Comparison of Central and Peripheral Bone Mineral Density Measurements in Postmenopausal Women

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Abstract

Objectives: The purpose of the current study was to compare central and peripheral bone mineral density at different regions including spine, hip, and wrist in postmenopausal women.

Methods: Forty postmenopausal women participated in this study. Their mean age, body mass, height, and body mass index were 53.5 ± 2.75 y, 68.6 ± 8.68 kg, 167.8 ± 6.46 cm, and 24.31 ± 1.69 kg/m^2, respectively. Bone mineral density (BMD) *T*-scores of spine, hip, and wrist regions were measured for all participants with a dual-energy X-ray absorptiometry scan.

Results: All measured regions (spine, hip, and wrist) had low BMD *T*-scores. Bone mineral density of the wrist was significantly lower (−2.58 ± 2.18) than that of both spine (−1.79 ± 0.98) and hip (−1.69 ± 1.37). In addition, there were no statistically significant differences in BMD between the spine and hip.

Conclusions: In this group of postmenopausal women, wrist BMD decreased more than spine and hip BMD. Both spine and hip BMD decreased by nearly the same percentage in postmenopausal women. Peripheral sites may be more representative of osteoporosis than central sites. Trial Registration: PACTR201602001478123. (J Chiropr Med 2017;16:199-203)

Key Indexing Terms: *Bone Density; Osteoporosis, Postmenopausal; Postmenopause; Spine; Hip; Wrist*

Introduction

Bone mineral content is the amount of hydroxyapatite relative to the area of bone[1] and is an excellent predictor of fracture risk. Bone mineral density (BMD) is similar to serum cholesterol as a predictor of heart disease and blood pressure as a predictor of stroke.[2] Bone turnover is a dynamic process and is important when considering the management of osteoporosis.[3] Bone turnover involves degradation of the bone matrix by osteoclasts and the formation of new matrix by osteoblasts.[4] Normally, these 2 processes are tightly balanced in a manner ensuring that formation adequately restores resorption.[5] Imbalance between these 2 processes leads to pathologies, such as low bone mass and quality, as seen in osteoporosis.[6]

Osteoporosis is the most common metabolic bone disease[7] and is an increasingly common disease in aging societies. Osteopenia is a condition of decreased BMD and is considered a precursor to osteoporosis. Osteopenia is analogous to prehypertension as it relates to cardiovascular disease.[8] During aging, muscle mass, force, and power and BMD decrease.[9] When BMD decreases, osteoporosis occurs. This problem typically has no signs or symptoms until a fracture occurs so it has often been referred to as a silent condition.[10]

Fractures are associated with osteoporosis, and the hip, spine, forearm, and shoulder are the most common sites.[11] However, the age-adjusted incidence of hip fractures in females is about twice that in males, which has been attributed to greater age-related bone loss. A higher incidence of falls is documented in females.[12,13] A 50-year-old white woman has a 15% to 20% lifetime risk of sustaining a hip fracture associated with long-term morbidity and a 20% to 33% mortality rate 1 year after fracture.[14] Osteoporosis is important to consider when developing a treatment plan such as when considering manual therapies or therapeutic exercise. When applying force to patients with osteoporosis (eg, high-velocity, low-amplitude manipulation), the caution that must be observed depends on the degree of osteoporosis and the fragility of the patient's bones.[15]

Dual-energy X-ray absorptiometry (DEXA) scans of the central skeleton of the hip, spine, and pelvis is used to measure BMD *T*-scores to screen for osteoporosis, predict fracture risk, and determine the need for treatment. Evaluation of the BMD of other sites, like the forearm, calcaneus, and hand (peripheral DEXA), is also recommended. This information may help in predicting the regions most

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susceptible to fracture. Current osteoporosis management guidelines recommend routine BMD screening with the use of DEXA scans.[16] Central DEXA of the lumbar spine and proximal femur is the preferred method for BMD testing.[17,18]

The World Health Organization (WHO)[19] has proposed a diagnostic classification for BMD based on the *T*-scores measured by DEXA scan. The *T*-score is the number of standard deviations above or below the normal mean value of BMD for young adults. The BMD was classified as follows: normal, *T*-score ≥−1; osteopenia, *T*-score between −1 and −2.5; osteoporosis; *T*-score ≤−2.5. Because the widely accepted WHO definition for osteoporosis is based on the BMD *T*-score, this measure must serve as the reference standard against which other BMD modalities are compared and validated.[17] Many researchers have concentrated on assessing BMD via central DEXA scan and did not pay considerable attention to the peripheral sites such as forearm (wrist) and calcaneus. Therefore, the purpose of the current study was to measure both central and peripheral BMD at different regions including lumbar spine, hip (femur), and wrist (distal radius) and to compare the measured outcome among these regions.

Methods

Participants

Forty postmenopausal women from 50 to 60 years of age participated in this study. All participants did not engage in regular sports or athletic activities. They were admitted to El-Haram Hospital, Giza, Egypt, to assess their BMD with DEXA scans. The participants' mean age, body mass, height, and body mass index were 53.5 ± 2.75 y, 68.6 ± 8.68 kg, 167.8 ± 6.46 cm, and 24.31 ± 1.69 kg/m^2, respectively. All participants gave written consent on agreement to participate in the study. The Research Ethics Committee of the Faculty of Physical Therapy, Cairo University, approved this study. The clinical trial registry number is PACTR201602001478123.

Central and Peripheral DEXA Scan

Spine DEXA scan is a central scan starting at L5 and ending at T12. During examination, the patient is asked to assume a supine position on the table, with knees flexed and shins elevated to decrease lumbar lordosis and flatten the spine against the table. The BMD measure is detected for L1–L4 in the posterior-anterior projection, while the X-ray tube is placed behind the patient and the screen over the abdomen. In scanning the proximal femur (hip region), which is a central scan, the leg is abducted and internally rotated. If the femur is not adequately rotated, the femoral neck is foreshortened and falsely increases the BMD. Peripheral DEXA scanning of the forearm (wrist region) is performed with the patient sitting next to the table. The forearm rests on the table and BMD measurements are reported for the ultradistal radius, distal (midradius), and shaft (one-third radius). The ultradistal site contains the highest percentage of trabecular bone in the forearm and, thus, is the region most often used clinically. The one-third radius region also contains entirely cortical bone.[20]

Statistical Analysis

Before starting the study procedures, a power analysis was done to determine the appropriate sample size for the study. A pilot study was conducted on 6 participants to obtain data necessary for calculating the sample size at a significance level of 5% and a test power of 80%. The test revealed that a minimum of 18 participants were required for the study. Because a sample size (n = 40) greater than that predetermined by the power analysis was used, the study achieved a 93% power of significance.

One-way within subject analysis of variance (ANOVA) was conducted to assess if there were any significant differences in mean BMD values among the 3 tested regions. The study included 1 independent variable: tested region with 3 levels (spine, hip, and wrist). Only 1 dependent variable (BMD) was measured. All statistical measures were calculated using the Statistical Package for Social Sciences (SPSS), Version 20 for Windows (IBM, Armonk, New York). The level of significance for all statistical tests was set at $P < .05$.

Results

The results revealed that all measured regions in the postmenopausal women had low BMD *T*-scores based on the normal standard BMD values mentioned in the Introduction. Descriptive statistics (mean ± standard deviation [SD]) for BMD *T*-scores of the spine, hip, and wrist were −1.79 ± 0.98, −1.69 ± 1.37, and −2.58 ± 2.18, respectively. These values indicate that the same women who had spine and hip osteopenia also had wrist osteoporosis. The wrist BMD *T*-score was found to be significantly lower than that of both spine and hip regions ($P < .05$). In addition, there were no statistically significant differences in BMD *T*-scores between the spine and hip ($P > .05$) (Table 1).

Table 1. *Results of Bone Mineral Density T-Scores in the 3 Body Regions Tested*

Body Location	Bone Mineral Density *T*-Score (Mean ± SD)
Spine	−1.79 ± 0.98
Hip	−1.69 ± 1.37
Wrist	−2.58 ± 2.18
	P Value
Spine vs hip	1.000
Spine vs wrist	.009
Hip vs wrist	.000

SD, standard deviation.

Discussion

Early diagnosis and management of osteoporosis are important. The high prevalence and staggering costs of osteoporosis-related fractures in postmenopausal women mean that prevention and management of this disease are very important.[21] New pharmacologic treatments during recent years have encouraged physicians to screen patients at risk of fragile fractures by BMD measurement.[22]

In the current study, the results revealed that postmenopausal women had spine and hip osteopenia and wrist osteoporosis. This reduction in BMD was explained by Baxter-Jones et al,[23] who stated that peak bone mass is reached in the 20s, and from then onward, bone resorption has the upper hand. Additionally, it was reported that postmenopausal women have different BMD responses to treatment, such as exercise, than premenopausal women. Premenopausal women significantly increased their BMD in response to the training exercise, whereas postmenopausal women did not.[24] Snow-Harter et al[25] explained that postmenopausal women require longer periods of intervention and higher loads because they are in a period of accelerated bone loss. The current study results also revealed that osteoporosis is more obvious and, thus, more easily detected in the peripheral regions (wrist) than in the central regions (spine and hip). It was confirmed that wrist osteoporosis and fracture are common among postmenopausal women. It has been observed that women aged <66 years with wrist fracture have considerably low BMD in the hip.[26]

The results of the current study are supported by Eftekhar-Sadat et al,[27] who evaluated the role of wrist BMD in diagnosing osteoporosis in postmenopausal women. BMD measurements revealed osteopenia and osteoporosis in the wrist in 40.4% and 59.6% of participants, in the hip in 38.4% and 24.2% of participants, and in the lumbar spine in 36.4% and 49.5% of participants. There was a positive strong correlation between wrist BMD and hip BMD, whereas there was a weak correlation between wrist BMD and lumbar BMD. Eftekhar-Sadat et al[27] also concluded that wrist BMD has better accuracy than lumbar BMD in diagnosing osteoporosis in postmenopausal women. It was reported that lack of agreement between central and peripheral DEXA is a barrier to recommending peripheral DEXA scan methods.[28,29]

In the same context, Wigderowitz et al[30] examined the extent to which patients with Colles' fractures have osteopenia. They measured BMD in the contralateral radius of 235 women ranging from 21 to 92 years in age presenting with Colles' fractures over a 2-year period. Although women of all ages had low BMD values in the ultradistal radius, the values were particularly low among premenopausal women aged <45 years. They reported that it is very important to examine young patients with fractures of the distal forearm to identify those with osteoporosis to consider treatment.

Rey et al reported a significant correlation between wrist BMD and hip and lumbar BMD.[31] Brownbill and Ilich[32] observed that hand (forearm) BMD is significantly correlated with BMD of all skeletal sites. They concluded that wrist BMD evaluation in postmenopausal women is better than evaluation at other sites in predicting fracture risk. It is reported that at least half of the patients who undergo DEXA exhibit *T*-score discordance between spine and total hip measurement sites.[33,34] This discordance was attributed to the effect of osteophytes that develop secondary to degenerative joint disease of vertebrae, resulting in higher spine BMD in vertebrae with osteophytes.[35]

Other studies have also evaluated the relationship between osteophytes and BMD at other sites, including the hip, and obtained the same finding. Osteophytes could not be differentiated from bone mineral of the vertebrae during evaluation of BMD, and it is possible to overestimate BMD at involved sites. Osteophytes could cause spine BMD misinterpretation; therefore, spine BMD is not a proper marker for evaluating osteoporosis.[36] For this reason, in older women, lumbar BMD should be interpreted with caution. The higher rate of osteoporosis in the wrist in comparison with lumbar sites in our study also supports the possible effect of osteophytes and degenerative change in the lumbar spine on lumbar BMD and its false-negative effects.

Conclusions

This study reports that wrist BMD decreases more than spine and hip BMD, whereas both spine and hip BMD decreased nearly the same percentage in postmenopausal women. Peripheral sites of the body such as the wrist (distal radius) and calcaneus should be assessed for BMD as they may be more representative of osteoporosis than central sites.

Funding Sources and Conflicts of Interest

No funding sources or conflicts of interest were reported for this study.

Contributorship Information

Concept development (provided idea for the research): A.M.A.
Design (planned the methods to generate the results): A.M.A.
Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): A.M.A.
Data collection/processing (responsible for experiments, patient management, organization, or reporting data): A.M.A.

Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): A.M.A.
Literature search (performed the literature search): A.M.A.
Writing (responsible for writing a substantive part of the manuscript): A.M.A.
Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): A.M.A.

Practical Applications

- Peripheral sites of the body, such as the wrist (distal radius) and calcaneus, are more representative of osteoporosis than central sites.
- When these sites are assessed for osteoporosis and not neglected, management and therapy can be administered early.
- This, in turn, eliminates fracture risk for all body sites.

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