

Comparative study of the density of L₂, L₃, and L₄ vertebrae in menopausal women aged over 50 years with osteoporosis

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ABSTRACT

Background: The Index used for osteoporosis detection was BMD measured in L₂, L₃, and L₄ vertebrae. We compared the density of the vertebrae to select the one with maximum change in the density for decreasing the cost and the time. **Methods and Materials:** Ninety seven osteoporotic post-menopausal women with a mean age of 61.78 ± 8.48 (50 - 86) years and a mean body mass index (BMI) of 24.75 ± 2.66 (kg/m²) (18 - 30) without any known diseases and on any medication affecting bone mineral density (BMD) were examined at osteoporosis section of a teaching hospital. The vertebral bodies (L₂-L₄) of participants were measured by using a dual energy X-ray absorptiometry system (DEXA). To investigate if the BMD measurement of a single vertebra could replace the total L₂-L₄ measurement, the mean BMDs and the correlations of the L₂-L₄ were compared. **Results:** Among the 97 studied women, the mean BMI was 24.75 ± 2.66 . The mean BMD of L₂, L₃, and L₄ vertebrae were 0.7199, 0.7258, and 0.7402, respectively. There was no significant difference between the mean BMD of L₂ and L₃ vertebrae ($P > 0.05$), suggesting a strong relationship between L₂ and L₃. The mean BMD in the L₄ vertebra was significantly higher than the other two vertebrae ($P < 0.05$). Statistical analysis showed that the BMD in all three L₂, L₃, and L₄ vertebrae were associated with BMI ($r > 0$ and $P < 0.05$), but there was no significant relationship between BMD and age in the three L₂, L₃, and L₄ vertebrae ($r \approx 0$ and $P > 0.05$). **Conclusion:** Since the mean BMDs of L₂ and L₃ were not significantly different, and due to a very high correlation between L₂ and L₃, we recommend the measurement of L₂ rather than L₂-L₄ in order to save patient scanning time, cost, and the patient X-ray exposure.

Key words: Bone mineral density test, dual energy X-ray absorptiometry (DEXA), menopause, osteoporosis, quantitative computed tomography

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INTRODUCTION

Osteoporosis is the most common metabolic bone disease. Today, it is known as a public health problem, and its importance will increase day-by-day by increasing the mean age of the society population. This disease is common in women after menopause, but it also occurs in the men and women with underlying conditions or risk factors associated with reduced bone mineral.^[1] World Health Organization (WHO) announced osteoporosis along with cancer, heart attack, and stroke as the 4 main enemies of human health in 1991.^[1] Osteoporosis is the silent epidemic in modern times, because it has no clinical symptoms and will progress if not

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prevented and left untreated. Osteoporosis shows itself at first with the side-effects (bone fractures and even sometimes death).^[2] However, today this debilitating disease could be prevented and treated in early detection. Post-menopausal osteoporosis is defined with BMD below 2.5 and standard deviation of the mean BMD value of the young age. Severe osteoporosis is defined with the same threshold too, but the individual must have a history of traumatic fracture of a bone or two (fragility fracture). With the above definition, approximately 15-20% of women will have osteoporosis.^[3] At the time of conducting this research, a similar study was not available, which was in line with the objective of this study. However, there were some studies with different methods of measuring the BMD, and the locations and sites that were measured as follows:

Different methods in assessment

Bone loss in older women has been shown in many studies, but the importance of this loss of bone density (bone loss) is being discussed in pre-menopausal and may be related to bone area.^[4,5] The underlying osteoporosis occurs immediately after menopause^[4] and also increases with age.^[6] However, the amount of the variation with age-related variance in BMD in adults is based on the location of the measurement and the used technique.^[7-9] The intermediate changes between these 2 cases were seen in the bone loss of forearm DEXA and anterior posterior spine and hip. For example, at the age of 80 years, the average of T-score for lateral DEXA at the spine is -5 SD. Anyhow, it is -2 SD for some of the devices, which measure with an ultrasound of the heel.^[10] In a case - control study, in individuals with and without fractures, the sensitivity of different techniques were different. To diagnose the patients with fractures more than 4 times with a detection threshold of -2.5 SD,^[11] and for expressing a golden standard for location and measurement technology for diagnostic purposes, it should be noted that none of the techniques or the measurement sites respond to all of our demands for densitometry. However, if we choose to measure a location in the skeleton for purposes of diagnosis and prediction of the fracture risk, total hip and femoral neck are good candidates. Hip measurement has high predictive values for hip fracture. Several studies have shown that BMD measurement of femoral neck would be the best reflection for trochanter fracture, but total hip is the best prediction reflection for any type of hip fracture.^[12,13] Using the spinal BMD to predict fracture risk of any type (in other words, the fractures anywhere in the skeleton) can be good or even better than hip BMD. In the years before menopause that the risk of hip fracture is low, in older ages, sensing the spine that is also associated with osteoarthritis arthritis is confusing. While this disease in this age is very rare in the pelvis.^[14,15] Based on the criteria of WHO, currently, the best technology in the measurement of BMD is DEXA. Evidence suggests that the T-score must remain for hip DEXA. Finally, due to this fact that the scans of the spine for the vertebrae of L₂ - L₄ is the routine method for evaluation of osteoporosis, the purpose of this study was to evaluate the point between the vertebrae that which one of the vertebrae is more indicative of osteoporosis.

MATERIALS AND METHODS

The study population comprised menopausal women with osteoporosis who were older than 50 years. They were referred for the diagnosis of osteoporosis to Sayed-al-Shohada Hospital, a teaching hospital of Isfahan University of Medical Sciences. The inclusion criteria were the menopausal women over 50 years with osteoporosis. The exclusion criteria were chronic renal and/or liver failure, thyrotoxicosis, hyperparathyroid, hypogonadism, diabetes, gastrointestinal diseases (sidosis, malabsorption syndrome), malignancy, hemolytic anemia, corticosteroid therapy, chemical therapy, use of drugs such as anti-coagulant drugs, anti-convulsants, levothyroxine, pregnancy, lactation and immobilization, rheumatic disorders such as rheumatoid arthritis and ankylosing spondylitis, BMI above 30 and/or below 18 kg/m², the history of fracture, smoking, endocrine disorders as Cushing's syndrome, adrenal insufficiency, and or acromegaly, hormone replacement therapy (HRT).

Method of sampling

This study was conducted on 97 menopause women over 50 years who were referred for evaluation of bone density to diagnose osteoporosis, and their data were recorded in the collection form specified the osteoporosis of hip or vertebral column (convenient sampling method is used). These patients should not have tested treatments with specified drugs and diseases mentioned in the exclusion criteria. These 2 cases were performed by the complete history taking and thorough examination before entering the study. Then, the bone mineral density (BMD) of the specified areas (hip and spine, including vertebrae L₂, L₃, and L₄) was calculated by DEXA device. The collected information was recorded in the desired form. The number of samples to achieve the 95% confidence level was obtained as 86 patients, but the study was conducted on 97 subjects. Data was collected using questionnaires and measuring DEXAs device that was conducted on patients (attached questionnaire). The data were analyzed using the statistical software of SPSS and ANOVA method with repeated observations. The test of "analysis of variance with repeated observations" was used for comparing the mean density of L₂, L₃, and L₄.

RESULTS

In this study, 97 women over 50 years were studied with the mean age of 61.8 ± 8.5. The minimum and maximum observed ages were 50 and 86 years, respectively. Forty (41.23%) of patients aged 50-59 years, 38 patients (39.27%) aged 60-69 years, 16 patients (16.59%) aged 79-70 years, and 3 subjects (3.1%) were aged over 80 years.

Among the women of over 50 years, the lowest BMI was 18 and the highest was 30. The mean BMI was 24.75 with a standard deviation of 2.66, respectively.

Descriptive information of BMD in the vertebrae of L₂, L₃, and L₄: The mean BMD of L₂, L₃, and L₄ vertebrae were calculated

as 0.7199, 0.7258, and 0.7402, respectively. According to the test of “analysis of variance with repeated observations,” there was no significant difference between the mean BMD of L₂ and L₃ vertebrae ($P > 0.05$). However, the mean BMD in the L₄ vertebra was significantly higher than the other two vertebrae ($P < 0.05$) [Table 1].

In 54 cases (55.7%), the patients were only suffering from osteoporosis with hip, 37 patients had only spinal osteoporosis, and 6 patients (6.2%) were suffering from osteoporosis in both parts.

Pearson correlation test showed that the BMD of L₂, L₃, and L₄ vertebrae are associated with each other ($r > 0$ and $P < 0.05$) [Table 2].

It is also showed that the BMD in all three L₂, L₃, and L₄ vertebrae were associated with BMI ($r > 0$ and $P < 0.05$), but there was no significant relationship between BMD and age in the three L₂, L₃ and L₄ vertebrae ($r \cong 0$ and $P > 0.05$) [Table 3].

DISCUSSION

The main objective of this study was to compare the mean BMD of L₂, L₃, and L₄ vertebrae in menopausal women over 50 years with osteoporosis, respectively. In this study, the mean BMD in the L₂ and L₃ vertebrae showed no significant difference,

Table 1: Mean BMD in the L₂, L₃, and L₄ vertebrae (gr/cm²)

Mean	SD	Mean	Max	Min	Number of vertebrae
0.7199	0.1274	0.7199	1.0400	0.3758	L ₂
0.7258	0.1255	0.7258	1.0760	0.4194	L ₃
0.7402	0.1377	0.7402	1.0730	0.3794	L ₄

BMD=Bone mineral density, SD=Standard deviation

Table 2: Correlation coefficients between the BMD of the vertebrae (L₂, L₃, and L₄)

Vertebra	L ₂	L ₃	L ₄
r=L ₂	-	0.884	0.766
P value		0	0
r=L ₃	0.884	-	0.797
P value	0		0
r=L ₄	0.766	0.797	-
P value	0	0	

BMD=Bone mineral density

Table 3: Correlation coefficients between BMD of vertebrae with age and BMI

Vertebrae	Age	BMI
r=L ₂	0.09	0.302
P value	0.371	0.003
r=L ₃	0.08	0.294
P value	0.449	0.004
r=L ₄	0.09	0.246
P value	0.392	0.01

BMD=Bone mineral density, BMI=Body mass index

but the mean BMD in the L₄ vertebra was significantly higher than the other two vertebrae. Osteoporosis is the most common metabolic bone disease that is known as a public health problem today.^[16] Its importance will increase day-by-day, and it is more common in women after menopause. It has no clinical signs until a fracture occurs. Therefore, early detection of osteoporosis before the stabilization is very important. With early detection of bone loss in women who are in the early stages and still have not been fractured, early treatment may also be effective.^[17] Among the BMD measurement methods for diagnosis of osteoporosis, DEXA is the most reliable detection method.^[17,18] Much time and costs is spent in order to measure the BMD of L₂, L₃, and L₄ vertebrae by the DEXA, and more radiation reaches the patient. According to the results of this study, the mean BMD in the L₄ vertebra was significantly higher than the mean BMD in the L₂ and L₃ vertebrae. There was no significant difference between the mean BMD of L₂ and L₃ vertebrae. Considering all three vertebrae for osteoporosis detection may reduce precision of diagnosis. Hence, it is suggested to measure BMD of either L2 or L3 as an indication of osteoporosis diseased.

There is no same reported study in the literature to compare with this study. The only one I have found is the study by Ryan *et al.* (1994).^[19] They have found significant difference between BMD of L1 and L4 in both normal and osteoporotic women. The mean BMD for L1 to L4 in normal women were 0.841 to 1.017 g/cm² and in osteoporotic women were 0.562 to 0.709 g/cm². From their study, they conclude that L1 and L2 are more sensitive indicator of osteoporosis, which is in confirm with the present study.

CONCLUSION

Based on the results of this study, it can be stated that for the diagnosis of osteoporosis by DEXA, the BMD of L₂ or L₃ vertebrae can only be used because the BMD of L₄ vertebra will be higher than the other mentioned two vertebrae. However, there was no significant difference between the BMD of L₂ and L₃ vertebrae, and the BMD of these two is less than the L₄ vertebra BMD. By this way, less time and cost will be spending and less radiation reaches the patient. Scanning L₂ as a region of interest will shorten the scanning time and the patient dose.

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