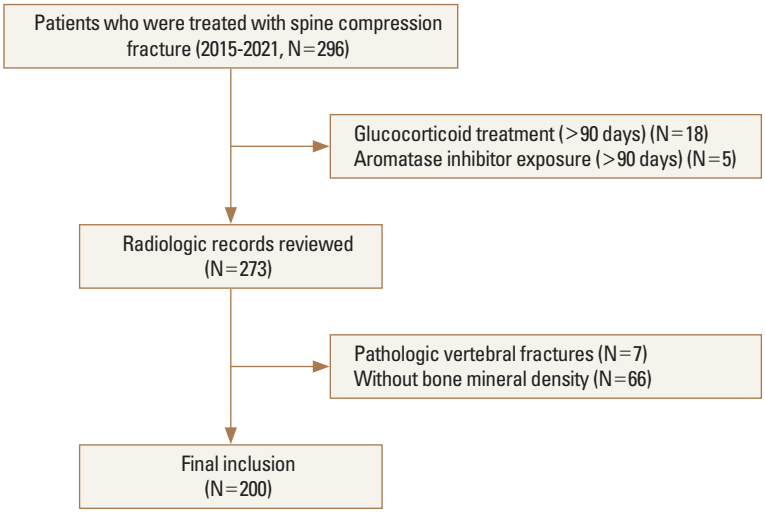

Fig. 1. Flow diagram of patient inclusion/exclusion.

https://doi.org/10.11005/jbm.2022.29.1.43

a history of previous osteoporotic fracture and 64 patients (32.0%) had been treated with osteoporosis treatment. Other demographic data are presented in Table 1.

2. Definition of T-score discordance

BMD of the lumbar spine and hip (total hip and femur neck) was measured using a Lunar Prodigy scanner (Lunar Prodigy; GE Medical Systems, Madison, WI, USA). Daily calibration and quality assurance testing were performed, and the BMD precision was lesser than 0.1%. We used the mean lumbar spine areal BMD value from at least 2 evaluable vertebrae from L1 to L4, and if there was a fracture, focal structural defect or a discrepancy of >1 standard deviation in T-score between adjacent vertebrae, the physicians excluded that vertebral level. The femoral neck and total hip T-scores were measured in the both (unfractured if injured) femur, and the lowest score at either site was used as the femoral T-score for the analysis. All densitometry was performed within 2 weeks after fracture occurrence. A T-score below -2.5 was considered osteoporosis; between -1 and -2.5, osteopenia; and more than -1, normal were diagnosed according to the World Health Organization (WHO) criteria. T-score discordance was defined as different WHO T-score categories at the 2 skeletal sites (femur and spine) of the same individual.[17] The patient was considered to have minor discordance when the difference was no greater than 1 WHO category and major discordance when 1 skeletal site was osteoporotic and the other was normal.[18,19]

3. Outcome variables

We evaluated the prevalence of T-score discordance in patients with OVCFs and also investigated demographic differences between the T-score concordance and T-score discordance groups. To determine associated risk factors for T-score discordance, we assessed medical conditions affecting osteoporosis were questioned including age of menopause, hypertension, angina or even myocardial infarction, rheumatoid arthritis, chronic obstructive pulmo-

Table 1. Clinical details of included patients

Measures	Total (N=200)	Discordance		
		Yes (N=63)	No (N=137)	*P*-value
Age at fracture (yr)	81.3±7.6	79.3±8.7	82.2±6.9	0.014
Female	163 (81.5)	51 (81.0)	112 (81.8)	0.183
Height (cm)	154.1±8.1	155.4±7.7	153.5±8.2	0.131
Weight (kg)	54.8±10.4	56.1±9.8	54.2±10.6	0.226
BMI (kg/m^2)	23.0±3.7	23.2±3.8	22.9±3.7	0.540
COPD	2 (1.0)	1 (1.6)	1 (0.7)	0.556
Hypertension	119 (59.5)	39 (61.9)	80 (58.4)	0.571
Cardiovascular disease	34 (17.0)	13 (20.6)	21 (15.3)	0.048
Diabetes	160 (80.0)	49 (77.8)	111 (81.0)	0.743
Thyroid disease	4 (2.0)	2 (3.2)	2 (1.5)	0.421
CKD	4 (2.0)	2 (3.2)	2 (1.5)	0.421
Liver cirrhosis	1 (0.5)	0 (0.0)	1 (0.7)	0.497
Rheumatoid arthritis	2 (1.0)	0 (0.0)	2 (1.5)	0.335
History of osteoporotic fracture	25 (12.5)	9 (14.3)	16 (11.7)	0.268
History of osteoporosis treatment	64 (32.0)	22 (34.9)	47 (34.3)	0.345
Fracture site				0.366
Thoracic compression fracture	75 (37.5)	21 (33.3)	54 (39.4)	
Lumbar compression fracture	114 (57.0)	40 (63.5)	74 (54.0)	
Thoracic and lumbar	11 (5.5)	2 (3.2)	9 (6.6)	
Fracture number				0.445
Multiple compression fracture	38 (19.0)	10 (15.9)	28 (20.4)	
Single compression fracture	162 (81.0)	53 (84.1)	109 (79.6)	

The data is presented as N (%) or mean±standard deviation.
BMI, body mass index; COPD, chronic obstructive pulmonary disease; CKD, chronic kidney disease.

nary disease, diabetes, thyroid disease, renal failure, liver cirrhosis.[20] History of osteoporotic fracture and osteoporosis treatment were also investigated.

4. Statistical analysis

According to the normal distribution, Student's *t*-tests or Mann-Whitney U test was used to compare continuous data, and the χ^2 test or Fisher's exact test was used to analyze categorical data. For all other tests, a 2-sided *P*-value of 0.05 was considered significant. To determine the risk factors of discordance, multivariable regression analysis was performed in variables with a *P*-value less than 0.1. Statistical analyses were conducted with STATA software (version 14.0; Stata Corp., College Station, TX, USA). The level of significance was set at *P* of less than 0.05.

RESULTS

Based on the femoral neck, osteoporosis was found in 122 patients (61%), osteopenia in 67 patients (33.5%), and normality in 11 patients (5.5%). Also, osteoporosis was determined by the bone density of the lumbar vertebrae in 143 patients (71.5%), osteopenia in 45 patients (22.5%), and normality in 12 patients (6%). In all cases, T-score was inconsistent in 63 out of 200 cases was 31.5%. Among them, there was a major disagreement in 4 cases (2%), with all cases classified as having osteoporosis in the anteroposterior lumbar vertebrae but normal in the femur neck. In remaining 59 minor discordance cases, 48 patients (81.3%) had a spinal T-score that was lower than their femoral T-score (Table 2).

Sex, history of osteoporosis treatment and osteoporotic fracture, fracture location/number, weight, height, body mass index and several comorbidities did not differ between the concordance and discordance groups (Table 1). However, the age at fracture and cardiovascular disease did differ significantly between these groups. In the multivariable analysis, the age at fracture was an independent solitary risk factor for discordance (regression coefficient, -0.01; 95% confidence interval [CI], -0.002 to -0.018; $P=0.014$) but cardiovascular disease was not (odds ratio, 1.04; 95% CI, 0.47-2.31; $P=0.402$).

Table 2. The details of concordance and discordance between lumbar and femur neck sites

Lumbar area	Femur	N	Classification
Osteoporosis	Normal	4	Major discordance
Normal	Osteoporosis	0	Major discordance
Osteoporosis	Osteopenia	33	Minor discordance
Osteopenia	Normal	3	Minor discordance
Osteopenia	Osteoporosis	16	Minor discordance
Normal	Osteopenia	7	Minor discordance
Osteoporosis	Osteoporosis	96	Concordance
Osteopenia	Osteopenia	38	Concordance
Normal	Normal	3	Concordance

DISCUSSION

The reason why measurement of bone density by region is necessary is that, there is considerable inconsistency in bone density by region, so, the risk of fracture is considered to be different by region.[21] The spine is mainly composed of trabecular bone, so it has a fast metabolic rate and is sensitive to changes in the body environment, otherwise, femur neck BMD is associated with a higher gradient of risk for hip fracture than BMD measurements at other sites, with similar or better prediction of major fractures.[8] Thus, the lumbar spine and femur are preferred when measuring bone density.[22] However, the combination of these 2 skeletal regions could cause some problems for clinicians in decision making when there is a large discrepancy in the T-scores at these 2 regions in a given individual.[9,23]

To the best of our knowledge, this is first study that evaluated the prevalence of spine-hip T-score discordance in Korean patients with OVCFs. A proportion of 31.5% in our patients showed T-score discordance between lumbar spine and hip, whereas only 3.3% (2/61) of the discordance cases were major discordance. These results are comparable to previous studies of postmenopausal women that found minor discordance in 30% to 50% of postmenopausal woman and major discordance in less than 5% of these. The results of our sample of patients are tabulated and compared with those of previous studies in Table 3.

Most subjects having discordance in our study (all major discordance and 81.3% of minor discordance) showed lower lumbar spine BMD compared to hip BMD. Reduced BMD at the lumbar spine tend to be more prevalent compared to that at the hip in 60 and 70 years of age. However, T-score of the spine tend to reverse that of the hip in the elderly over 80 years of age due to degenerative changes in the

https://doi.org/10.11005/jbm.2022.29.1.43

Table 3. Prevalence of T-score spine-hip discordance form several single cohort studies

References	Year	Country	Enrollment period	Inclusion	N	Minor discordance	Major discordance	Mean age (yr)	Risk factors
Chan et al. [25]	2020	Malaysia	2018-2019	≥40 years in Klang Valley, Malaysia	786	30.3%	2.3%	57.2	Advanced age, decreased height
Singh et al. [18]	2012	India	2012-2016	A population-based screening program was offered to women aged >40	5,708	54.2%	3.4%	50.4	Age, menopause, and obesity
Younes et al. [8]	2014	France	2006-2010	Outpatient osteoporosis testing center of the department of Rheumatology	1,780	45.7%	4.8%	59.5	Menopause
Mounach et al. [9]	2009	Morocco	2008-2012	A community-based outpatient osteoporosis tested	3,479	42.0%	4.0%	55.7	Age, menopause, and obesity
Moayyeri et al. [13]	2005	Iran	2000-2003	A community-based outpatient osteoporosis tested	4,229	38.9%	2.7%	53.4	Older age, menopause, obesity, and belated menopause
Woodson [17]	2000	USA	1988-1999	A community-based outpatient osteoporosis tested	5,051	39.0%	5.0%	55.2	None
Current study	2022	Korea	2015-2021	Patients who had been treated with osteoporotic vertebral compression fractures	200	31.5%	3.5%	81.3	Age

lumbar spine and calcification of the aorta.[14,24] Since the average age of this study was in their 80s, a different pattern of spine-hip discordance was expected but not. Clinicians need to be aware of the possibility of spine-hip discordance in the age group over 80 and carefully examine the risk group of OVCFs.

Discordance was found to be highest incidence in the elderly group especially in 60s and decreased from the 70s in general population. Chan et al. [25] reported discordance was about 32% and found highest in people in their 60s (47%). It is explained that discordance is that created by the different rates of bone loss, and the rapid bone loss due to menopause is most prominent in the 60s of postmenopausal osteoporosis.[25-27] In our study, the age at fracture was the only independent solitary risk factor for discordance with negative regression coefficient of -0.01. This negative correlation is line with the results of previous studies, because the average age of this study is in their 80s and the discordance is highest in their 60s.

As compared to hip fractures, vertebral fractures have often been underestimated in clinical practice. One study that compared the effectiveness of femoral neck and lumbar spine BMD for estimation of the risk of vertebral fractures using FRAX.[24] Because FRAX adopts only femoral neck BMD for calculating fracture risk, the risk of major osteoporotic fracture might be underestimated when the lumbar spine T-score is much lower than the hip. For example, if 2 individuals had identical femur neck T-score but different lumbar spine T-scores would generate the same fracture risk under FRAX. Thus, when confronted with highly discordant measurements (lumbar spine worse than femoral neck) in patients aged 7 to 80 years, clinicians should be alerted of the risk of OVCF and focused on lowering offset between the lumbar spine and femoral neck.[28]

The present study has some limitations. First, the design of our study was single center, retrospective and included number of patients were relatively small. Second, the cause of discordance can be classified into physiologic, pathophysiologic, and artifacts but we did not evaluate the possible causes for discordance in this study.

CONCLUSION

The spine–femur BMD T-score discordance was demonstrated in approximately 32% of Korean elderly patients with OVCFs even with their mean age of 80s. Considering the worldwide increase of the aging population, more attention should be paid to the appropriate evaluation and management of subjects with hip-spine BMD discordance. Also, a longitudinal study would be necessary to verify the clinical importance of T-score discordance in this group.

DECLARATIONS

Ethics approval and consent to participate

This study was conducted according to the principles expressed in the Declaration of Helsinki and was approved by the Institutional Review Board (IRB no. EUMC 2021-10-031).

Conflict of interest

Byung-Ho Yoon has been the associate editor of the Journal of Bone Metabolism since 2015. No potential conflict of interest relevant to this article was reported.

ORCID

Byung-Ho Yoon *https://orcid.org/0000-0001-8518-6331*
Ho Won Kang *https://orcid.org/0000-0002-0792-9045*
Young Do Koh *https://orcid.org/0000-0002-3784-7059*

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