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## USE OF ULTRASOUND DENSITOMETRY FOR THE ASSESS OF STRUCTURAL AND FUNCTIONAL DISORDERS OF BONE TISSUE AND PREDICTION OF FRACTURES RISK

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### Abstract

**Objective:** To determine the dependence of lumbar spine compression degree on BMD state and the patients' age. The relationship of BMD state, the patients' age and the degree of compression of the vertebrae were studied. Correlation and regression analysis of the relationship between SOS index, score of compression and patients' age have been examined. Results. The data obtained allowed us to develop a mathematical model for predicting BMD reduction and the severity of vertebral compression fractures. Conclusions. Ultrasonic indexes of bone mineral density may be used not only for its screening assessment in general population of different ages, but also in assessing the degree of structural and functional changes of BT, predicting the severity of low-energy osteoporosis fractures. It will help to assign treatment in preclinical stage, and carry out prevention of compression fractures.

**Key words:** bone mineral density, low-energy fracture, vertebra compression.

**Urgency.** Osteoporosis (OP) is a systemic skeletal disease characterized by low bone mass and bone tissue (BT) micro architectonics disorders, which leads to a significant increase in bone fragility and possibility of their fractures [1]. According to WHO data OP belongs to the three top prevailing pathologies together with cardiovascular diseases and diabetes [2].

OP's development is directly related to the pathology of a human's fundamental physiological processes - remodeling of BT, the violation of which can lead to the emergence of other pathological conditions beyond osteoporotic fractures. Recently the attention of the researchers caught on the role of the calcium homeostasis in the development of OP, osteoarthritis, arteriosclerosis, hypertension, dementia. These diseases, which along with OP are the most common diseases of aged persons, are defined as "calcium-deficient" human diseases [4,5].

Bone fractures are the clinical consequences of OP. In addition to increased mortality, fractures are associated with acute and chronic pain, disability, reduced quality of life and significant economic expenses and psychosocial problems [1, 6, 7, 8].

To prevention BT is easier than to restore it, so OP's forecasting and early diagnosis is actual medical and social task.

Ultrasonic densitometry (UD) is rather available, reliable and inexpensive method for BT structural and functional state assessment. According to the last recommendations of the International Society for Clinical Densitometry it is considered as informative and safe screening method for determination of OP risk group patients and assessment of fractures risk in the patients of different age [2, 9].

At analysis of interaction between X-ray absorptiometry and ultrasound diagnostics indexes in postmenopausal women a significant moderate positive correlation between indexes of bone mineral density (BMD) of the whole skeleton and index of BT stiffness ( $r = 0.60$ ;  $p = 0.0001$ ) [6] has been revealed. At the analysis of interactions between indexes of double - photon X-ray absorptiometry and ultrasound diagnostics in postmenopausal women with low - energy fractures in history a significant positively expressed moderate effect between BMD of the whole skeleton and index of BT stiffness and a weak correlation between BMD of femoral bone and index of BT stiffness also has been revealed [9].

**The objective:** To determine the dependence of lumbar spine compression degree on BMD state and the patient's age.

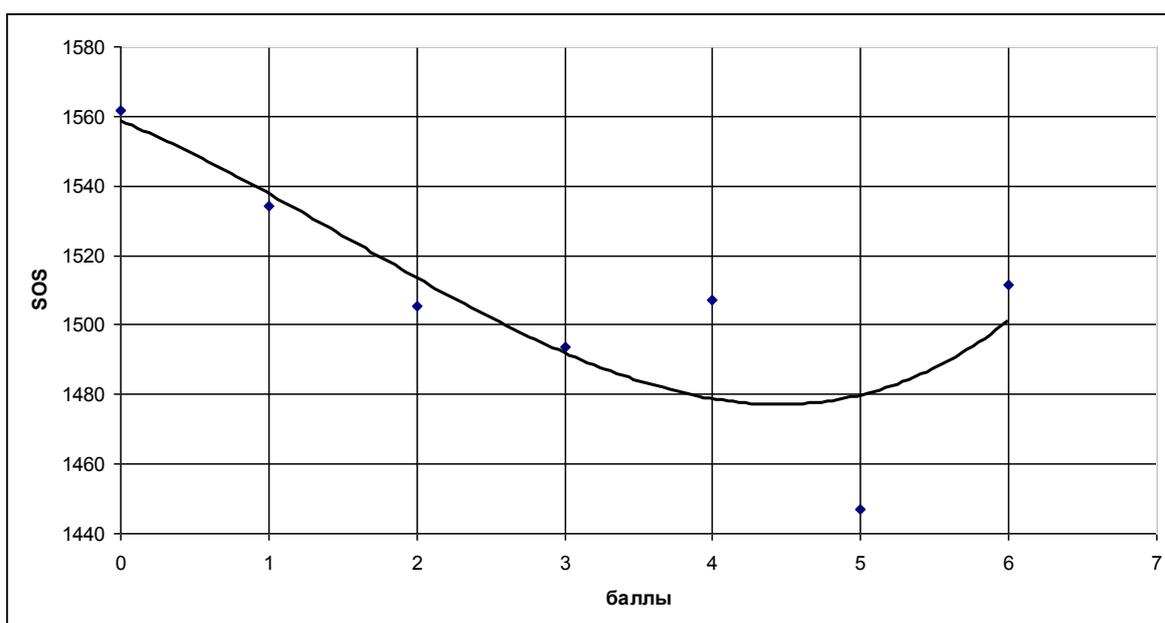
**Materials and methods.** 85 patients aged 15 - 75 years old have been examined. Bone changes were analyzed with ultrasound densitometry ( apparatus "Achilles Express", Lunar). Measurements were made on the calcaneus bone which consists of trabecular BT.

BMD was measured by ultrasound, the index of bone and ultrasound values (OSI), Z score of OSI, T score of OSI have been determined. OSI is a comprehensive (terminal) index of the value of acoustic diagnostics of BT state. It includes characteristics and the velocity of sound passing SOS, and index of ultrasound transmission (TI). TI can be viewed as an indicator of BT elasticity. There is a correlation between these three indexes and BMD.

The degree of compression of the lumbar vertebrae was studied by X-ray films. A score from 0 to 5 depending on compression indexes was used.

The relationship of BMD state, the patients' age and the degree of compression of the vertebrae were studied. Correlation and regression analysis of the relationship between SOS index, score of compression and patients' age have been examined.

**The results.** The data obtained allowed us to develop a mathematical model for predicting BMD reduction and the severity of vertebral compression fractures. It allows to administer timely therapy and conduct prevention of compression fractures.

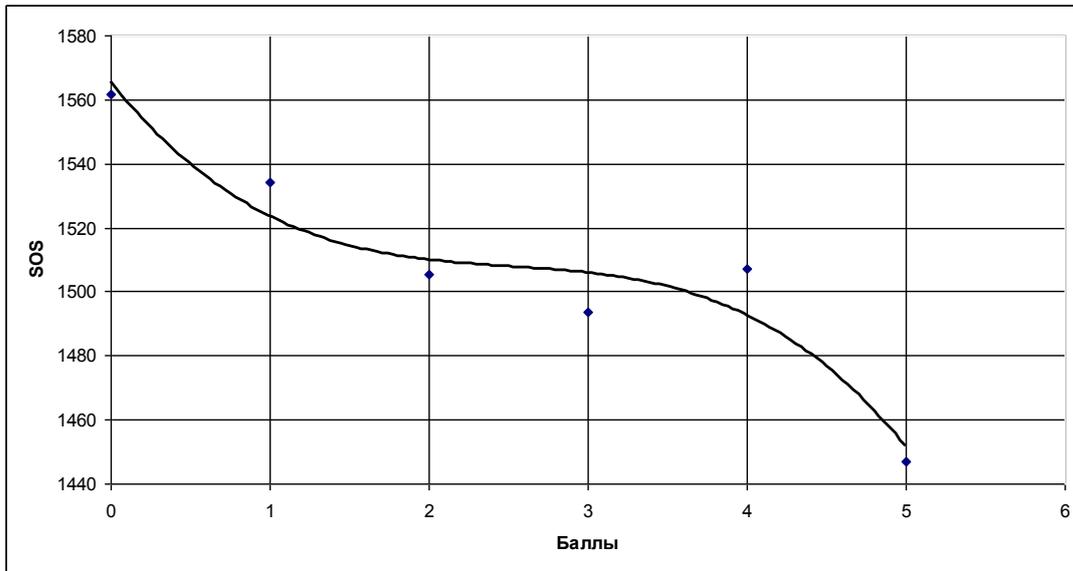


*Fig. 1. The dependence of SOS index on the degree of compression*

Taking into account the nature of dependence, the regression curve was sought in the form of a polynomial of the third degree. The result of the analysis gave the following regression curve:

$$SOS = 0.979 \cdot x^3 - 4.6 \cdot x^2 - 17.25 \cdot x + 1558.6$$

The value of the correlation coefficient has a value of  $R = 0.725 \pm 0.13$ , which corresponds to a significant correlation.

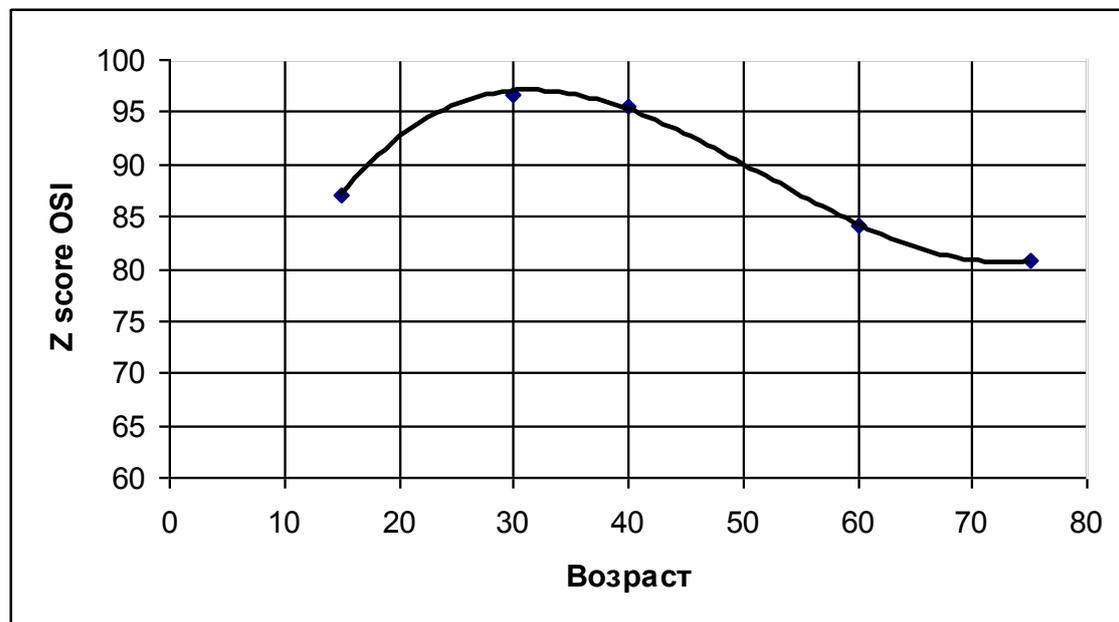


*Fig.2. The dependence of SOS index on the degree of compression*

The regression equation is as follows:

$$\text{SOS} = - 3.1245 \cdot x^3 + 23.54 \cdot x^2 - 62.394 \cdot x + 1565.6$$

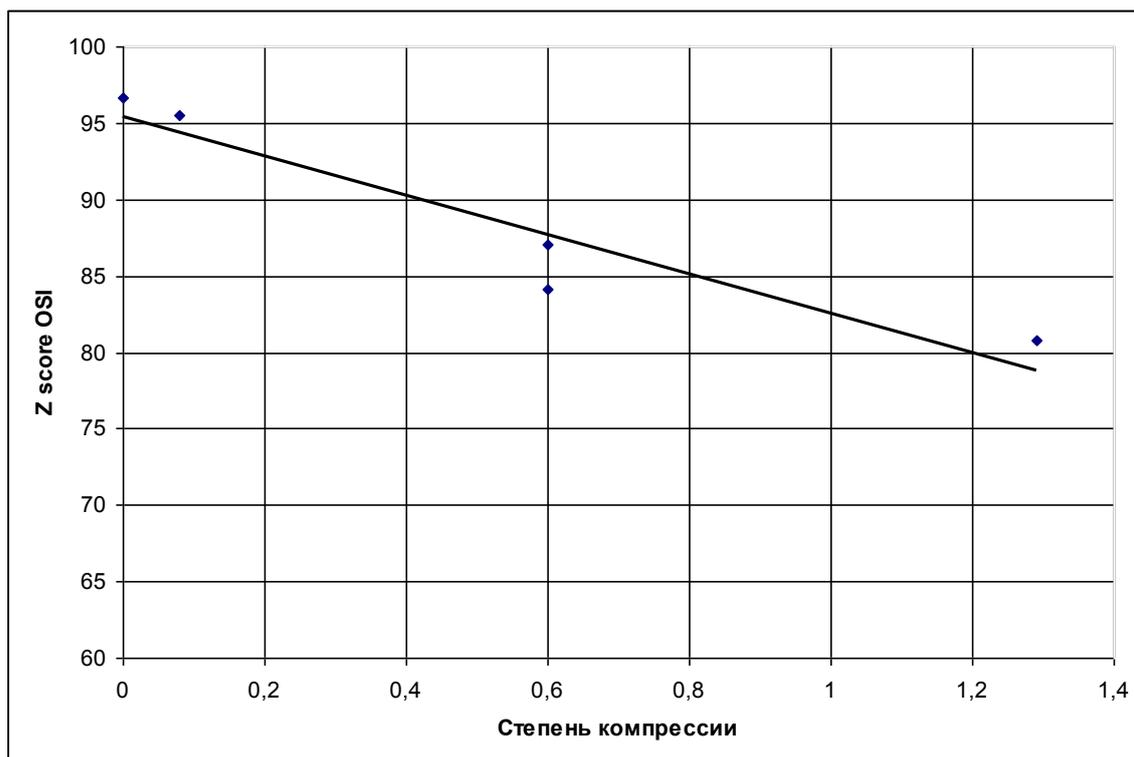
The correlation coefficient is  $r = 0.96 \pm 0.032$



*Figure 3. Dependence of the Z score of OSI on patient's age*

$$\text{Z score OSI} = 0.005 \cdot x^3 - 0.074 \cdot x^2 + 3.25 \cdot x + 53.27$$

The correlation coefficient is  $r = 0.998 \pm 0.002$



*Figure 4. Dependence of index Z score of OSI on the degree of compression*

$$\text{Z score OSI} = -12.885 \cdot x + 95.44$$

The correlation coefficient is  $r = 0.94 \pm 0.052$

Thus, the direct relationship between the degree of compression of the lumbar vertebrae and ultrasound indexes of BMD has been revealed.

**Conclusions.** Ultrasonic indexes of bone mineral density may be used not only for its screening assessment in general population of different ages, but also in assessing the degree of structural and functional changes of bone tissue, predicting the severity of low-energy osteoporosis fractures. It will help to assign treatment at preclinical stage, and carry out prevention of compression fractures.

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