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Research Article

Bone Mineral Density and Trabecular Bone Score in Postmenopausal Women with Lumbar Spine Osteoporosis

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Abstract

Background: Spine osteoporosis is a common case in postmenopausal women. Trabecular Bone Score (TBS) is a specific bone texture extent that can be extracted from DEXA images and will be support data in raising trabecular bone condition for this sample of people. ***Objective***: To determine the association between BMD and TBS values in spine osteoporosis in postmenopausal women. ***Methods***: Spine BMD and TBS were conducted for 348 postmenopausal women; the participation samples were divided into three groups (116 each). Group 1 represents women with severe spine osteoporosis; group 2 represents osteoporotic women with moderate spine osteoporosis; and group 3 represents healthy postmenopausal women matched for age with others. ***Results***: The preponderance of the patients had partially degraded (-9.72) and highly degraded microarchitecture (-14.36) in TBS. The BMD (0.792 and 0.829) significantly decreased and adjusted TBS values (1.27 and 1.33) in cases groups compared with control respectively. A significant diminution was found in group case 1 (-3.7) and case group 2 (-2.6) in T-score compared to healthy spine density. ***Conclusions***: When menopausal women have low BMD in the lumbar-sacral spine and low TBS values, this indicates that osteoporosis has a low crest mass in the bone. TBS was also shown to be strongly linked with decreasing bone density in the lower back region, indicating a favorable relationship between this indicator and decreased bone mass in postmenopausal women.

Keywords: Bone mineral density, Lumbar spine, Osteoporosis, Postmenopausal women, Trabecular bone score.

كثافة المعادن في العظام ودرجة العظام التربيقية لدى النساء بعد انقطاع الطمث المصابات بهشاشة العظام في العمود الفقري القطني

الخلاصة

الخلفية: هشاشة العظام في العمود الفقري هي حالة شائعة عند النساء بعد انقطاع الطمث. درجة العظام التربيقية (TBS) هي مدى محدد لنسيج العظام يمكن استخراجه من صور DEXA وستكون بيانات داعمة في رفع حالة العظام التربيقية لهذه العينة من الأشخاص. **الهدف**: تحديد العلاقة بين قيم كثافة العظام و TBS في هشاشة العظام في العمود الفقري لدى النساء بعد انقطاع الطمث. **الطرائق**: تم إجراء BMD العمود الفقري و TBS لـ 348 امرأة بعد انقطاع الطمث ؛ تم تقسيم عينات المشاركة إلى ثلاث مجموعات (116 لكل منها). تمثل المجموعة 1 النساء المصابات بهشاشة العظام الشديدة في العمود الفقري. المجموعة 2 تمثل النساء المصابات بهشاشة العظام المصابات بهشاشة العظام في العمود الفقري المعتدل. وتمثل المجموعة 3 النساء الأصحاء بعد انقطاع الطمث المتطابقات مع الآخرين. **النتائج**: تدهورت نسبة المرضى جزئيا (-9.72) والبنية الدقيقة شديدة التدهور (-14.36) في TBS. انخفض BMD (0.792 و 0.829) بشكل ملحوظ وعدلت قيم TBS (1.27 و 1.33) في مجموعات الحالات مقارنة بالشواهد على التوالي. تم العثور على انخفاض كبير في المجموعة 1 (-3.7) ومجموعة الحالة 2 (-2.6) في درجة T مقارنة بكثافة العمود الفقري الصحية. **الاستنتاجات**: عندما يكون لدى النساء في سن اليأس كثافة العظام المنخفضة في العمود الفقري القطني العجزي وقيم TBS منخفضة، فهذا يشير إلى أن هشاشة العظام لها كتلة قمة منخفضة في العظام. كما تبين أن TBS مرتبط ارتباطا وثيقا بانخفاض كثافة العظام في منطقة أسفل الظهر ، مما يشير إلى وجود علاقة إيجابية بين هذا المؤشر وانخفاض كتلة العظام لدى النساء بعد انقطاع الطمث.

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INTRODUCTION

Osteoporosis is a disease characterized by deteriorating bone quality and declined bone mass associated with a decrease in bone strength [1]. It is commonly known as a "thief disease." Osteoporosis generally manifests without any features that will lead to fractures in the future, combined with bone architecture fragility [2]. The ability to fracture increases with developing abnormalities in the bone architecture and mass deficiency [3]. Also, fractures may occur at various positions of the skeletal body system, generally in the distal forearm, proximal femur, and vertebrae [4]. The first sign that a woman is getting osteoporosis is a change in her ovary's functional cycle. This is because the estrogen hormone decreases, which speeds up bone

remodeling and causes rapid bone loss and changes in bone architecture mass [5]. Previous research on women after menopause who had hard fractures also found that both the trabecular and cortical microarchitecture got worse [6]. However, regardless of the underlying cause of low bone density, it is plausible to hypothesize that women with persistently low bone mineral density during early menopause are primarily at high risk for fracture [7]. Men who are under the age of forty are at risk of this disease due to secondary indicators that are closely related to bone quality, such as smoking, taking certain medications like steroids, or chronic diseases including diabetes and also thyroid diseases.[8]. Numerous studies closely link bone health to its ability to withstand sudden fractures. The level of bone health is also connected to the structure inside the bone that makes it hard and gives a clear picture of the molecular details that can be used to build a cohesive bone mass. This is known as the trabecular bone score [9]. The women with BMD at a low point who had certainly not had a fracture were as severely affected as others with low BMD and frailty fractures, so measurement of BMD is routinely done by DEXA; the estimation of bone architecture is necessary to use bone biopsies as a real technique or analysis tool, such as high-resolution peripheral computed tomography (HR-pQCT) [10]. This is a new term for the values of an osteoporosis measuring device. This device provides a computed tomography scan of the vertebrae in the spine and gives an idea of the future risk of fractures for people who have low bone mass due to primary or secondary causes. This helps lower these risks and may even prevent fractures in the thoracic vertebrae, which can happen to both men and women. [11]. The basic values come from changes in the tables that can be found in the gray gradient. It was discovered that the bone structure depends on the interspaces within this gradient to give hardness and cohesion if the result is positive and vice versa if it is negative, which means that the bones' internal structure is broken down and they are more likely to break suddenly [12]. The study's goal is to find out how bone density and trabecular bone score values are related in cervical osteoporosis in women who have gone through menopause.

METHODS

Study design and setting

Our study is a case- control study carried out on every postmenopausal woman. 348 female (aged between 50-75 years old, the body weight between 55-70 kg and average length 150-166 cm) was visiting Ibn Albitar Hospital, Alzahra center, Basrah, Iraq, for BMD evaluation from October, 2022, to December 2023.

Patient selection

Patients who were 50 years of age or older and had interpretable DEXA scans were eligible. Females were divided into three groups; group 1 includes 116 osteoporotic women have severe spine osteoporosis while group 2 contains 116 osteoporotic women with moderate spine osteoporosis, and group 3 includes 116 women have normal spine density similar to years and age during menopause. These groups are classified based on their lowest T-scores from L1 to L4, which included osteoporosis, osteopenia, and normal. Patients with skeletal malignancy or metastasis, prior spinal surgery, include spine fixation, cement augmentation, or intervertebral disc replacement, anti-osteoporotic drugs, glucocorticoid excess, hypo-gonads, hyper or hypo thyroidism, and diabetes mellitus, were excluded. All the women completed a questionnaire, included weight (kg), height (cm), age (years), risk factors for osteoporosis, reproductive history, smoking, and calculate the body mass index (kg/m^2).

Measurement of bone density

Femoral neck and lumbar spine bone mineral densities (BMD, g/cm^2) were measured for all the women by a single DEXA scan (GE Lunar Prodigy, USA, software version 16). The bone density was quantified based on T-score and used to categorize the subjects into three groups, e.g., osteoporosis group (T-score < -2.5), osteopenia group (T-score < -1) and normal group (T-score > -1) [13].

Trabecular bone score evaluation

TBS was calculated by reanalyzing the DEXA lumbar spine (L1-L4) scans using the TBS iNsight software version 16 (USA). The utilized regions for the trabecular bone score estimation are similar to those used for the BMD analysis. Based on the TBS scores, the patients were categorized into three groups, called the normal micro-architecture (NM) group, the partially degraded microarchitecture (PDM) group, and the fully degraded microarchitecture (HDM) group [14].

Statistical Analysis

To contrast clinical characteristics, TBS, and BMD data among the three groups, the one-way analysis of variance (ANOVA) was employed. Analysis of all variables was done by statistical software SPSS (version 24.0). Descriptive statistics were expressed as means ±SD (p< 0.01).

RESULTS

The clinical characteristics of the study participants are shown in Table 1.

Table 1: The clinical and demographic features of controls matched to cases

Variables	Group 1 (n=116)	Group 2 (n=116)	Group 3 (n=116)
Age (year)	69.4±3	63.5 ± 2.5	60.6± .5
Height (cm)	155.5±3.5	156.3±2.2	158.2±3.8
Weight (kg)	59.5±1.7	61.2±1.5	64.5±2.5
BMI (kg/m^2)	19.03±2.3	19.55±2.1	20.25±1.3
Age at menarche (year)	12.9±1.4	13.5±1.5	13.4±1.2
Age at menopause (year)	49.7±2.5	50.3±2.2	50.5±2.1
Years since menopause	18.2±2.1*	15.1±1.2	11.6±2.6

Values were expressed as mean±SD. Group 1: severe spine osteoporosis; Group 2: moderate spine osteoporosis; Group 3: normal spine density *Differences considered as increases between case 1 and control since years menopause at p<0.01.

This includes the range of ages, heights, and weights for each group, as well as the average number of years of menopause and how these factors relate to the women in the study, who were split into groups based on how severe their osteoporosis was, and how these factors compared to healthy women. Table 2 shows the TBS, BMD, and BMI classifications of the women who took part in the study across different age groups.

Table 2: Features of participants in various age groups regarding TBS categorization, BMI and BMD

Age (year)	Number	BMI	BMD	TBS
50-59	89	21.04±2.55	0.57±1.07	-1.74±0.06
60-69	166	18.12±1.67	0.62±1.04	-2.88±1.11
70-75	93	19.67±1.88	0.60±1.02	-2.95±1.13
Total	348	58.83±3.13	0.59±1.08	-2.52±1.17

It also shows how these classifications relate to the numbers broken down by age for both women with osteoporosis and healthy women. In terms of the link between patients and TBS values and the fact that there was statistical significance between the groups based on the immersion division, it was explained that the groups with severe and moderate osteoporosis had significantly lower TBS values than the control women (Table 3).

Table 3: Features of participants in various age groups regarding the patients in TBS categorization

Age (year)	n	Normal TBS microarchitecture	Partially degraded TBS microarchitecture	High degraded TBS microarchitecture
50-59	89	3.18±1.61	-2.46±2.15*	-4.12±3.01*
60-69	166	2.23±1.73	-3.37±2.21*	-4.91±3.36*
70-75	93	2.02±1.66	-3.89±2.51*	-5.33±4.06*
Total	348	7.43±3.79	-9.72±3.65*	-14.36±4.32*

Values were expressed as mean±SD. *Significant differences between parameters in various age groups at p<0.01.

In Table 4, the BMD and TBS values dropped significantly at the p<0.01 level when comparing women with severe osteoporosis to women with moderate osteoporosis and healthy women as a control group.

Table 4: Comparison between BMD and TBS values of control and cases (n=116 in each group)

Variables	Group case 1	Group case 2	Control group 3
Lumbar sacral spine (L1-L4) T-score	-3.7±2.2*	-2.6±3.1*	-0.81±1.1
Lumbar sacral spine BMD (g/cm^2)	0.792±0.07*	0.829±0.04*	0.881± 0.03
Lumbar sacral spine (L1-L4) TBS T-score	-3.3±2.1*	-2.9±3.4*	-0.52±1.6
Lumbar sacral spine BMD amendment TBS	1.27±0.06	1.33±0.05	1.35±0.06

Values were expressed as mean±SD. Group 1: severe spine osteoporosis; Group 2: moderate spine osteoporosis; Group 3: normal spine density. *Significant differences between parameters in case 1 and case 2 compared with control at p<0.01.

DISCUSSION

The relationship between bone health and strength is a close moral connection known through scientific research and studies conducted on many patients around the world. It's because of how active and effective the female hormone estrogen is. Estrogen has the most significant effect on bone strength during adolescence, but it can have different effects on different age groups depending on genetic, physical, or psychological factors [15]. The countdown to bone mass loss begins when individuals pass the age of thirty; these decreases include bone density strength for both sexes, but they increase at a greater rate in women, especially after menopause, as the female hormone begins to decline after menopause [16]. There is a close relationship through scientific studies between the T-score factor and the TBS factor, especially when conducting a DXA examination of the back area [17]. This relationship gives a good picture of how bad the bone damage is in the spine because of a loss of bone mass. This is shown by a drop in the TBS level within the curve of the tables, which can be found by using the gray scale within the TBS range [18]. The research findings revealed a robust correlation between the T-score and TBS levels in postmenopausal women [19]. The best substitute technique to estimate trabecular bone properties of cancellous bone and microarchitecture is TBS [20]. To explain bone fragility, many experiments have been done on people with osteoporosis or other related diseases, showing that TBS is a separate test to tell you about your risk of breaking a bone [21]. In contrast, more spoilage of architecture bone related to postmenopausal bone loss had a higher loss in TBS value. In this way, it may be clear why osteoporotic women had a lower TBS value compared to healthy controls when it came to BMD in the vertebra. The higher value of TBS may help predict the likelihood of future hard fractures and bone loss in postmenopausal

women with severe osteoporosis [22]. The rating of TBS in postmenopausal women with extremely low vertebral T-scores indicated their risk of fracture, which is remarkable [23]. Since different diseases have varied actions on bone structures, which could change the architecture's rate in different ways, we excluded osteoporotic women as secondary effects. To be sure of our results, we would also need to use a standard method like HRpQCT, even though trabecular bone doesn't directly show bone architecture [24]. To test our working hypothesis, which is that TBS might be able to help us understand what causes osteoporosis in this particular group of people, we need to look at what happens when the fine structures of the bones start to lose the reinforcements that keep these structures together. This is when osteoporosis will eventually show up in the bone and give positive results for BMD values if the right treatment and precautions are taken to keep the bones from getting worse and entering the danger stage where they can break easily and kill older people in the community [25,26]. These differences in the appearance of the results and the significant differences between the values indicated a link in the TBS values [27].

Study limitations

This study focused on one diagnostic center and relied exclusively on measuring osteoporosis in postmenopausal women in Basrah Governorate. The differences in environment, customs, and character of living may prevent us from generalizing these results to all Iraqi people. Therefore, there is a need for deep research to include other categories within broader areas of Iraq.

Conclusion

This study showed that there is a positive relationship between BMD and TBS in women who have gone through menopause. This is because as people get older, their bone mass decreases, which causes the TBS values in the results tables to decrease.

Ethical considerations

Permission was obtained from the Presidency of Basrah University, Iraq, and the study was approved by the Ethics and Professional Conduct Committee of the College of Medicine, Basrah University (030405-044-2024).

Conflict of interests

No conflict of interest was declared by the authors.

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Data sharing statement

Supplementary data can be shared with the corresponding author upon reasonable request.

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