International Journal of Medical, Medicine and Health Sciences
ISSN: 2517-9969
Vol:11, No:5, 2017

Bone Mineral Density and Frequency of Low-Trauma Fractures in Ukrainian Women with Metabolic Syndrome

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Abstract**—**Osteoporosis is one of the important problems in postmenopausal women due to an increased risk of sudden and unexpected fractures. This study is aimed to determine the connection between bone mineral density (BMD) and trabecular bone score (TBS) in Ukrainian women suffering from metabolic syndrome. Participating in the study, 566 menopausal women aged 50-79 year-old were examined and divided into two groups: Group A included 336 women with no obesity (BMI ≤ 29.9 kg/m^2), and Group B – 230 women with metabolic syndrome (diagnosis according to IDF criteria, 2005). Dual-energy X-ray absorptiometry was used for measuring of lumbar spine (L1-L4), femoral neck, total body and forearm BMD and bone quality indexes (last according to Med-Imaps installation). Data were analyzed using Statistical Package 6.0. A significant increase of lumbar spine (L1-L4), femoral neck, total body and ultradistal radius BMD was found in women with metabolic syndrome compared to those without obesity ($p < 0.001$) both in their totality and in groups of 50-59 years, 60-69 years, and 70-79 years. TBS was significantly higher in non-obese women compared to metabolic syndrome patients of 50-59 years and in the general sample ($p < 0.05$). Analysis showed significant positive correlation between body mass index (BMI) and BMD at all levels. Significant negative correlation between BMI and TBS (L1-L4) was established. Despite the fact that BMD indexes were significantly higher in women with metabolic syndrome, the frequency of vertebral and non-vertebral fractures did not differ significantly in the groups of patients.

Keywords**—**Bone mineral density, trabecular bone score, metabolic syndrome, fracture.

I. Introduction

OSTEOPOROSISIS referred to as one of the worldwide problems due to associated complications, such as fractures, which reduce the quality of life, increase morbidity, disability and mortality among people [1]. The risk of osteoporosis and osteoporotic fractures increases with age and is especially associated with women in a menopausal period [8]. Increased life expectancy allows scientists to predict a doubling of the number of patients with this disease the next 40-50 years [2].

In the case of absent low-trauma fractures, osteoporosis is traditionally diagnosed according to the results of BMD, which is determined by means of X-ray densitometry. However, only 70-75% of bone strength accounts for BMD. Other affecting factors include cortical macro-geometry and trabecular micro-architecture, presence of damages and cracks [4], [11]. In recent years, to assess trabecular bone micro-architecture TBS was introduced and patented by MED-Imaps (Bordeaux, France) in 2006 [2].

Epidemiological evidence suggests an association between metabolic syndrome (MS) and fractures [6]. Consensus was established to identify a population of patients with high cardiovascular risk at the turn of the previous century [5]. Several studies have shown that the presence of MS is not only associated with development of atherosclerosis, diabetes, biliary dyskinesia, chronic cholecystitis, cholelithiasis, tumors of various localization, but also diseases of the musculoskeletal system. However, more attention is paid to osteoarthritis and less to risk of osteoporosis and fractures as a result of low-energy trauma in these patients. Meta-analysis of studies did not give a clear answer as to the relationship between the state of bone and factors that influence the development of fractures [6], [9], [10]. A number of scientists showed the lower incidence of fractures in patients with MS [7], [12], others have noted an increased frequency of this complication in patients with osteoporosis in the presence of MS [3]. The discrepancy of opinions prompted this investigation.

The aim of our study was to evaluate the BMD and TBS in Ukrainian women with MS.

II. Materials and Methods

The study involved 566 postmenopausal women aged 50-79 years (mean age – 64.309±8.144 years; mean height – 1.606±0.062 m; mean weight – 73.997±13.599; mean BMI – 28.737±5.260 kg/m^2; mean duration of menopause period – 15.090±8.623). Patients were divided into two groups: A – 336 women without obesity, BMI≤29.9 kg/m^2 (mean age – 64.190±8.127 years; mean height – 1.610±0.062 m; mean weight – 66.688±8.896; mean BMI – 25.549±2.773 kg/m^2; mean duration of menopause period – 14.997±8.62453), B – 230 women with MS (diagnosed according to the International Diabetic Federation criteria of 2005) (mean age – 64.483±8.183 years; mean height – 1.598±0.061 m; mean weight – 84.674±12.148; mean BMI – 33.393±4.510 kg/m^2; mean duration of menopause period – 15.226±8.857). Additionally groups were divided according to age of patients

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(50-59 yrs; 60-69 yrs; 70-79 yrs).

BMD of lumbar spine (L1-L4), femoral neck, total body and forearm was measured by the DXA method (Prodigy, GE Medical systems, Lunar, Madison, WI, USA, 2005).

TBS at the L1-L4 was evaluated by TBS iNsight® software (Med-Imaps, Pessac, France) which was installed on DXA machine.

One-way ANOVA test and correlation analysis were performed with usage of Statistical Package 6.0 ©StatSoft, Inc., results presented as M±SD. Associations between continuous variables were examined by Pearson correlation coefficient, significance set at $p<0.05$.

III. Results

We found that women without obesity have a significantly lower BMD of lumbar spine (A – 0.926±0.169 g/cm^2, B – 1.108±0.193 g/cm^2; F=140.537; p<0.001); femoral neck (A – 0.769±0.112 g/cm^2, B – 0.873±0.147 g/cm^2; F=91.557; p<0.001), total body (A– 0.819±0.126 g/cm^2, B – 0.970±0.158 g/cm^2; F=158.389; p<0.001) and ultra-distal forearm (A – 0.346±0.074 g/cm^2, B – 0.429±0.090 g/cm^2; F=141.497; p<0.001) compared to women with MS. The bone tissue quality (TBS L1-L4) significantly differed in women without obesity in comparison with those with an MS (A – 1.187±0.146, B – 1.156±0.175; F=5.049; p<0.05).

BMD of lumbar spine (L1-L4), femoral neck, total body and ultradistal radius significantly differed in females of 50-59 years, 60-69 years and 70-79 years (p<0.001) (Tables I-IV). TBS (L1-L4) was significantly higher in group A compared to group B - 50-59 years old patients (p<0.05), and not statistically significant in groups of 60-69 years, 70-79 years (Table V).

It was found a significant positive correlation between BMI and BMD at all measured sites. The study reveals significant negative correlation between BMI and quality of bone tissue (Fig.1).

We calculated the percentage of vertebral and non-vertebral low-trauma fractures in anamnesis (Fig. 2).

TABLE I
BMD of Lumbar Spine (L1-L4) in Ukrainian Women without Obesity and with MS

Age groups, years	Groups of patients	BMD lumbar spine (L1-L4), g/cm^2	p
50-59	without obesity (n=112)	0.989±0.151	<0.001
	with MS (n=67)	1.127±0.210	
60-69	without obesity (n=114)	0.899±0.175	<0.001
	with MS (n=84)	1.093±0.190	
70-79	without obesity (n=110)	0.889±0.163	<0.001
	with MS (n=73)	1.109±0.181	

Low-trauma non-vertebral fractures occurred most frequently (34%) in women without obesity compared to females with MS (27%). Vertebral low-trauma fractures were present in 9% of each group of patients.

It was not found significant, the differences in the frequency of vertebral and non-vertebral fractures in the groups of women (X2=0.132, p>0.05 and X2=3.641, p>0.05, respectively).

TABLE II
BMD of Femoral Neck in Ukrainian Women without Obesity and with MS

Age groups, years	Groups of patients	BMD femoral neck, g/cm^2	p
50-59	without obesity (n=112)	0.821±0.104	<0.001
	with MS (n=67)	0.959±0.154	
60-69	without obesity (n=114)	0.768±0.110	<0.001
	with MS (n=84)	0.863±0.121	
70-79	without obesity (n=110)	0.714±0.096	<0.001
	with MS (n=73)	0.812±0.132	

TABLE III
BMD of Total Body in Ukrainian Women without Obesity and with MS

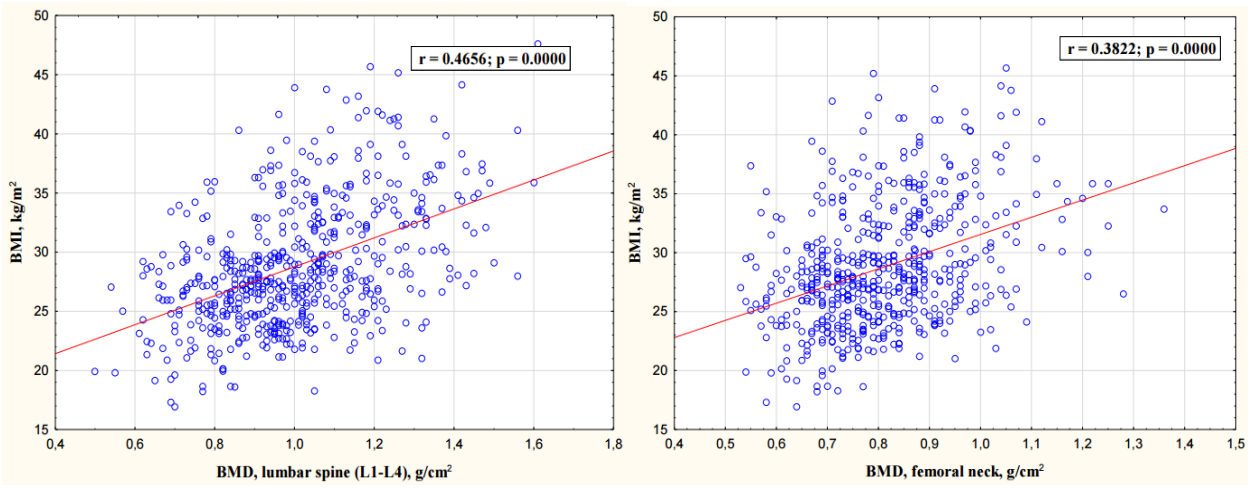
Age groups, years	Groups of patients	BMD total body, g/cm^2	p
50-59	without obesity (n=112)	0.874±0.104	<0.001
	with MS (n=67)	1.057±0,166	
60-69	without obesity (n=114)	0.819±0.128	<0.001
	with MS (n=84)	0.961±0.141	
70-79	without obesity (n=110)	0.761±0.119	<0.001
	with MS (n=73)	0.906±0.134	

TABLE IV
BMD of Ultradistal Radius in Ukrainian Women without Obesity and with MS

Age groups, years	Groups of patients	BMD ultradistal radius, g/cm^2	p
50-59	without obesity (n=112)	0.384±0.056	<0.001
	with MS (n=67)	0.474±0.088	
60-69	without obesity (n=114)	0.350±0.065	<0.001
	with MS (n=84)	0.420±0.079	
70-79	without obesity (n=110)	0.302±0.075	<0.001
	with MS (n=73)	0.401±0.090	

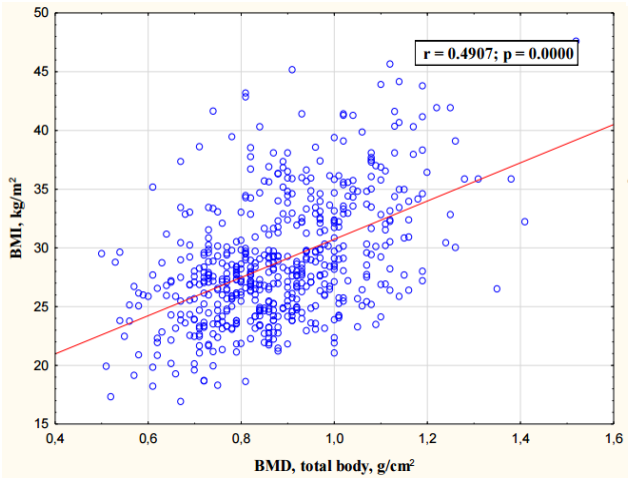
TABLE V
TBS (L1-L4) in Ukrainian Women without Obesity and with MS

Age groups, years	Groups of patients	TBS (L1-L4)	p
50-59	without obesity (n=112)	1.260±0.112	<0.05
	with MS (n=67)	1.204±0.179	
60-69	without obesity (n=114)	1.153±0.149	0.963
	with MS (n=84)	1.154±0.149	
70-79	without obesity (n=110)	1.147±0.148	0.194
	with MS (n=73)	1.115±0.187	



(a)

(b)



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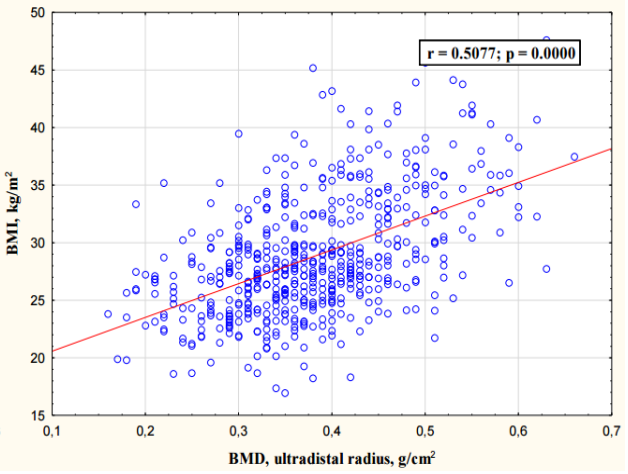

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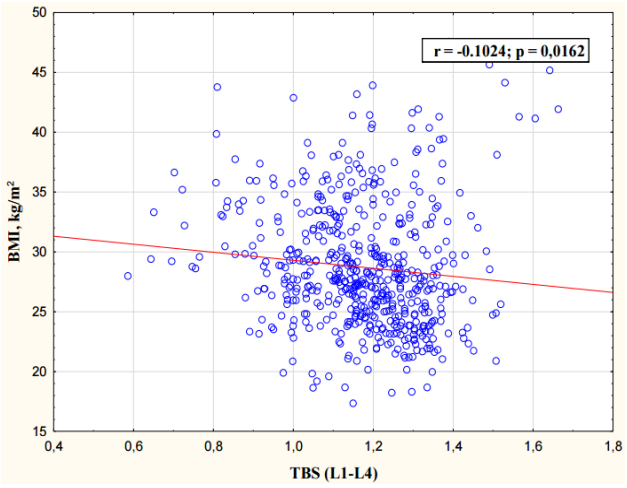

(e)

Fig. 1 Correlation between BMI and BMD of (A) lumbar spine (L1-L4), (B) femoral neck, (C) total body, (D) ultradistal radius, (E) TBS

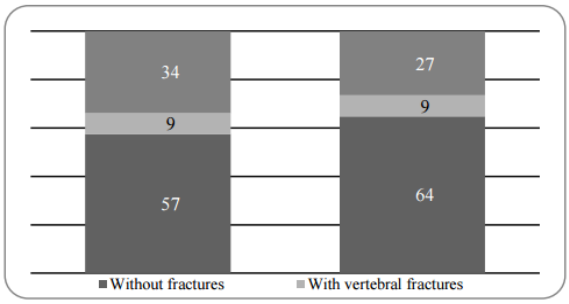

Fig. 2 Frequency of low-trauma vertebral and non-vertebral fractures in women without obesity and with MS

IV. Conclusion

Ukrainian women with MS have a significantly higher BMD at all measured sites compared with females without obesity. TBS is significantly lower in 50-59 year-old women with MS in comparison with non-obese ones of the same age. A significant positive correlation was established between BMI and BMD at all levels. Correlation between BMI and TBS (L1-L4) was significant and negative. At the same time, there is no significant difference in frequency of low-trauma fractures in the examined groups of women.

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