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The cut-off point of dual energy X- ray and laser (DXL) of calcaneus osteoporosis diagnosis in postmenopausal women

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Background: Dual X-Ray Absorptiometry (DXA) is a method which can extensively be used for bone mineral densitometry (BMD). Another more recent method is DXL, which associate with dual X ray absorptiometry, assisted by laser measure heel thickness. In this study the cut off points for DXL of calcaneus in the diagnosis of osteoporosis in different bone regions in postmenopausal women had been determined. ***Materials and Methods:*** In 268 postmenopausal women, BMD of the spinal and femoral regions was measured by DXA, and the value for the calcaneous was measured by DXL. The agreement of the two methods in the diagnosis of osteoporosis and optimal cut-off point for DXL in defining osteoporosis was obtained. What obtained was the agreement of the two methods in the diagnosis of osteoporosis, as well as the optimal cut-off point for DXL in defining osteoporosis. ***Results:*** DXA showed osteoporosis in 40.7% of cases with 35.2% in L2-L4, 16.2% in the femoral neck, and 11.7% for the femoral total region. The DXL found osteoporosis, considering -2.5 SD as a threshold, in 26.1% of cases. Agreement of the two methods in the diagnosis of osteoporosis (Kappa score) was 0.443 for the lumbar region, 0.464 for the neck, and, 0.421 for total femur regions (all P values were significant). Using Receiver Operating Characteristic (ROC) curves, it was found that a T-score of -2.1, -2.6 and -2.4 as the optimal cut-off point of DXL in the diagnosis of osteoporosis in the lumbar spine, the neck and total region of femur, respectively. ***Conclusion:*** The results of this study showed a moderate agreement between the two methods in the diagnosis of osteoporosis. It seems that the DXL cannot be used as a substitute for the DXA method, but it can be used as a screening method to find (to diagnose) osteoporosis. **Iran. J. Radiat. Res., 2005; 3 (2): 69-72**

Keywords: *Dual energy X- ray and laser (DXL), calcaneus, dual X-ray absorptiometry (DXA), osteoporosis.*

INTRODUCTION

Osteoporosis has been defined as "a disease characterized by low bone mass and microarchitectural deterioration of the bone tissue leading to increased bone fragility and a consequent increase in fracture risk". WHO has defined osteoporosis as a disorder in which the bone mineral density of the spine or the hip region is lower than 2.5 SD below the mean peak value in young adults. Osteoporosis, whether primary or secondary, causes increased susceptibility of the bone to fractures.

The mortality rate in elderly patients with hip fracture is about 20%. Half of the cases are permanently disabled[1]. Early detection of those at highest risk of osteoporotic fractures is of clinical relevance to prevent such fractures and their potential consequences for both patients and the health care system[2].

DXA, which measures BMD as an absolute value (gm/cm2), is the gold standard for the diagnosis of osteoporosis and the prediction of fractures[3-5]. DXA of the axial skeleton is the most widely used, but some studies have shown that BMD in the peripheral sites, such as the calcaneus and the radius, can also be used to assess fracture risk, with similar predictive power at hip and spine[6, 7].

The calcaneus consists of more than 90% trabecular bone, and trabecular bone has a high turnover rate[6]. Wasnich suggested calcaneus as the best peripheral site for risk prediction of future spine and appendicular fractures in a group of postmenopausal women (mean age 64 years)[8]. The peripheral

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DXA method developed by Kullenberg is called the dual X-ray and laser (DXL) technique[9]. It uses two X-ray energies in combination with laser (L in DXL) measurements of the bone mass and thickness of the heel in order to determine the bone mineral, the lean tissue and the adipose tissue more accurately. The photon attenuation by soft tissues is determined by combining DXA and heel thickness measurements. Doing so, errors of the traditional DXA technology are reduced. It has generally lower cost, more compact size, shorter scanning time, and lower radiation; therefore, it can be used more easily and widely anywhere in the world to diagnosis low bone mass[9].

There have been few studies on the agreement of the axial DXA and the DXL of the calcaneus in the diagnosis of osteoporosis; however, one study has shown the sensitivity and specificity for the lumbar spine, for a T score of −2.5, to be 21.8 % and 96.5 % respectively[10].

The sensitivity for a T score of −2.5 in the diagnosis of osteoporosis in neck and total regions of the femur was 36.4 % and 58.8% respectively, and it was specificity the same in the two aforementioned regions, and was equal to 97%[10]. Another study has shown the DXL sensitivity and specificity for diagnosis of osteoporosis in axial region to be 80% and 82% respectively[11]. In another study, Salminen has concluded that the influence of the reference populations on the T scores is substantial when different DXA methods are being compared; the total number of subjects classified as osteoporotic varied from 7% to 53% between the sites and with different reference populations [12].

Therefore, this study was planned to find the cut off point of this method for osteoporosis diagnosis in an Iranian population. Therefore, the method can be applied extensively for the assessment of bone density in different conditions and regions.

MATERIALS AND METHODS

A total number of 268 postmenopausal women, referred to BMD Center in Karaj, Iran, for routine examination, were volunteered to take part in the study.

Inclusion criteria: All of the subjects who have became menopause were included in the study consecutively. All the patients had been referred to the aforementioned clinics are checked by specialists.

Exclusion criteria: All patients who had any defect in heel area as ulcer or had amputation. Patients with a very low BMD (lower than −4SD), a sever osteoporosis (osteoporosis with a fragility fracture) and those otherwise declining to take part in the trial were excluded from the study.

DXA and DXL

DXA measurements of the lumbar spine and left hip were performed using a Lunar DPX-MD+ densitometer (GE, Lunar Corp, Madison, WI). DXA BMD values were shown as T scores for NHANES III reference population. DXL Calscan is a device from "Demetech" factory. All the tests were carried out by skillful operators.

Statistical Analysis

The T-score values were used as the basis of the analysis. Osteoporosis and osteopenia were diagnosed according to the WHO standards and criteria (osteoporosis: T-score<−2.5, osteopenia: T-score<−1 and >−2.5, normal: T-score>−1) for DXA and considering −2.5 SD as a threshold for DXLz[11]. SPSS version 11.5 was used for the statistical analysis.

The T-score values were obtained for lumbar spine, femoral neck and total region of the hip measurements with the NHANES III reference population. Events and non-events were defined by the DXA T-scores: osteoporosis cases were defined as 'events' and the 'nonevents' were the normal or osteopenia cases.

Kappa score is an index for the comparison of agreement of the two methods in the diagnosis of events (e.g. osteoporosis here) and non-detection of a nonevent (e.g. osteopenia or normal, here).

ROC curve was drawn for DXL T-score. The points on the fit curve closest to the left upper corner were defined as cut-off points for the diagnosis of osteoporosis and osteopenia, or otherwise normal. By applying the acquired cut-off point, the sensitivity and specificity of the DXL T-score in diagnosing

osteoporosis, and also the way to rule out the normal cases were assessed

RESULTS

The mean age of the participants was 59.4±8.37 years. The mean age of menopause and number of years since menopause were 47.2 ± 5.8 and 12.2 ± 9.1 respectively. Osteoporosis was found in 40.7% of cases with the DXA method (35.2% in the L2-L4 region, and 16.2% and 11.7% in the neck and total regions of femur respectively), and in 33.2% of cases with the DXL method.

The agreement of the two methods in the diagnosis of osteoporosis (Kappa score) was 0.443 (P-value<0.01) for the lumbar region, 0.464 (P-value<0.01), 0.421(P-value<0.01) for the neck and total regions of femur, respectively. According to a descriptive measure, the correlation of the two methods was defined as moderate.

Using ROC curves, a T-score = −2.1 SD was found to be the optimum cut-off point of the DXL in the diagnosis of osteoporosis in the lumbar spine, sensitivity and specificity were 82% and 79% respectively. The optimal cut-off point of the DXL in the diagnosis of osteoporosis in the neck region of femur was a T-score of −2.6 SD (sensitivity and specificity values were 85 % and 86% respectively). Also, a T-score of −2.4 SD was found to be the optimum cut-off point for DXL in the diagnosis of osteoporosis in the total region of femur (sensitivity and specificity being 100% and 74% respectively). The area under the curve for the spine, neck, and total regions were 0.808 (P value <0.0001), 0.926 (P value <0.0001), and 0.946 (P value <0.0001) respectively (figures 1, 2, 3).

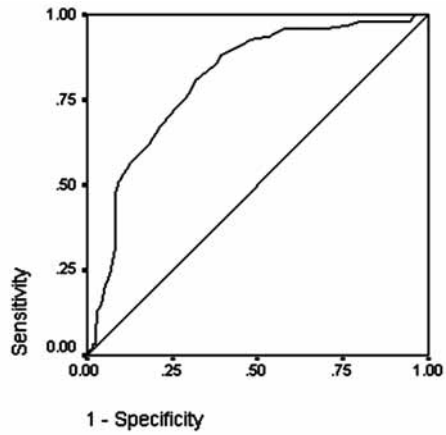

Figure 1. Roc curve (DXL and lumbar spine) T- score of -2.1 SD shows 82% sensitivity and 79% specificity.

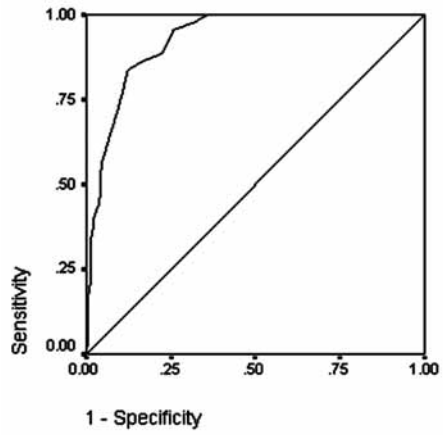

Figure 2. Roc curve (DXL and femoral neck) T score of -2.6 SD shows 85% sensitivity and 86% specificity.

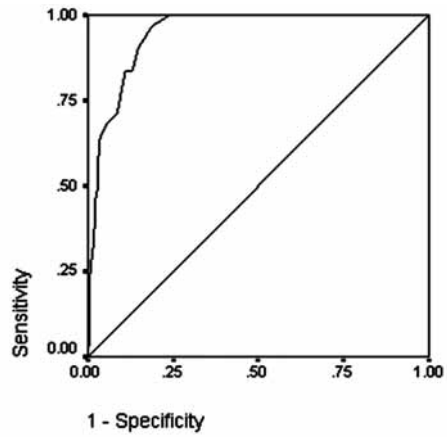

Figure 3. Roc curve (DXL and total hip) T- score of -2.4SD shows 100% sensitivity and 74% specificity.

DISCUSSION

Over time, axial DXA has come to be an established valuable method and gold standard for the measurement of BMD. A cut-off value of −2.5 SD below the average for the healthy young control group is valid at any site provided the measurements at that site identify approximately well with the same proportion of adult women having osteoporosis (also with the lifetime risk of fracture at the hip, spine, or forearm) as defined by WHO.

However, it seems that other factors (other than bone mineral density) such as bone metabolism are also important in bone

fragility. Trabecular bones are good sites for assessing the bone metabolic state, and its subsequent effect on bone fragility, due to their high metabolism. Studies showed that the calcaneus was a good site for the prediction of lumbar spine fractures.

Our study showed a moderate agreement between DXA and DXL findings in the diagnosis of osteoporosis in postmenopausal women. We know femoral bone is more cortical bone than spine; therefore, a moderate agreement between the two methods in this region is acceptable. The spinal region is mostly a trabecular bone region; so, agreement between the two methods at this site is far better than that of the total femoral region. However, there are some factors such as age and degenerative joint disease which are prevalent in postmenopausal women affecting the lumbar spine. These are not very effective in calcaneal bone, and need to be taken into account. Also, the differences can arise from the differing parameters that two devices measure, as well as the different populations who are tested as reference groups in the measurements. As shown before, the DXL T-scores for osteoporosis diagnosis in the lumbar, neck and total femoral region were found to be −2.1, −2.6, and −2.4 SD, respectively.

This study has proved a moderate agreement between the two methods of diagnosis of osteoporosis, and it is supposed that a lower threshold (−2.1 SD) used for osteoporosis diagnosis by DXL. It followed that DXL cannot be used entirely as a substitute for DXA method, but it fares fairs well as a screening method for finding osteoporosis.

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