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Assessment of bone mineral density with dual energy X-ray absorptiometry in pre- and post-menopausal women

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Background: Osteoporosis is a chronic disease that contributes substantially to decrease physical activity and decline in the quality of life. Osteoporosis can be diagnosed easily with the use of dual-energy X-ray absorptiometry (DXA) equipment. The aim of this study was to investigate the magnitude of bone loss on proximal femur and lumbar spine LS in pre- and post-menopausal women from Isfahan Osteoporosis Diagnosis Center (IODC) since 2005. ***Materials and Methods:*** Bone mineral density (BMD) measurements using DXA have been performed at IODC. 185 pre-menopausal and 174 early post-menopausal women were selected randomly. A Norland XR46 system was used for the investigations. The student *t-test* was done to find the difference between the T-scores of the femoral neck (FN) and lumbar spine (LS) in pre- and post-menopausal women. ***Results:*** Mean BMDs for the FN and LS in pre-menopausal women were 0.859 ± 0.136 and 1.012 ± 0.161 and in post-menopausal women were 0.816 ± 0.119 and 0.919 ± 0.140, respectively. Long-term BMD CVs of 1.0% and 1.2% for the LS and FN were found, respectively. The differences between the FN and LS for pre- and post-menopausal women were $t = -9.02$, $p < 0.05$ and $t = -3.50$, $p < 0.05$, respectively. ***Conclusion:*** In spite of, the reported lower BMD T-scores for the LS compared with the FN for women, we found that the FN had significantly lower T-score than LS for both pre- and post-menopausal women. **Iran. J. Radiat. Res., 2008; 6 (2): 103-107**

Keywords: *BMD, osteoporosis, proximal femur, lumbar spine, DXA.*

INTRODUCTION

Osteoporosis is an important health problem characterized by low BMD and a reduction in bone strength[1]. The definition of osteoporosis by the World Health Organization (WHO) is a BMD that is 2.5 standard deviation (SD) or more below the mean of a young normal reference population [2]. This definition offers the practitioner an objective standard by which to make a diagnosis and to make subsequent management decisions.

Bone loss may start before menopause. Serum follicle-stimulating hormone levels (FSH) raise prior to menopause [3-5] and bone turn over markers activity appears to correspond with this raise in FSH [6].

Osteoporosis causes no symptoms until a fracture occurs. Osteoporosis or low BMD is estimated to occur in about 44 million American men and women, accounting for 55% of the population age 50 and over [7].

BMD measurement is widely used for diagnosis of osteoporosis and determination of its severity [8-14]. The Surgeon General's "Report on Bone Health and Osteoporosis" [15], and the National Osteoporosis Foundation's (NOF) "Physician's Guide to Prevention and Treatment of Osteoporosis" [16] identify osteoporosis as a major public health concern, and emphasize the importance of using BMD testing as a clinical tool to diagnose patients at high risk of fracture before the first fracture occurs. Low BMD is an important risk factor for osteoporosis and its related fractures [17]. DXA instruments are widely available and have the capacity

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of multi-site measurements mainly of the spine, hip and forearm [18]. DXA is the preferred method for the diagnosis of osteoporosis and monitoring BMD changes over time [19]. Precision and accuracy of DXA are excellent [20] and radiation exposure with DXA is very low [21].

The aim of this study was to investigate the magnitude of bone loss on FN and LS in pre- and post-menopausal women referred to the IODC to identify local reference values from two groups of Iranian women living in Isfahan.

MATERIALS AND METHODS

Bone mineral absorbs much more radiation than soft tissue. The amount of X -ray energy which was absorbed by bone mineral calcium in one section determined the measured bone mineral content (BMC). BMC was divided by the area or volume of the bone estimates BMD. Machine calibration was performed daily using a phantom provided by the manufacturer. The scanner calibration was also done routinely. The long-term reproducibility (coefficient of variation, CV) of the DXA scanner for BMD measurements during the study period was assessed, using the phantom provided by the manufacturer. Heights and weights were measured before the scans were taken.

The BMD of LS, left FN and trochanter was determined using the DXA (Norland XR 46, USA). Specially trained personnel carried out the measurements at IODC.

Data were generated from 185 pre-menopausal and 174 early post-menopausal women, who were randomly selected. The women had no known history of any diseases and were not on hormone replacement therapy (HRT), or any medication which could have affected BMD. Each woman was scanned by an expert technician, and BMDs were determined for the LS and proximal femur, which included the FN and the trochanter.

For this study, the following groups were successively excluded:

- Hysterectomized women (for whom it was not possible to define menopausal status) and bilaterally ovariectomized women.
- Women who had used HRT either before or after menopause.
- Women with diseases or medications known to affect bone metabolism, as described by Kröger [22].

The most common way of interpreting BMD is to adopt the WHO definition for osteoporosis, based on BMD T-Score. BMD T-Score measures how a subject's BMD value compares to those of a typical young normal subject, defined in terms of the standard deviation (SD) of young, normal subjects. The WHO classification of BMD into categories of normal (T-score>-1), osteopenia (-1<T-score<-2.5), osteoporosis (T-score<-2.5), and severe osteoporosis (T-score<-2.5 with a fragility fracture) have widely been used since their introduction in 1994 [23]. This classification has been based on the T-score, which is calculated according to the following equation, with BMD values expressed as g/cm^2.

$$\text{T - score} = \frac{(\text{Subject's BMD value - Mean young normal BMD value})}{(1\,\text{SD young normal BMD})}$$

In order to find the significance of difference between the T-scores of the FN and LS in pre and postmenopausal is significant, the student t-test was performed. Data were analyzed with SPSS software (version 15) at the 0.05 significant level.

RESULTS

Tables 1 and 2 show the details of the pre and early postmenopausal women, respectively. The long-term reproducibility of the DXA instrument for BMD during the study period, as determined by regular phantom measurements, was 1.0% and 1.2% for the LS and FN, respectively.

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BMDs and T-scores of the spine and various proximal femur regions of the studied women are shown in tables 3 and 4. At the 0.05 level, the differences between the FN and LS for both pre- and post-menopausal women were $t = -9.02$, $p < 0.05$ and $t = -3.50$, $p < 0.05$, respectively. The FN had significantly lower mean T-score.

DISCUSSION

The purpose of this study has been to identify local reference values from two groups of Iranian women living in Isfahan, in order to compare the obtained results with those of other countries. As it can be shown perceived by previous investigations in different countries (such as: USA [24], Europe [25-27] and Arab countries [28-31]), FN T-scores has been higher than the LS T-scores for all the mentioned nations, except the studied subjects in Isfahan. In contrast to the previous findings, a significant difference was found between the LS and FN BMD T-scores; i.e., a significantly lower BMD T-score for FN was found in comparison with for both pre- and post-menopausal women. This might have been due to physiological, life-style, poor calcium, and low activity factors. In a study carried out in Isfahan, two groups of female athletes, footsal players and female non-athletes were compared for the BMD of lower body and upper body. The athletes had significantly higher FN BMD T-score (0.664 SD) comparing with the non-athlete volunteers T-score (-1.154 SD). The athletes also had a significantly higher vertebral body BMD T-score (0.384 SD) in comparison with the non-athletes vertebral body (-0.090 SD). The footsal players had significantly higher FN T-score (0.664 SD) comparing with their vertebral body (0.384 SD). However, the non-athlete women had

Table 1. Details of pre-menopausal women, n=185.

Age (y)	37.2±7.8 (23-40)
Height (m)	1.57±0.056 (1.40-1.74)
Weight (kg)	70.0±11.3 (45-115)
BMI* (kg/m^2)	28.4±4.4 (18.9-43.3)

*Body Mass Index. Results are mean ± SD (Range).

Table 2. Details of post-menopausal women, n=174.

Age (y)	51.8±4.5 (40-60)
Height (m)	1.56±0.057 (1.42-1.75)
Weight (kg)	65.8±5.5 (57-81)
BMI* (kg/m^2)	27.0±1.8 (21.3-30)

*Body Mass Index. Results are mean ± SD (Range).

Table 3. BMDs and T-scores of the (L_2-L_4) and proximal femur regions in pre-menopausal women.

Region	BMD (g/cm^2)	T-score (SD)
L_2-L_4	1.012 ± 0.161 (0.653- 1.387)	-0.551 ± 0.99 (-2.770- 1.759)
FN	0.859 ± 0.136 (0.538 - 1.236)	-1.09 ± 1.17 (-3.832 - 2.129)
Trochanter	0.690 ± 0.115 (0.386 - 0.999)	-0.885±1.051 (-3.675- 1.948)

Results are mean ± SD (Range).

Table 4. BMDs and T-scores of the (L_2-L_4) and proximal femur regions in post-menopausal women.

Region	BMD (g/cm^2)	T-score (SD)
L_2-L_4	0.919 ± 0.140 (0.555 - 1.403)	-1.13 ± 0.919 (-3.36 - 0.84)
FN	0.816 ± 0.119 (0.478 - 1.142)	-1.46 ± 1.01 (-4.35 - 1.32)
Trochanter	0.636 ± 0.097 (0.342 - 0.894)	-1.39 ± 0.892 (-4.09 - 0.97)

Results are mean ± SD (Range).

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significantly lower FN T-score compared to their vertebral body [32]. The results for these athletes had shown significantly higher BMDs for the LS and FN compared to non-athletes women (tables 3 and 4). Foods are not fortified with vitamin D in Iran [33, 34]. A recent nationwide study with random sampling from five major cities in Iran reported a high prevalence (about 80%) for vitamin D deficiency in Iranian population [35]. Other studies have confirmed this finding [36]. Therefore, further researches are required to determine the reason(s).

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