Discordance in diagnosis of osteoporosis using spine and femur bone densitometry: prevalence and related factors

Original Article

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ABSTRACT

Introduction: This study was conducted to evaluate prevalence and risk factors for diagnostic discordance for osteoporosis due to different T-scores of lumbar spine and femoral neck.

Methods: In this cross sectional study demographic, anthropometric and risk factors for osteoporosis were derived from a database on 3,039 post-menopausal women who underwent bone densitometry for the first time in our department (Kurdistan Nuclear Medicine Center) from 2003 to 2010. DXA was performed on L2-L4 vertebrae and femoral neck for all cases. Major discordance (one site osteoporotic and the other normal) and minor discordance (difference between two site no more than one WHO diagnostic class) were determined. The association of related risk factors with discordance of interest was assessed.

Results: Prevalence of osteoporosis and osteopenia in these post-menopausal women with mean age of 58.5 ±8.7 years, menopausal period of 11.2±9.4 years and mean BMI of 28±4.5 were 37.7% and 50.7%, respectively. Frequencies of minor and major discordances were 40.0% and 1.8%, respectively.

Conclusion: The minor discordance was a common finding; however, the major discordance is uncommon. The most important risk factors for major discordance were age, menopausal duration and BMI. There was no significant relationship between other risk factors (smoking and history of bone fracture) and diagnostic T-score discordances.

Key words: Osteoporosis; Discordance; Densitometry; Menopause

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INTRODUCTION

Osteoporosis is the most common metabolic bone disease. Post-menopausal women are the most common high-risk group. The International Osteoporosis Foundation (IOF) estimates that 200 million women suffer from osteoporosis across the world [1]. Indeed one in three women over the age of 50 will have an osteoporosis related fracture in her remaining lifetime [2]. It is estimated that 36% of Iranian Kurdish women to be osteoporotic [3].

Dual energy X-ray absorptiometry (DXA) is the gold standard of measuring bone mineral density (BMD). Areal BMD measured by DXA is expressed as 'T-score'. 'T-score' indicates difference, in term of standard deviations, between patient's BMD and mean bone density of normal reference population in the age of 20-25. Osteoporosis, according to the World Health Organization (WHO) classification, is defined as T-score $\leq$ -2.5. T-score between -1 and -2.5 is considered as osteopenia.

The T-scores are usually calculated for two standard sites of lumbar vertebrae and femoral neck.

Discordance in diagnosis of osteoporosis is defined when there are different categories of T-scores in the two skeletal sites of an individual patient. This phenomenon is divided into two subgroups: major and minor [4]. Minor discordance means that the different diagnostic classes are close (osteoporosis in one site and osteopenia in the other site or osteopenia in one site and normal in the other site). If one site is osteoporotic while the other site has normal BMD, the phenomenon is known as major discordance.

The discordance, particularly major discordance, can affect diagnosis, fracture risk assessment and therapeutic plan in an individual. Osteoporosis is a systemic disorder however the rate of bone loss in different sites of skeleton could be different. Actually, one of the reasons for measuring BMD in several sites is the presence of discordance [5-6]. Fortunately, several studies showed that major discordance is not prevalent. Some of these studies also evaluated risk factors and protective factors for this phenomenon [7-8].

To estimate the impact of this phenomenon in our province, we aimed to demonstrate prevalence of minor and major diagnostic discordance and related risk factors in a large number of Iranian Kurdish post-menopausal women.

METHODS

This was a descriptive-analytical study. Participants in this study were 3,065 apparently healthy post-menopausal women who underwent bone mineral densitometry by DXA in outpatient clinic of Kurdistan Nuclear Medicine Center in Sanandaj, Iran from 2004 to 2010. They were referred by clinicians for diagnostic densitometric evaluation. None of them were on the treatment with bone active agents, hormone replacement therapy or other drugs affecting bone mineral density. Women with disorders that may cause secondary osteoporosis were excluded because decision making in secondary osteoporosis is less likely to be affected by diagnostic discordance.

Patients with secondary osteoporosis were also excluded. Following informed consent, each participating woman was interviewed by a health care worker using a questionnaire about socio-demographic information such as age, life style, history of fracture after age 20 and menopause. Menopause was defined as cessation of menopausal period for more than 12 months and serum FSH greater than 40 IU/L.

The subjects were classified into two categories concerning history of any bone fracture after age 20: with or without history of fracture. Smoking was defined as current smoking at least 1 cigarette per day. The subjects were classified as smoker or non-smoker. Sufficient physical activity was defined as weight-bearing exercise at least 30 minutes three times a week. The participants were classified into two groups: having or not having sufficient physical activity.

The standing height in centimeters (cm) and weight in kilogram were measured and recorded for all subjects. Body mass index (BMI) was calculated as weight (kg) divided by height (cm) squared and recorded as kg/m^2.

BMD was measured at the lumbar spine (L2-L4) and femoral neck with DXA using a Norland densitometer (Norland XR6000, Norland, 2002) by a trained operator according to the manufacture's instruction. The instrument was calibrated weekly by using appropriate phantom. Precision error for BMD measurements was 2.5% in the spine and 3.5% in the femoral neck. The device normative data of US population was used as reference values to drive the T-scores. The measured T-scores were classified as normal, osteopenic and osteoporotic according to the WHO classification.

All of the densitometric and questionnaires data were entered into a comprehensive rational database. Prevalence of minor and major discordances was calculated. To compare presence of various risk factors in the participants with and without T-score discordance, chi-square test was used. Odds ratios with 95% confidence intervals were also reported. *P* values less than 0.05 were taken to indicate statistically significant. Statistical analyses were performed using SPSS, version 16.0.

RESULTS

Characteristics of all participants and their risk factors are summarized in Tables 1 and 2. Totally, 1,147 women (37.7%) had osteoporosis according to their lowest T-score (T-score < -2.5 in the femoral neck *or* lumbar spine). Only 358 women (12%) had normal BMD both in their femoral neck and lumbar spine. The rest of the participants (1,534 women, 50.3%) had osteopenia in one site and normal BMD in the other site or osteopenia in both sites. T-scores classifications are presented in Table 3.

Major discordance was observed in BMD results of 56 women (1.8%). Minor discordance was observed in 1,215 women (40.0%). The measured T-scores of two sites had concordance in 1,768 women (58.2%). Distribution and pattern of T-score discordances and concordances is depicted in Table 4.

Table 1. Characteristics of the study population

	Range	Mean (±SD)
Age (year)	35-91	58.5 (±8.7)
Weight (kg)	34-151	67.3 (±11.7)
Height (cm)	134-178	154.6 (±5.9)
Body Mass Index (kg/m^2)	15.1-63.6	28 (±4.5)
Menopausal duration (years)	1-52	11.2 (±9.4)
Lumbar T-score	-4.28 to 2.98	-1.60 (±1.00)
Femoral neck T-score	-6.10 to 3.74	-1.90 (±1.20)

Table 2. Risk factors in the study population

	Yes	No
Current smoker	100 (3.3%)	2938 (96.7%)
History of fracture after age 20 years	730 (24%)	2308 (76%)
Insufficient physical activity	2356 (77.6%)	682(22.4%)

Table 3. The prevalence of different WHO T-score classes in the study polpulation

Diagnosis	Femoral neck	Lumbar spine
Osteoporosis (T-score $\leq$ -2.5)	1,008 (33.2%)	575 (18.9%)
Osteopenia (-2.5<T-score < -1)	1,439 (47.4%)	1,722 (56.7%)
Normal (T-score $\geq$-1)	592 (19.4%)	742 (24.4%)

Table 4. Distribution of diagnostic discordance according to WHO criteria

	N (%)	Subtotal
Major T-score discordance	56 (100%)	
Hip osteoporosis, Lumbar normal	52 (92.8%)	56 (1.8%)
Hip normal, Lumbar osteoporosis	4 (7.2%)	
Minor T-score discordance	1,215 (100%)	
Hip osteoporosis, Lumbar osteopenia	519 (42.7%)	
Hip osteopenia, Lumbar osteoporosis	134 (11%)	1215 (40%)
Hip osteopenia, Lumbar normal	332 (27.3%)	
Hip normal, Lumbar osteopenia	230 (19%)	
T-score concordance	1,768 (100%)	
Hip & lumbar osteoporosis	437 (24.7%)	1768 (58.2%)
Hip & Lumbar osteopenia	973 (55%)	
Hip & Lumbar normal	358 (20.3%)	
Total	3039 (100%)	

There was significant relationship between major T-score discordance and age, duration of menopause and BMI (Table 5).

Table 5. Results of the chi-squared test for risk factors of major T-score discordance

Variable	χ^2	*P* value
Age	41.41	< 0.001
Duration of menopause	29.01	< 0.001
BMI(> 30 kg/m^2)	40.28	< 0.001
Current smoker	1.29	0.52*
History of fracture after age 20	2.56	0.27*
Inadequate physical activity	0.03	0.85*

*Non-significant *P* value

The major T-score discordance was more prevalent in older age group (5.3% after age 70 vs. 0.3% before age 50, $p<0.001$). The number of women with major T-score discordance was higher ($p<0.001$) in women with more than 20 years of menopause (23 of 651; 3.5%) than women with less than 10 years of menopause (16 of 1413; 1.1%). Obesity was also a risk factor for major T-score discordance (5.6% in women with BMI > 35 vs. 1.6% in women with normal BMI, P < 0.001). No significant relationship was seen between major T-score discordance and current smoking, history of fracture after age 20 and adequate physical activity (Table 5).

DISCUSSION

This study revealed that, using WHO criteria for definition of osteoporosis and osteopenia, most of the post-menopausal women (88%) have osteopenia or osteoporosis. A significant fraction of them (41.8%) would show T-score discordance between hip and spine. The prevalence of discordance in our study was similar to many other studies [9]. However, most of them (40%) were in minor category which could be due to minor variation in BMD techniques or some minor physiologic dissimilarity. Major discordance was not common in our study (1.8%). The prevalence of major discordance in our study was lower than that of similar studies [4,5,9-10].

In both minor and major discordances, lower BMD for femur was more prevalent (70% in minor discordance and 92.8% in major discordance). One reason for this discordance could be vertebral osteoarthritis. Various studies showed that spinal BMD is greater in vertebrae with osteophytes [11]. Osteophytes cannot be distinguished from vertebral bone mineral using a real BMD (eg. DXA) and in some cases overestimate the measurement of bone mass in the affected area. On the other hand, many studies showed that osteoarthritis can really delay

development of osteoporosis [12-13]. It showed that in post menopausal women increasing severity of disc space narrowing, but not osteophytes, is related to increasing bone mineral density. It has been suggested that the protective effect of spinal osteoarthritis against osteoporosis may be mediated through decreased rate of bone resorption, without any effect on bone formation [13-14]. It also has been shown that the marked differences in the prevalence of spinal degeneration features occur in association with older age and obesity [13]. Another reason for this phenomenon could be vitamin D deficiency in our participants. High prevalence (about 80%) for vitamin D deficiency in Iranian population was reported [15]. Vitamin D deficiency by means of raising serum parathyroid hormone (PTH) would induce reduction of cortical bones (e. g., femur) and may have a supportive role for density of trabecular bones (e. g., vertebra) [16].

In 30% of patients with minor discordance and 7.2% of those with major discordance, femoral BMD was higher than spinal BMD. It agrees partially with reports of Jarupanich et al. who found up to ten times higher prevalence of osteoporosis at lumbar spine than at the femoral neck in the postmenopausal women [17]. On the other hand, Heaney et al. showed that age-related areal expansion at the hip may be the reason of lower femoral neck BMD T-scores than spine BMD T-scores [18]. They revealed that when T-scores based on bone mineral content (BMC) rather than areal BMD were used, the mean discordance was not significantly different from zero.

Increased prevalence of major T-scores discordance in the older women, women with longer duration of menopause and women with high BMI is in agreement with the similar studies [7,9,10,19]. As mentioned above, increasing degenerative changes by increasing age and higher BMI could be the main reason for this phenomenon [13, 20]. Rate of BMD loss in the post-menopause stage is faster in the spine (1.8-2.3% per year) than in the hip (1.0-1.4% per year) [21]. This may cause T-score discordance after several years. There was no significant relationship between major T-score discordance and other risk factors including current smoking, history of fracture after age 20 and physical activity. It was not in agreement with another study which showed significant relationship between history of fracture and major T-score discordance [10]. This disagreement is most likely due to difference in the study populations. The participants were included both males and females in all age groups and also patient's with secondary osteoporosis in their study while our participants were only post-menopausal women. However, insufficient physical activity was also recognized as a risk factor for minor discordance in our study. It seems that previous fracture may cause different rate of bone loss in different sites of skeleton. However, this difference is not so large to cause major discordance in the post-menopausal women. Minor discordance generally does not influence the diagnosis or overall prognosis of patients. Follow-up of patients with hip osteopenia and normal BMD of lumbar spine seems to be reasonable [22]. Major T-score discordance could lead to diagnostic inconsistencies among different skeletal sites and low concordance with fragility fracture based diagnosis of osteoporosis [23]. Women who suffer from osteoporosis only at the spine would not have been identified from hip BMD measurement alone, and may have a sufficiently high fracture risk to warrant preventive treatment [24]. The WHO fracture risk assessment tool (FRAX) uses femoral neck BMD to predict hip and major osteoporotic fractures [25]. Lumbar spine measurements are not currently part of the FRAX formulation but are used widely in clinical practice, and this creates confusion when there is spine-hip discordance. Leslie et al. showed that in discordance subgroup with femoral neck and lumbar spine T-score differences greater than 1SD, there was a significant improvement in overall fracture prediction with a hybrid method in which nonvertebral fracture risk was assessed from the femoral neck BMD and clinical vertebral fracture risk was assessed from the lumbar spine BMD [26]. They also suggest a simple arithmetic procedure to conventional FRAX estimates of major osteoporotic fracture probability to modulate the risk assessment with knowledge of BMD at the lumbar spine [27].

This study however, had its limitations as was performed in a referral private center, the assumption of similarity of study population to exact community is not reasonable and the results could not be generalize to Iranian population.

CONCLUSION

Our study demonstrated that many (42%) of the participants had a T-score discordance. but only a minority (2%) had major discordance. The most important risk factors for major discordance were age, menopausal duration and BMI. Major T-score discordance causes some problems for caring physicians in treatment planning regarding these patients.

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