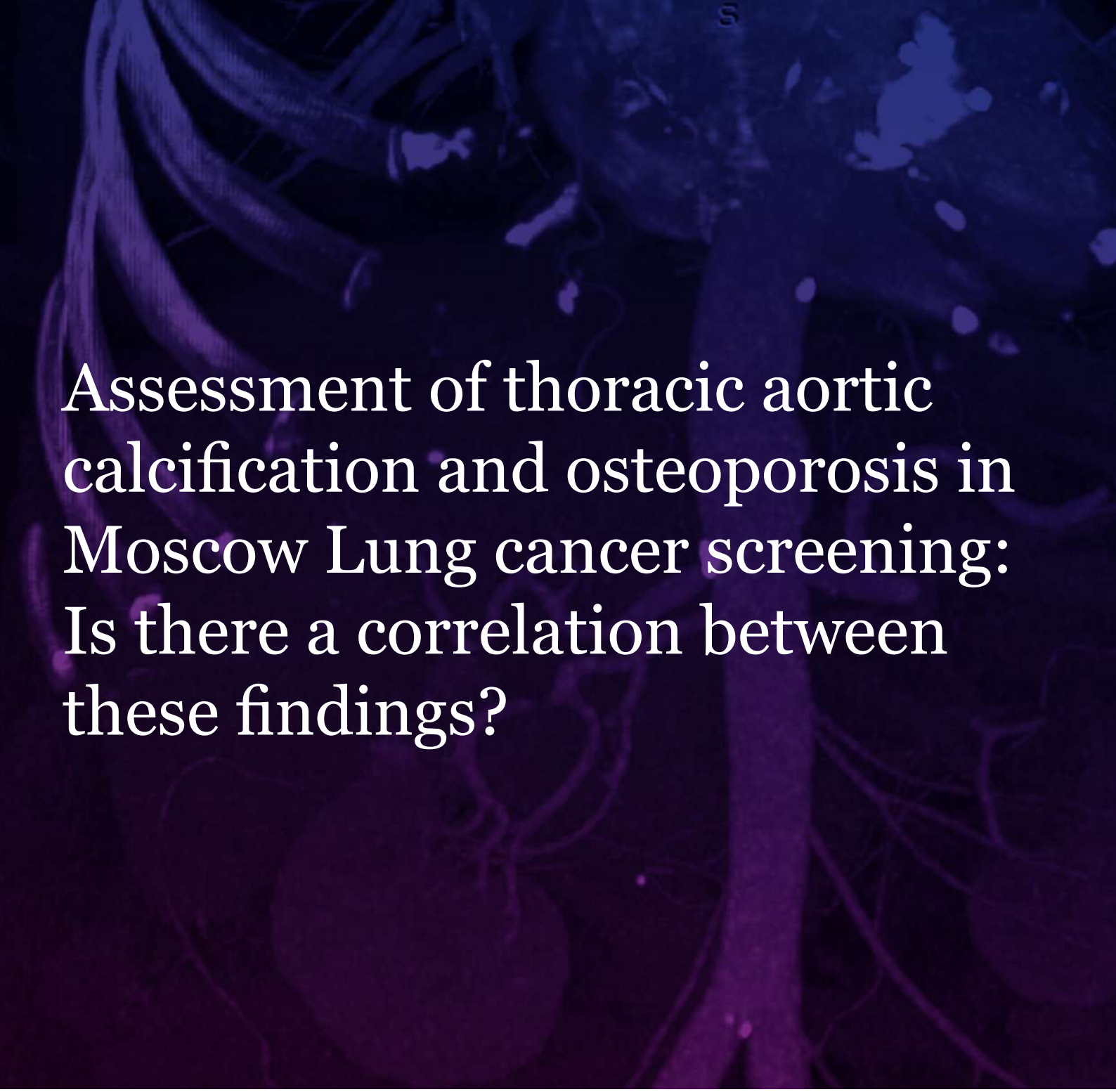

Assessment of thoracic aortic calcification and osteoporosis in Moscow Lung cancer screening: Is there a correlation between these findings?

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Aim

To assess the correlation between thoracic aortic calcification and osteoporosis in Moscow Lung cancer screening participants.

Materials and methods

A retrospective review included the results of 61 ultra-low-dose computed tomography (ultra-LDCT) performed in 57–87 year-old patients of whom 27 (44 %) were men and 34 (56 %) were women. The assessment of aortic calcification was performed only in this group. Agatston, Volume, and Mass indices for calcification of the ascending part, the arch, and the descending part of the thoracic aorta were quantitatively evaluated with semiautomatic method using OsiriX (picture 1). Quantitative evaluation of vertebral (Th 12, L1) bone mineral density (BMD) was performed with asynchronous QCT-densitometry.

Results

Quantitative evaluation of the aortic calcification severity was made with Agatston, Volume and Mass indices, as well as qualitative and quantitative analysis of the incidence of aortic calcification and osteoporosis in Lung cancer screening. The correlation between thoracic aortic calcification and BMD of vertebrae Th12-L1 was studied.

Conclusion

It is important to pay attention on the presence of thoracic aortic calcification when performing ultra-LDCT in lung cancer screening due to this change is associated with increased cardiovascular disease risk which may lead to death of the patient. Attention also must be paid to osteoporosis because its main complication is low-energy fractures development. Despite of the fact that there were no correlation between thoracic aortic calcification and osteoporosis in the study, the search for the correlation should be continued by measuring vertebral BMD at the level of aortic calcification where quantitative evaluation was performed which is an interesting task for further research.

Keywords:

aortic calcification, osteoporosis, ultra-low dose computed tomography

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Introduction

Cardiovascular findings are often detected with a low-dose computed tomography (LDCT), which is used in lung cancer screening. For example, National Lung Cancer Screening Trial (NLST) reports that screening followed by treatment leads to 20 % reduction in lung cancer mortality and 6.7 % reduction in overall mortality [1]. Thus, LDCT was established as an informative technique for the examination of the chest organs, an important advantage of which is the use of low doses of irradiation compared with standard examination protocols. In 2017, "Moscow Lung cancer screening" project was launched in Moscow where LDCT was used for selective screening of lung malignancies in the outpatient care [2]. This project was powered by Research and Practical Clinical Center of Diagnostics and Telemedicine Technologies, Department of Health Care of Moscow.

Potentially dangerous conditions such as latent cardiovascular diseases in smokers are among the various types of pathology detected with ultra-LDCT screening [3]. In the NLST studies at least 50 % of deaths were associated with manifest or latent cardiovascular diseases as confirmed by observations in other cohorts, that necessitating the widespread use of screening methods [4]. One of the undoubted factors indicating the high risk of cardiovascular diseases is thoracic aortic calcification, which is associated with atherosclerosis, although the pathogenesis and clinical manifestations of this condition cause disputes among cardiologists at these time.

In 1994 the World Health Organization officially identified osteoporosis as an independent disease characterized by a decrease in the amount of bone mineral content that results in a partial loss of bone strength and increased risk of fractures. Osteoporosis is currently ranked fourth in the world after cardiovascular diseases, cancer, and sudden death according to the numerous multidisciplinary studies [5].

The main complications of osteoporosis are low-energy fractures developing due to a decrease in bone mass and deterioration of bone microarchitecture [6]. Bone mineral density (BMD) is used for quantitative evaluation of osteoporosis. BMD primarily characterizes the mechanical strength of the bone associated with calcium hydroxyapatite.

Osteopenia is a precursor to osteoporosis. Osteopenia is a condition characterized with low bone mass and the value for BMD 1.0–2.5 SD which is lower compared with BMD in young healthy population, but not has reached the osteoporosis level yet (T-score ranging from -1.0 to -2.5) [7]. These two pathological conditions can be assessed during lung cancer screening with ultra-LDCT if the CT scanner is calibrated and if there are lumbar spine scans. BMD can be measured quantitatively with quantitative computed tomography (QCT) provided that the study met these two criteria. QCT allows to estimate amounts of calcium (weight in grams) in the vertebral body [8].

Population studies shows that one in three women and one in four men over 50 years of age suffer from osteoporosis, but osteopenia is found in more than 40 % of both sexes in Russian Federation [7]. Since inclusion criteria in lung cancer screening with ultra-LDCT are asymptomatic people over 55 years of age with a smoking history (30 pack-year index > 30), we consider it relevant to assess BMD.

Table 1. *Diagnosis of osteoporosis based on the decrease of BMD according to WHO criteria for postmenopausal women and men over 50 years of age; osteoporosis assessment based on BMD (WHO)*

Classification	BMD	T-score
Normal rage	Within 1 standard deviation (SD) from the mean in the healthy young population	T-score ≥ -1.0
Osteopenia	Ranging from 1.0 to 2.5 SD lower than the mean in the healthy young population	T-score ranging from -1.0 to -2.5
Osteoporosis	Lower than 2.5 SD or more compared to the mean in the healthy young population	T-score ≤ -2.5
Severe osteoporosis	Lower than 2.5 SD or more compared to the mean in the healthy young population	T-score ≤ -2.5 in addition to 1 or more fractures

According to the literature, severe aortic calcification at the level of Th12 or abdominal region is the predictor of a decrease in bone mineral density as well as low-energy fractures development [9, 10, 11]. Recent data of both epidemiological and clinical studies showed that patients with low BMD are at significantly high risk of cardiovascular diseases (CVD) as well as unexpected cardiovascular events, more severe coronary atherosclerosis, and vascular calcification development [12-17].

Aim of the study

The aim of the study was to assess the prevalence of thoracic aortic calcification and osteoporosis in patients undergone lung cancer screening and to investigate the correlation between them.

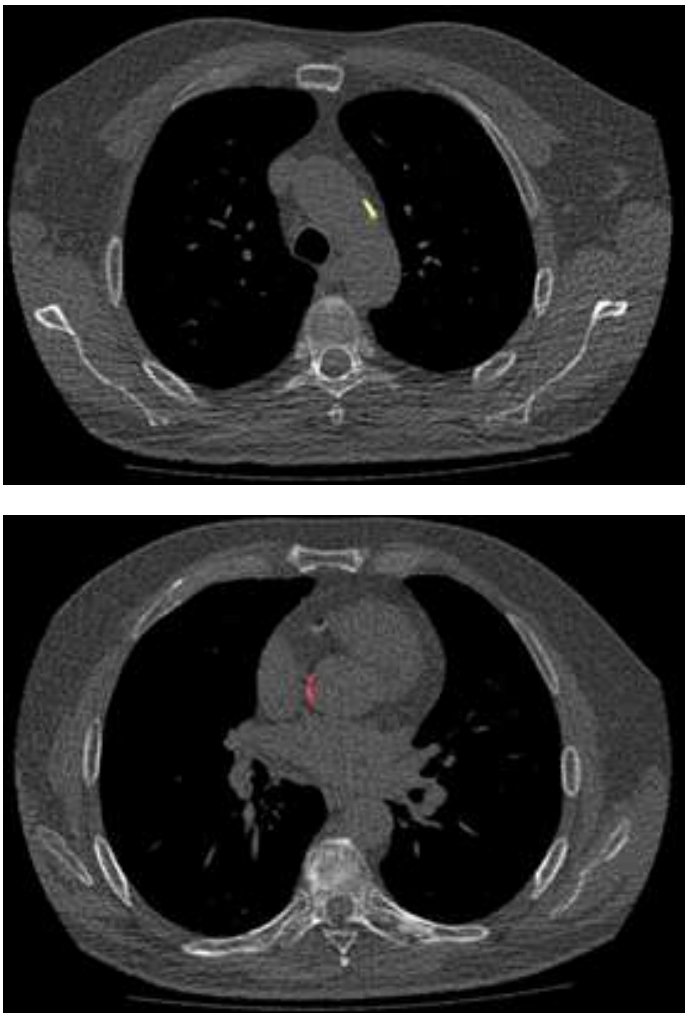
Materials and methods

The retrospective study included ultra-LDCT scans, obtained from Toshiba Aquilion 64 (Canon Medical System, Japan) CT scanner, which was calibrated in order to perform quantitative evaluation of BMD based on QCT-densitometry data. All the examinations were performed according to ultra-LDCT protocols with tube voltage of 135 kV and different mAs depending on the patient's body weight (3 groups: < 69 kg, 70–89 kg, > 90 kg), tube rotation time around the table was 0.5 seconds and radiation load – 1 mSv, iterative reconstructions were not applied to achieve noise reduction.

The study included ultra-LDCT scans of the patients who met the following inclusion criteria for the lung cancer risk group: 55 years of age or older; patients with a smoking history with pack-years index > 30 and patients who gave up smoking less than 15 years ago; no history of lung, bronchus, and trachea cancer as well as no other cancer metastases in the lungs.

Agatston, Volume, and Mass indices for calcification of the ascending part, the arch, and the descending part of the thoracic aorta were quantitatively evaluated with semiautomatic method using OsiriX (picture 1). Quantitative evaluation of vertebral (Th 12, L1) bone mineral density (BMD) was performed with asynchronous QCT-densitometry.

Pearson and Spearman correlation coefficients were calculated in order to evaluate the correlation between thoracic aortic calcification and vertebral BMD at the level of Th12-L1 vertebrae.



Picture 1. *Semi-automatic segmentation of calcified thoracic aorta with OsiriX software*

Results

The study included the results of 61 ultra-LDCT performed in 57–87 year-old patients of whom 27 (44 %) were men and 34 (56 %) were women. These data were used only for the evaluation of aortic calcification and BMD.

Quantitative evaluation of the thoracic aortic calcification was made with Agatston, Volume and Mass indices and indicated that there were no calcinates in 10 % of cases, calcium score was less than 5000 in 55 % of cases, calcium score ranged from 5000 to 10000 in 25 % of cases, and calcium score was more than 10000 in 10 % of cases. It was also noted that the Agatston calcium score was higher in men than in women when detected by ultra-LDCT.

Quantitative evaluation of vertebral bone mineral density at the level of Th12-L1 vertebrae with QCT-densitometry showed that osteoporosis and osteopenia were detected with the same frequency (44.3 % of cases).

Bone mineral density was within the normal range in 11.4 % of cases (Figure 1).

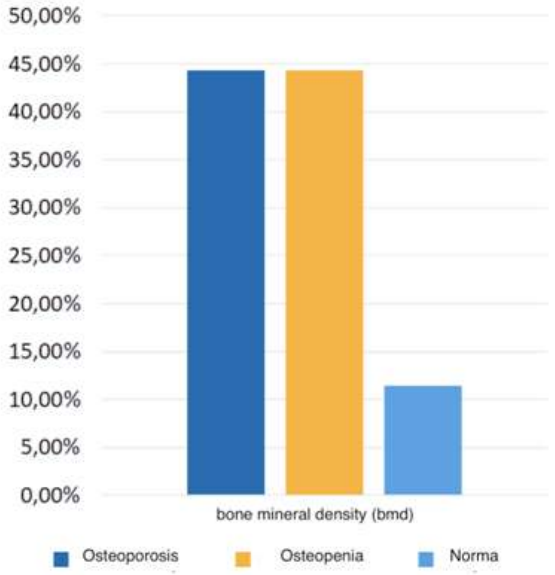


Figure 1. *The incidence rates of osteopenia, osteoporosis and BMD within the normal range*

Pearson correlation coefficient was 0 when estimating the correlation between thoracic aortic calcification and vertebral BMD, which shows no correlation between these two variables. Spearman's rank correlation coefficient was 0.14 that also reflects absence of any correlation.

Conclusion

Thoracic aortic calcification should be evaluated when performing lung cancer screening with ultra-LDCT as there changes are closely related to the high risk of cardiovascular diseases leading to death. It is also important to pay attention to osteoporosis because this condition is associated with low-dose fractures. Despite of the fact that this study did not reveal any correlation between two pathologies, the search should be continued by measuring vertebral BMD at the level of the part of aorta where the quantitative estimation was performed, which is an interesting task for further research.

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