Bone mineral density of lumbar spine and femoral neck assessed by novel echographic approach-Radiofrequency Echographic Multi Spectrometry (REMS)

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Summary

***Introduction*. Bone mineral density (BMD) is used to diagnose osteoporosis. According to World Health Organization (WHO) osteoporosis was defined as a BMD value more than 2.5 standard deviations below the mean for normal young White women. X-ray absorptiometry (DXA) of proximal femur and lumbar spine is currently the gold standard used to confirm this diagnosis. Recent published studies introduced an innovative echographic approach, defined as REMS technology. The aim of this study is to compare REMS-based BMD values of lumbar spine and femoral neck between premenopausal and postmenopausal women.**

***Methods*. In this study, a total of 165 women underwent echographic scan using REMS technology. Acquisitions of lumbar spine and femoral neck were done for each patient in two Bulgarian centers. The following characteristics of the women were recorded: age, weight, height, BMI and REMS-based BMD of lumbar spine L_1-L_4, total lumbar spine, femoral neck, trochanter and total hip.**

***Results*. The mean REMS-based BMD measurements of postmenopausal group of L_1-L_4 and total lumbar spine were significantly lower than those of the premenopausal group (p=0.000). Femoral neck REMS-based BMD (p=0.011), trochanteric REMS-based BMD (p=0.007) and total hip REMS-based BMD (p=0.009) also differed significantly between the premenopausal and postmenopausal group.**

Conclusion. Postmenopausal women showed significantly lower lumbar spine REMS-based BMD of L_1-L_4 and total lumbar spine REMS-based BMD compared to premenopausal women. Femoral neck REMS-based BMD of postmenopausal women was also significantly lower than those of premenopausal women.

KEY WORDS:

Introduction

Bone density is the amount of bone tissue in a certain volume of bone (g/cm^3) (1). Due to limited determination of bone density, the term bone mineral density (g/cm^2) is normally used. Bone mineral density is the actual expression of the bone in absolute terms of grams of mineral (primarily, as g/cm^2 of calcium) per square centimeter of the scanned bone (2). According to World Health Organization (WHO) osteoporosis was defined as a bone mineral density (BMD) value more than 2.5 standard deviations below the mean for normal young White women. Patients will be classified as ''osteopenic'' if -2.5 <Tscore< -1.0, or ''healthy'' if T-score ≥-1.0. A generic white woman will be classified as ''osteoporotic'' if her femoral neck BMD is ≤0.572 g/ cm^2, ''osteopenic'' if her BMD is internal to the range 0.572–0.737 g/cm^2, or ''healthy'' if BMD ≥0.737 g/cm^2 (3, 4).

Patients with osteoporosis are at an increased risk of fragility fractures, which are caused by injury that would be insufficient to break a normal bone. Vertebral compression fracture is the most common type of osteoporosis-induced fracture. Hip fractures are the most serious among osteoporosis-induced fractures, associated with up to 36% excess mortality within 1 year. More than 200 million of patients worldwide are diagnosed with osteoporotic hip fractures (5, 6). Hip and spine fractures compromise patients' activity and lead to increased patients' morbidity and mortality. In addition, osteoporosis and the subsequent fractures are associated with significant economic costs. Therefore, early detection of osteopenic patients is the most important point in prevention of osteoporosis (4).

Osteoporosis is currently diagnosed by measurements of bone mineral density (BMD) and dual X-ray absorptiometry (DXA) of proximal femur and lumbar spine is the gold standard used to confirm this diagnosis. Quantitative ultrasound (QUS) methods have been also developed, but most of them are applicable only to peripheral skeletal sites. Recent published studies introduced an innovative echographic approach, defined as Radiofrequency Echographic Multi Spectrometry (REMS), which is applicable on femoral neck and lumbar spine. Significant correlations between BMD of lumbar spine and femoral neck measured by REMS and DXA has been demonstrated in these studies (5, 7, 8).

The aim of this study is to assess REMS-based BMD of lumbar spine and femoral neck and to compare REMS-based BMD values between premenopausal and postmenopausal group.

Methods

In this study, a total of 165 patients underwent echographic scan using REMS technology. Acquisitions of lumbar spine and femoral neck were done for each patient in two Bulgarian centers. REMS-based BMD of L_1-L_4 and of the total lumbar spine, as well REMS-based BMD values of femoral neck, trochanter and total hip were measured. The following characteristics of the women were recorded: age, weight, height and BMI. Women were divided into two groups: premenopausal and postmenopausal.
Acquisitions were performed by certified operator who was the same for all assessments. Transducer focus and scan depth were set to appropriate centimeters to have each lumbar vertebrae and femoral neck interface in the focal zone and in the central part of the image.

Statistical analyses

SPSS version 21.0 was used to assess the data. Descriptive statistic was used to present the characteristics of the women. The values of REMS-based BMD between premenopausal and postmenopausal group were compared by independent sample t test.

Results

The groups consisted of 25 premenopausal women (15.2%) and 140 postmenopausal women (84.8%). The mean age of the premenopausal and postmenopausal women was 43 years (range 24-50) and 65 years (range 38-86), respectively. The mean age of the postmenopausal women was significantly higher than those of the premenopausal women (p=0.000). Postmenopausal group was on average heavier (mean weight-70 kg) than premenopausal women (mean weght-66 kg) but the difference between the groups was not statistically significant. The mean height of postmenopausal women was significantly lower (154.7) compared to those of premenopausal women (159.8), (p=0.001). Premenopausal women had lower mean BMI (25.8) compared to postmenopausal women (29.2) and the difference between the mean BMI values of premenopausal and postmenopausal women was statistically significant (p=0.007) (Table 1).
The mean REMS-based BMD measurements of postmenopausal group of L_1-L_4 (BMD=0.720; 0.795; 0.854; 0.876) and total lumbar spine (BMD=0.820) were significantly lower than those of the premenopausal group (BMD=0.843; 0.922; 0.971; 1.012 for L_1-L_4 and BMD=0.942 for total lumbar spine), (p=0.000). REMS-based BMD of femoral neck (p=0-011), trochanter (p=0.007) and total hip (p=0.009) also differed significantly between the premenopausal (femoral neck BMD=0.713, trochanteric BMD=0.901 and total hip BMD=0.870) and postmenopausal groups (femoral neck BMD=0.646, trochanteric BMD=0.816 and total hip BMD=0.792) (Table 2).

Discussion

In this study, we assessed the values of lumbar spine and hip REMS-based BMD of premenopausal and postmenopausal women using novel echographic approach - Radiofrequency Echographic Multi Spectrometry (REMS). Furthermore, we compared lumbar spine and hip BMD values in premenopausal and postmenopausal group.
Postmenopausal women had higher BMI as compared to premenopausal women and BMI values differed significantly between the two groups. In general, both groups had BMI in the overweight range (BMI>25 kg/m^2).
Postmenopausal women showed significantly lower REMS-based BMD of L1-L4 and total lumbar spine REMS-based BMD as compared with premenopausal women. Other studies, which compared BMD values of premenopausal and postmenopausal women using dual-energy X-ray absorbtiometry (DXA) technology, have reported similar results (9, 10).
It is well known that bone loss accelerates in postmenopausal years. Menopause in women significantly increases bone resorption due to low levels of estrogens (11). In the current study, there was also significant difference of femoral neck REMS-based BMD values between premenopausal and postmenopausal women. In our study, premenopausal women showed relatively low femoral neck BMD (0.713), which was within the osteopenic range. Low femoral neck BMD value among premenopausal women could result from significant femoral neck bone loss among this group as reported in other studies, which used DXA technology. Femoral neck bone loss more than 0.5 standard deviations (SD) **before menopause from age 30 through 50 years was supposed by Siu et al. (12). In addition, other study has found that** femoral neck site is sensitive to bone loss in the perimenopausal period with a significant 3-year decline (1%) in BMD at the femoral neck, whereas the same study did not find significant annual change in the lumbar spine in premenopausal women (13). The presence of low femoral neck BMD in the premenopausal women could be also explained

Table 1 - Age, weight, height and BMI of premenopausal and postmenopausal women-mean, maximum, minimum and p-value.

	Characteristics of the women						p-value
	Premenopausal (N=25)			Postmenopausal (N=140)			
	Mean	Maximum	Minimum	Mean	Maximum	Minimum	
Age	43	50	24	65	86	38	0.000
Weight (kg)	66	116	43	70	127	42	0.192
Height (cm)	159.8	178.0	148.0	154.7	169.0	134.0	0.001
BMI (kg/m^2)	25.7536	45.8800	16.9000	29.2423	47.2200	18.5200	0.007

Table 2 - Independent sample T test for REMS-based BMD measurements of lumbar spine and hip between the premenopausal and postmenopausal groups.

REMS-based BMD	Groups	N	Mean	Std. Deviation	Std. Error Mean	p-value (T test)
L1	premenopausal	25	0.843	0.109	0.022	P=0.000
	postmenopausal	140	0.720	0.115	0.010	
L2	premenopausal	25	0.922	0.102	0.020	P=0.000
	postmenopausal	140	0.795	0.117	0.010	
L3	premenopausal	25	0.971	0.108	0.022	P=0.000
	postmenopausal	140	0.854	0.116	0.010	
L4	premenopausal	25	1.012	0.106	0.021	P=0.000
	postmenopausal	140	0.876	0.115	0.010	
Total lumbar spine	premenopausal	25	0.942	0.101	0.020	P=0.000
	postmenopausal	140	0.820	0.111	0.010	
Femoral neck	premenopausal	25	0.713	0.115	0.024	P=0.011
	postmenopausal	140	0.646	0.116	0.010	
Trochanter	premenopausal	25	0.901	0.145	0.030	P=0.007
	postmenopausal	140	0.816	0.136	0.012	
Total hip	premenopausal	25	0.870	0.139	0.029	P=0.009
	postmenopausal	140	0.792	0.130	0.011	

with the peak of bone density. The peak bone density of the spine in premenopausal women was detected between 35 and 39 years of age, and that of femur before 20. This could be the reason why premenopausal women begin to lose bone mass earlier at femoral neck than at lumbar spine (14-17).

Limitations of the study

The present study suffered from some limitations associated with the novel approach. First of all, the physiological variability of the acoustic properties of the soft tissue from patient to patient was taken into account, but slight deviations could not be excluded. Secondly, REMS technology analyzed only the spectral features of ultrasound signals from the trabecular region, even if cortical region has been demonstrated to have important contribution to bone strength, especially at femoral neck (7). Despite of these limitations, recent published study showed highly correlation between DXA and REMS results.

Conclusion

This is the first study, which compared lumbar spine REMS-based BMD and hip REMS-based BMD values in premenopausal and postmenopausal women. Postmenopausal women showed significantly lower lumbar spine BMD values than premenopausal women and this tendency was also valid for femoral neck BMD.

Conflict of interest

Elena Kirilova, Nikola Kirilov, Iliya Popov and Stoyanka Vladeva declare that they have no conflict of interest.

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