Quantitative computed tomography in predicting the risk of osteoporotic vertebral fractures in postmenopausal women

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Aims and objectives

In connection with the general aging of the population, begin to occupy the leading position of the disease, age-related disorders that occur in the body. One of the pathologies arising due to hormonal and metabolic changes is postmenopausal osteoporosis. According to the literature, at least one third of postmenopausal women have osteoporosis, thus with increasing age of the frequency of this disease increases considerably [1, 2]. A consequence of the loss of bone mass are osteoporotic fracture, including vertebral compression fractures, the prevalence of which in different populations is from 2.9 to 25.3 %. The estimate of the epidemiology of vertebral fractures is associated with difficulties due to the paucity of clinical manifestations in the unexpressed vertebral deformities. However, the fractures can lead to disability of the patient, indicating the importance of health and social problems. Bone strength depends on various parameters, one of which is bone mineral density (BMD). The decrease BMD increases the risk of fractures [3, 4, 5]. In the initial stages of osteoporosis there is reduction of mineral density of the trabecular (spongy) bone, then - cortical (compact). Bone densitometry conducted by quantitative computed tomography allows the separate evaluation of mineral density of the trabecular and cortical bone [6].

There are numerous studies on the integrated study of the BMD by the three-dimensional densitometry to identify fracture risk [7, 8]. In addition, there are papers showing uneven distribution of the BMD in the vertebral body [9]. It was identified thresholds BMD anterior, middle and posterior parts of the vertebral bodies, with which the most likely to cause fractures. At the same time, there is a need bilateral vertebral BMD evaluation, which will assess the distribution asymmetry mineral density. Given that the problem of the increasing prevalence of osteoporosis remains open, the prediction of the risk of osteoporotic fractures require a search for new methodological solutions. Thus, the modeling system for forecasting the risk of osteoporotic vertebral fractures is relevant.

Objective: to develop a model for predicting osteoporotic vertebral fractures in women based on the results quantitative computed tomography.
The evaluation of the three-dimensional bone mineral density of lumbar vertebral bodies by quantitative computed tomography postmenopausal women. The study included 72 patients who underwent vertebral compression fractures and 210 women with no fractures. Quantitative computed tomography was performed CT scanner Somatom Emotion 16 (Siemens, Germany) using a mode Osteo. We investigated the trabecular and cortical parts II-IV of the lumbar vertebrae. Bone mineral density expressed in mg Ca-HA / ml. Estimated average mineral density of the trabecular and cortical bone of the vertebral bodies. When interpreting the results of bone densitometry excluded vertebrae fracture with signs. Asymmetry index was calculated for both trabecular and cortical bone for.

Data processing was performed using IBM SPSS Statistics 21. The standard methods of binary logistic regression. For each factor, the regression coefficient is calculated. The quality of the generated model was estimated using the ROC-analysis [14], namely the value of area under the curve (AUC, area under curve). Ranging significant predictor of fracture was carried out based on the Wald statistic. Construction of the model was carried out using a regression equation. When checking statistical hypothesis significance level was assumed to be 0.05 (p = 0.05).
Results

On the basis of data processing densitometry to assess the likelihood of fracture was a model of binary logistic regression. The factors that affect the risk of fracture were selected: trabecular BMD, cortical bone BMD and indices of bilateral asymmetry of the BMD. Regression coefficients of indicators to assess their significance are presented in Table 1.

<table>
<thead>
<tr>
<th>Indicators</th>
<th>B</th>
<th>Standard error</th>
<th>Wald</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMD trabecular bone (X1)</td>
<td>-0.044</td>
<td>0.020</td>
<td>4.571</td>
<td>0.033</td>
</tr>
<tr>
<td>BMD cortical bone (X1)</td>
<td>-0.014</td>
<td>0.007</td>
<td>4.502</td>
<td>0.034</td>
</tr>
<tr>
<td>The index of bilateral asymmetry of the BMD trabecular bone (X3)</td>
<td>3.443</td>
<td>1.361</td>
<td>6.401</td>
<td>0.011</td>
</tr>
<tr>
<td>The index of bilateral asymmetry of the BMD cortical bone (X3)</td>
<td>2.395</td>
<td>1.187</td>
<td>4.072</td>
<td>0.044</td>
</tr>
<tr>
<td>Constant</td>
<td>-2.551</td>
<td>3.337</td>
<td>0.584</td>
<td>0.445</td>
</tr>
</tbody>
</table>

Based on the data given can be seen that the lower the BMD of trabecular and cortical bone and above the bilateral asymmetry index, the more likely the risk of fracture.

Based on the regression coefficients can be calculated by the predictive probability of the possibility of fracture of the formula Fig. 1 on page 6.

In the present model area under the curve equal to 0.894 [0.855; 0.932], which indicates a high predictive ability of the model Fig. 2 on page 6.

The sensitivity of the model was 0.778 (77.8%), while specificity - 0.867 (86.7%).

The value of predictive probability of osteoporotic vertebral fractures in the range from 0 to 1. If the predictive probability of greater than 0.5, then the woman will be assigned to
a group of patients at high risk for fracture if the predictive probability in the range of 0.5 to 0.371 - the risk of fractures estimated as average, and if less than 0.371 - as low.

To optimize the work of the doctor on the basis of the predictive model was created a software application Fig. 3 on page 7.
\[ P(Y = 1 | X_1, X_2, X_3, X_4) = \frac{1}{1 + e^{(-2.551 - 0.044 X_1 - 0.014 X_2 + 3.443 X_3 + 2.395 X_4)}} \]

Fig. 1

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Fig. 2

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Fig. 3

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Conclusion

The proposed method makes it possible to predict with a high likelihood of osteoporotic vertebral fractures, which will allow for the timely prevention of this type of complications of osteoporosis.


