ORIGINAL ARTICLE

FREQUENCY OF DISCORDANCE BETWEEN SPINE AND HIP T-SCORE DETERMINED ON DUAL X-RAY ABSORPTIOMETRY (DXA)

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ABSTRACT

AIMS: Diagnostic discordance for osteoporosis is the observation that T-score of an individual patient varies between skeletal sites, falling into two different diagnostic categories defined by the World Health Organization (WHO) classification system. The principle aim of the study was to examine the frequency of T-score discordance between the hip and lumbar spine using dual energy X-ray absorptiometry (DXA). **METHODS:** This is a cross-sectional study conducted from 14th July 2008 till 14th January 2009 at National Guards Health Affairs Hospital, King Abdulaziz Medical City, Saudi Arabia. BMD images for 692 female patients were searched for various combinations of T-scores reflecting the nine possible discordant and concordant premutations of normal, osteopenia, and osteoporosis. The WHO diagnostic classification system for osteoporosis categorizes patients into three diagnoses----normal, osteopenia, or osteoporosis----based on their T-scores. Concordance was defined as present when the spine and hip T-score placed the patient in the same diagnostic class. Minor discordance was defined as present when the difference between two sites is no more than one WHO diagnostic class. Major discordance was defined as present when one site is osteoporotic and the other site is normal. **RESULTS:** Out of 692 participants (mean age 57.6 ± 9.92 years), major discordance, minor discordance, and concordance of T-scores were seen in 4.5%, 39% and 56.5%, respectively. Most common major discordance observed was osteoporosis of spine and normal hip T-scores while most common minor discordance was osteopenia of spine and normal total hip T-scores. **CONCLUSION:** T-score concordance between the hip and PA L1-L4 spine measurement is the most likely finding, discordance is also a common occurrence. This phenomenon of T-score discordance should be regarded as a real and prevalent finding.

Key words: Dual X-ray absorptiometry; bone mineral density; concordance; discordance; osteoporosis; osteopenia.

Introduction

Osteoporosis is the most common metabolic bone disease in which increased bone fragility predisposes to the occurrence of fracture with minimal trauma.[1] Post-menopausal women are the most common high risk group.[2] Dual energy X-ray absorptiometry (DXA) is the gold standard of measuring bone mineral density (BMD).[3] BMD measured by DXA is statistically expressed as T-score that indicates difference in terms of standard deviation (SDs), between patient's BMD and mean bone mineral density of the sex and race matched normal reference population between ages 20-30.[4-5] Thus, the WHO diagnostic criteria for osteoporosis define osteoporosis in terms of a T-score below - 2.5 and osteopenia when T-score is between - 2.5 and -1.[4-6] (Tab. 1) shows WHO working group's T-score based classification system.

Osteoporosis is a systemic disorder and in most of the cases, BMD at different anatomic regions is correlated, however the rate of bone loss in different anatomical sites could be different.[7-8] Keeping in mind intrasite variation of BMD, T-scores are usually calculated for two standard sites of lumbar vertebrae and femoral neck.[7-8]

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Diagnosis	T-score
Normal	> - 1.0
Osteopenia	< - 1.0, > - 2.5
Osteoporosis	< - 2.5
Severe Osteoporosis	< - 2.5 plus fragility Fractures

Table 1: WHO Osteoporosis Classification System

Discordance in the diagnosis of osteoporosis is defined as presence of different categories of T-score (osteoporosis, osteopenia, and normal) in two skeletal sites of an individual patient.[9] Furthermore, discordance has been classified by degree into either minor or major categories. Minor discordance is defined as being present when the T-score difference between two sites is no more than one WHO diagnostic classification: in other words, when one site is osteopenic whereas the other is osteoporotic, or when one site is normal and the other is osteopenic. Major discordance is defined as being present when one site is normal and the other site is osteoporotic.[10-15]

All instances of discordance have a cause that permits their further classification into several general etiologic types which include physiologic, pathologic, anatomic, artifactual, and technical reasons.[10-12]

Various studies have analysed the prevalence of T-score discordance in the diagnosis of osteoporosis showing almost similar results.[10-14] Few studies have focused on evaluating risk factors and protective factors for this commonly observed phenomenon. The most important risk factors recognized causing major discordance were old age, obesity and menopause.[10,12,14-15]

There is lack of any published data addressing the prevalence of variation of BMD values at different skeletal sites in Saudi Arabian population. Reported BMD measurements in Saudi females are significantly lower than in their Caucasian and American counterparts.[16-17] This may be due in part to increased number of pregnancies and longer duration of lactation together with high incidence of vitamin D deficiency.[18-19] Given this background and considering high incidence of osteoporosis in Saudi Arabia, this study was conducted to assess the frequency of nine possible diagnostic combinations of lumbar spine and hip discordant and concordant T-score values in the local population referred to our centre.

Methods and Materials

This was a retrospective descriptive analytical study and data was recorded from patients hospital charts. A total 692 postmenopausal women and women over the age 50 (mean age, 55.6 yr) were recruited in the study referred by the Endocrinology clinic for bone mineral density evaluation using dual energy X-ray absorptiometry (DXA).

Patients who had undergone laminectomy or hip surgery, recent bone scans and contrast studies and patients with lumbar spine and hip fractures were excluded from the study. Patients with incomplete data were also excluded.

BMD was measured at the lumbar spine and hip with dual X-ray absorptiometry (DXA) using a Lunar Prodigy GE Model SA 1058 X ROI, by a trained operator according to the manufacturer's instructions. BMD (g/cm^2), T-score and Z-score were determined using LUNAR® and NHANES III databases. BMD findings were interpreted based on WHO diagnostic classification by two experienced nuclear physicians with the knowledge of the patient's history as well as clinical findings.

Demographic data, patient's height, weight and densitometric finding were entered into the standardized Performa. The data was searched using SPSS version 15.0 to determine the relative frequency of major and minor discordance and 95% confidence interval was computed for all combinations of discordance and concordance. Concordance, minor discordance and major discordance were observed according to the definition given in the introduction and recorded for the PA L1-L4 spine and hip. (Tab. 2) lists the nine possible diagnostic combinations of normal, osteo-

No Discordance	Minor Discordance	Major Discordance
Normal Spine, Normal Hip	Osteopenia Spine, Normal Hip	
Osteopenia Spine , Osteopenia Hip	Osteopenia Hip, Normal Spine	Normal Spine, Osteoporosis Hip
Osteoporosis Spine, Osteoporosis Hip	Osteopenia Spine, Osteoporosis Hip	Normal Hip, Osteoporosis Spine
	Osteopenia Hip , Osteoporosis Spine	

Table 2: Nine possible diagnostic combinations of normal BMD, Osteopenia and Osteoporosis based on T-score

penia and osteoporosis between two key measurement sites depending on T-score values.

Results

Patients were diagnosed as having normal BMD values, osteopenia and osteoporosis based on WHO T-score classifications system.

Totally, 48 (6.9%) participants were diagnosed in osteoporotic range in the hip area and 121 (17.5%) participants in the lumbar area. Osteopenia that is considered a pre-condition to osteoporosis was noted involving spine in 290 (41.9%) of the participants and effected hip in 260 (37.5%) of the participants (Tab. 3).

Prevalence of Osteoporosis, Osteopenia and Normal BMD						
	Lumbar Spine			Total Hip		
	No.	%	95%Confidence Intervals	No.	%	95%Confidence Intervals
Osteoporosis	121	17.5	14.7-20.3	48	6.9	5.1-8.8
Osteopenia	290	41.9	38.2-45.6	260	37.5	34-41.2
Normal	281	40.6	35.4-42.6	384	55.5	51.8-59.2

Table 3: Prevalence of Osteoporosis, Osteopenia and Normal BMD according to WHO diagnostic criteria

Concordant T-score values between hip and lumbar spine were seen in 391(56.5%) participants. Major discordance was observed in BMD results of 31 (4.5%) participants and minor discordance was observed in 270 (39%) participants as depicted in (Fig. 1).

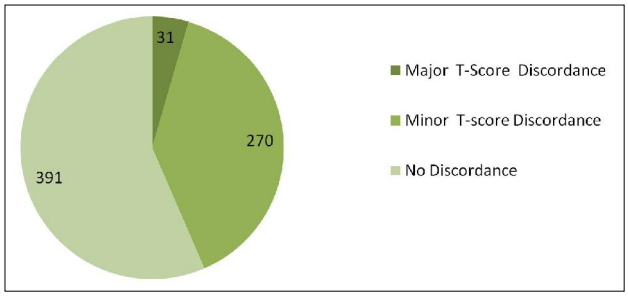

Figure 1: Frequency of T-score discordance and concordance in our study

The most common major discordance observed was osteoporosis of spine and normal hip and the most common minor discordance was osteopenia of the spine and normal hip showing that in both the minor and major category of discordance, lower BMD for lumbar spine was more prevalent. Distribution and pattern of T-score discordances and concordances is depicted in (Tab. 4).

	Frequency	%	95% Confidence Interval
Major Discordance	31	4.5	2.94 - 6.02
Normal Spine and Osteoporosis Hip	2	0.3	- 0.11 - 0.69
Osteoporosis Spine and Normal Hip	29	4.2	2.7 - 5.7
Minor Discordance	270	39.0	35.4 - 42.7
Normal Spine and Osteopenia Hip	57	8.2	6.2 - 10.3
Osteopenia Spine and Normal Hip	133	19.2	16.3 - 22.2
Osteopenia Spine and Osteoporosis Hip	17	2.5	1.3 - 3.6
Osteoporosis Spine and Osteopenia Hip	63	9.1	7.0 - 11.3
No Discordance	391	56.5	52.8 - 60.2
Normal Spine and Normal Hip	222	32.1	28.6 - 35.6
Osteopenia Spine and Osteopenia Hip	140	20.2	17.3 - 23.2
Osteoporosis Spine and Osteoporosis Hip	29	4.2	2.7 - 5.7

Table 4: Distribution of diagnostic discordances and concordances according to WHO criteria

Discussion

This data analysis revealed that, using WHO criteria for definition of osteoporosis and osteopenia, simultaneously measured T-score at the PA L1-L4 spine and total hip showed that most of the post-menopausal women (59.4%) had osteopenia or osteoporosis.

Concordant T-score values between hip and lumbar spine was the most commonly observed finding, however, a significant number of patients showed discordant T-score values, majority of them from minor category.

Minor discordance, present when the PA L1-L4 total spine and total hip BMD values differ by only one WHO diagnostic class, showing slight differences in T-score between two sites, was found in 39% of patients. Major discordance, present when one site is osteoporotic and the other is normal, was observed

in only 4.5% of the participants. The prevalence of both types of discordance observed in our study is in close agreement with the results of the similar studies.[10-13] Derakhshan et al. reported lower frequency of major discordance (1.8%) in comparison to the rest of the published data.[14]

The most common minor discordance observed was "osteopenia of spine and normal hip" followed by the combination of "normal spine and osteopenia of hip". Presence of minor discordance could be due to physiological differences between two sites or minor variations in procedure techniques. Minor discordance generally does not alter the probable course of the disease and therapeutic plan; however, follow up would be advisable to prevent further progression of disease and future risk of fracture.[20]

In our study and the other two studies by Moayyeri et al.[11] and El Maghraoui et al.[12] lower BMD for lumbar spine was more prevalent in both major and minor discordance. Variation in rate of bone loss between different anatomical sites could be the main reason.[21-22] Rapid loss of bone mineral density observed in peri-menopausal and post-menopausal years is predominantly seen involving trabecular bone, and thus the axial skeleton is the primary target.[23-25] Reported rate of bone deprivation in post–menopausal stage is faster (1.8-2.3% per year) in the lumbar spine which is rich in trabecular bone component in comparison to the hip and femur with higher proportion of cortical bone content (1.0-1.4% per year).[26] Secondary osteoporosis (such as glucocorticoid excess, hyperthyroidism, liver disease, and rheumatoid arthritis) also affect spinal column before other skeletal sites.[27-28] In addition, weight bearing can cause rise in bone density especially in the hip and femur regions.[29]

In comparison to our study, Woodson's data analysis[10] showed that when major discordance occurred, the pattern of the osteoporotic hip with the normal spine was about twice as likely an osteoporotic spine with a normal hip. One possible explanation could be falsely elevated BMD values due to pathophysiologic factors (vertebral osteophytosis, end plate sclerosis and compression fractures) which more commonly affect the spine than the hip.[30-31] It is likely that despite the quality control, some data containing these abnormalities were not excluded.

Although this task is beyond the scope of this article to determine the underlying etiological factor contributing to discordant T-score values, some of the features of each of the five causes mentioned for discordance between the spine and the hip sites are discussed herein.

1. Physiologic discordance is due to skeleton's natural adaptive response to mechanical factors. Weight bearing plays a key role in this kind of discordance causing difference in bone density between dominant and non-dominant hip.[22,29] Physiological causes are usually age related and depend on factors effecting growth and development.
2. Pathophysiologic discordance is seen secondary to a disease or due to medication use. Common examples include vertebral osteophytosis, vertebral compression fracture, vertebral end plate and facet sclerosis, osteochondrosis, and aortic calcification.[30-31] Another cause in younger patients is ankylosing spondylosis syndesmophytes.[27,28]
3. Anatomic discordance is owing to the proportion of trabecular and cortical bone components at the site of BMD measurement. An example is the difference in T-scores found for the PA lumbar spine and the supine lateral lumbar spine in the same patient.
4. Artifactual discordance occurs when dense synthetic substances such as metallic objects or barium sulphate are within the field of region of interest.
5. Technical discordance occurs due to improper patient positioning, technician's variability, patient's movement or the hardware or software related errors.[32,33]

Generally, the above mentioned causes provide an explanation for most of the cases of discordance observed in clinical practice. It is important that DXA readers become well familiar with this condition and establish a particular strategy for reporting discordant results. Densitometrists and clinicians should try to look for the underlying aetiology of this phenomenon; however, they should be prepared to accept the fact that they might not always have an obvious explanation for it.

This study however, had its limitations as we could not exclude the possibility of referral bias. Patients referred to us already had high suspicion of having osteoporosis. There is a need to evaluate general

population which will give normative data as well as true prevalence of discordance. Different Technologists operating the same machine might have caused variation in patient positioning and variable ROI for analysis. Morbid obesity is very common in Saudi female population due to sedentary lifestyle and eating habits. Excessive and non-uniform distribution of fat surrounding the bones might lead to errors in evaluation of BMD values.

Considering the high prevalence T-score discordance in our study population, there is a need to further assess the prevalence and association of risk factors for T-score discordance. Evaluation of the clinical and biochemical variables associated with the discordant bone mineral density at various skeletal sites in a larger patient population with longer follow-up designs might help to determine the causes of this skeletal feature.

Conclusion

In summary, our study data showed that 44% of the participants had T-score discordance between lumbar spine and hip measurement sites, majority of them from minor class and only 4.5% had major discordance. Minor discordance generally does not influence the diagnosis or overall prognosis of patients. Major discordance though not very common, can cause problems in interpretation of the densitometry results, effecting diagnosis and therapeutic plan. We recommend using DEXA to measure BMD in both hip and spine and classifying the patient based on the lowest T-score of these measurements.

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