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Coronary Artery Calcium Score and Severity of Ischemic Heart Disease in Obesity

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Abstract: This study evaluated the relationship between coronary artery calcium (CAC) score and the severity of coronary artery disease in 105 patients with obesity using multislice CT angiography. Calcification was detected in 92.4% of cases and was more frequent in men. Higher CAC scores were strongly associated with multiple and severe coronary stenoses. Despite limited sex and age differences, CAC scoring proved valuable for cardiovascular risk stratification and guiding further diagnostic and therapeutic strategies.

Keywords: Coronary artery calcium, multislice computed tomography, coronary artery disease, obesity, cardiovascular risk, coronary stenosis, risk stratification.

Introduction: Atherosclerosis is the principal underlying cause of ischemic cardiovascular diseases. In many cases, the first clinical manifestation of coronary artery disease (CAD) is myocardial infarction or sudden cardiac death resulting from rupture of an atherosclerotic plaque that does not significantly obstruct the arterial lumen [15]. Elevated blood cholesterol levels represent a key driver of atherogenesis. According to a large population-based study (n = 52,075), median total cholesterol levels exceed 5 mmol/L in men older than 30–35 years and women older than 30–40 years, while in the 40–69-year age group, the proportion of individuals with levels ≥ 6.2 mmol/L reaches 40.1% [8].

Given the high prevalence of hypercholesterolemia, early detection of atherosclerotic involvement of the coronary arteries is of paramount importance for timely implementation of preventive and therapeutic strategies. This is particularly relevant for individuals with familial hypercholesterolemia, a hereditary disorder characterized by markedly elevated low-density lipoprotein cholesterol levels and associated with an approximately 20-fold increase in the lifetime risk of premature cardiovascular events. At the same time, the true prevalence of this condition in the Russian Federation remains insufficiently defined [64,20].

Conventional diagnostic approaches for CAD, including exercise testing (exercise electrocardiography and stress echocardiography), demonstrate limited sensitivity (45–85%) and specificity (80–90%) and are not capable of identifying early stages of coronary atherosclerosis [13]. Coronary computed tomography angiography (CCTA) is a highly sensitive imaging modality (95–99%) that enables detection of even minor arterial stenoses. However, its widespread use is limited by high cost, as well as contraindications to iodinated contrast agents in patients with iodine hypersensitivity and severe renal impairment [3,18].

It is well established that progression of atherosclerosis is accompanied by calcium deposition within the coronary arterial walls. In the 1980s, a group of American cardiologists led by Arthur Agatston developed a computed tomography–based method for quantifying coronary artery calcium [1]. They demonstrated that the presence and extent of

coronary calcification correlate with the severity of atherosclerotic disease. The Agatston score (coronary artery calcium score) is currently regarded as the gold standard for CT-based assessment of coronary calcification in clinical practice [11]. Coronary artery calcification reflects underlying atherosclerosis and serves as an independent predictor of future cardiovascular events beyond traditional risk factors [2,9].

Aim**.** To evaluate the role of the coronary artery calcium index in predicting the severity of coronary artery involvement in patients with chronic coronary artery disease combined with obesity.

METHODS

The study included 105 patients diagnosed with coronary artery disease and obesity. All participants underwent a comprehensive assessment, including standard clinical and laboratory examinations, as well as coronary angiography. Detection and quantification of coronary artery calcification were performed using multislice computed tomography. The coronary calcium score was calculated according to the Agatston method. Based on the obtained values, patients were stratified into the following categories: 0 units (no calcification), 1–100 units, 101–400 units, and >400 units.

Statistical analysis was carried out using STATISTICA 6 software. Correlation analysis was performed using Spearman's rank correlation coefficient. Differences between groups were considered statistically significant at $p < 0.05$.

RESULTS

The findings of multislice CT coronary angiography were analyzed in 105 patients with coronary artery disease and obesity. The cohort included 75 men (71.4%) and 30 women (28.6%) aged 45–75 years; the mean age was 61.1 ± 7.8 years. According to CT data, coronary artery calcification was detected in 92.4% of participants (97 patients), including 75 men and 22 women. In the overall sample, there was a tendency toward a higher prevalence of calcification in men compared with women (including three cases with more than five stenoses), although this difference did not reach statistical significance ($p = 0.5$). Age-stratified analysis showed that in the 45–60-year group, calcification was present in 35 men (100%) and in 2 of 10 women (20%). In the older age group (61–74 years), the prevalence reached 100% in both sexes. However, the increase in calcification frequency with age, as well as differences in calcium score values and number of stenoses, were not statistically significant ($p = 0.82$ and $p = 0.61$, respectively).

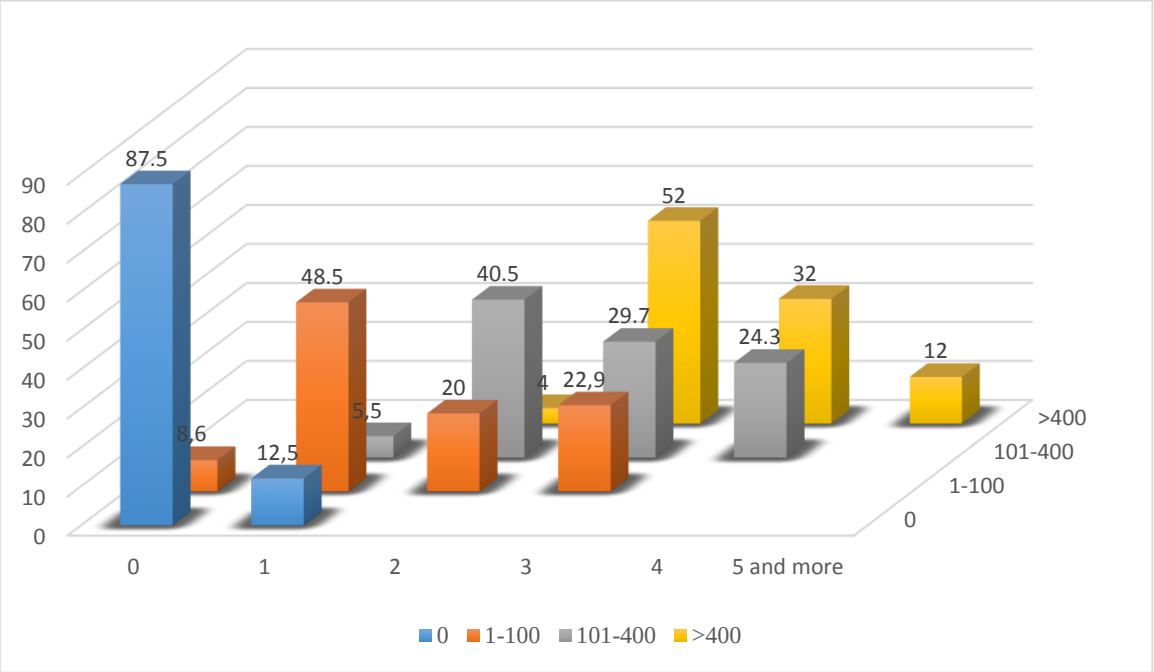
Assessment of calcification severity using the Agatston scale demonstrated that scores of 1–100 units were more common in middle-aged patients (45–60 years), whereas values of 101–400 units were more typical for older individuals. Scores of 0 and 1–100 units were more frequently observed in women, while higher scores (101–400 and >400 units) were somewhat more common in men across both age groups; however, these sex-related differences were not statistically significant (Table 1).

The Agatston score ranged from 0 to 1103 units. A score of 0 was identified in 8 patients aged 45–50 years, none of whom were men. In this subgroup, multislice CT was performed as a screening tool for coronary artery disease. None had a history of myocardial infarction or acute cerebrovascular events. However, many underwent imaging due to a family history of severe coronary artery disease, prior myocardial infarction in parents, elevated cholesterol levels, or increased health concern. Only one 47-year-old woman (12.5%) had a single stenosis of the circumflex artery with a 41% luminal narrowing (Diagram 1).

Table 1. Distribution of patients according to the severity of coronary artery calcification.

CAC score	Patients	Men (75)	Women (30)
0 ед.	8	-	8 (100%)
1-100 ед.	35	18 (51,4%)	17 (48,6%)
101-400 ед.	37	35 (94,5%)	2 (5,5%)
>400 ед.	25	22 (88%)	3 (22%)
Total	105	75	30

Diagram 1. Number of coronary artery stenoses in patients with ischemic heart disease and obesity depending on the coronary artery calcium (CAC) score.



Patients with calcium scores of 1–100 units were aged 47–75 years and included 18 men and 17 women. In three men aged 51, 57, and 69 years, with scores of 9.1, 15.2, and 79 units, no coronary stenoses were detected. Single-vessel stenoses were identified in 17 individuals, most commonly involving the left anterior descending artery (88.2%), while fewer cases affected the circumflex artery. Stenoses of 50–75% or greater were observed in 26 of 35 patients (74.2%).

The group with calcium scores of 101–400 units consisted of older individuals (49–71 years; mean age 65.7 ± 7.1 years), with a predominance of men (35 of 37; 94.6%). Only 5 patients had stenoses in the 30–50% range (three of them had two lesions each). In the majority (86.4%), stenoses exceeded 50% and were multiple (two or more).

Among patients with scores >400 units, all 19 individuals had multiple coronary stenoses, with the most severe exceeding 50% luminal narrowing. In 24 patients (96%), between three and five stenoses were identified. Of the 7 patients with scores >1000 units, 4 had 3–4 stenoses with severe narrowing (up to 90–97%), and in 3 of them, two stenoses each ranged from 94% to 95%. In 3 patients, the total number of stenoses exceeded five. These findings indicate that elevated cardiovascular risk is associated with the overall calcium burden in the coronary arteries. However, a calcium score of 0 does not completely exclude the presence of coronary stenosis.

Correlation analysis demonstrated a strong association between the calcium score and the number of stenoses ($r = 0.881$), as well as the maximum degree of stenosis ($r = 0.833$). A moderate correlation was observed with the presence of angina ($r = 0.511$) and its functional class ($r = 0.539$, $p = 0.002$), while the relationship with patient age was weak ($r = 0.474$).

DISCUSSION

For a long time, coronary artery calcification was primarily viewed as a factor contributing to plaque stabilization by increasing its mechanical strength and thereby reducing the likelihood of rupture. However, current evidence indicates that this process is more complex and exhibits a dual nature. In particular, a zone of increased mechanical stress may form at the interface between the calcified cap and the intima due to differences in tissue elasticity, which can, in contrast, promote plaque disruption and rupture [19]. Furthermore, the presence of even small calcium deposits within so-called early or “young” plaques is considered an unfavorable prognostic feature associated with an elevated risk of atherothrombotic events. Thus, progression of calcification may be accompanied by an increased probability of cardiovascular complications [6,17].

Male sex is traditionally regarded as a non-modifiable risk factor for coronary artery disease. Accordingly, coronary artery calcification, as a key component of the atherosclerotic process, has been shown in numerous studies to occur more frequently in men. For instance, in the Multi-Ethnic Study of Atherosclerosis (MESA) conducted in the United States, the prevalence of coronary calcification among men in the general

population reached approximately 70%. Comparable findings were reported in the Framingham Heart Study and the Cardiovascular Health Study [16].

Coronary computed tomography angiography (CCTA) is a highly informative imaging modality for detecting atherosclerotic plaques and assessing the degree of coronary artery stenosis. In a controlled comparative study by I. Danad et al., CCTA demonstrated higher sensitivity for diagnosing coronary artery disease compared with single-photon emission computed tomography (SPECT) and positron emission tomography (PET) (90%, 57%, and 87%, respectively), although its specificity was lower (60%, 94%, and 84%, respectively) [7].

A substantial body of literature confirms a strong association between coronary artery calcium, the presence of coronary artery disease, and the risk of cardiovascular events [5–14]. The results of the present study are consistent with findings from researchers in South Korea, who highlighted the important role of coronary calcium in cardiovascular risk stratification among patients with coronary artery disease [14].

At the same time, it has been observed that in certain cases, a slight increase in the calcium score may not be accompanied by hemodynamically significant coronary stenosis. This may be explained by the fact that calcium deposition can occur not only within the media during plaque progression but also within the adventitia of the arterial wall [12].

It is important to emphasize that not only the quantitative value of the calcium score but also the pattern of calcium distribution has clinical relevance. Using optical coherence tomography, it has been demonstrated that spotty calcifications are associated with more vulnerable atherosclerotic plaques [10].

In clinical practice in the Russian Federation, a degree of reluctance toward statin therapy persists among both patients and physicians. Visualization of coronary artery involvement and the degree of luminal narrowing in percentage terms has been shown to significantly improve patient motivation and adherence to long-term treatment. Additionally, there is evidence that risk assessment based on coronary calcium scoring enhances adherence to preventive measures and pharmacotherapy [2].

The coronary calcium score provides valuable information for the indirect assessment of atherosclerotic involvement of the coronary arteries. This method is relatively cost-effective and does not require the use of contrast agents, which expands its applicability, particularly in patients with contraindications such as thyroid disorders or renal insufficiency.

High calcium scores enable more accurate classification of patients into high and very high cardiovascular risk categories, facilitating timely initiation of preventive and therapeutic interventions and improving patient adherence.

Nevertheless, for a more precise evaluation of the extent of coronary atherosclerosis, coronary CT angiography or invasive coronary angiography remains necessary. Considering that a substantial proportion of patients in the present study exhibited coronary stenoses of 20–49% (high-risk group) and ≥50% (very high-risk group) in combination with elevated calcium scores, this parameter may be regarded as an additional tool for cardiovascular risk stratification.

CONCLUSIONS

The coronary artery calcium score, assessed by multislice computed tomography, can serve as an important screening tool for detecting atherosclerotic involvement of the coronary arteries and for stratifying cardiovascular risk in patients with coronary artery disease and obesity.

Calcium scores exceeding 100 units are associated with the presence of multiple coronary artery stenoses in the majority of patients, while values above 400 units suggest a high likelihood of hemodynamically significant lesions. In such cases, further diagnostic evaluation, including contrast coronary angiography, is recommended to determine optimal patient management strategies.

A calcium score greater than 1000 units is indicative of a high probability of critical coronary artery stenoses and necessitates appropriate pharmacological therapy, as well as consideration of contrast coronary angiography to guide decisions regarding revascularization procedures, including percutaneous coronary intervention (stenting) or coronary artery bypass grafting.

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