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BURDEN AND PATTERNS OF CORONARY ARTERY CALCIFICATION IN PATIENTS WITH CORONARY ARTERY DISEASE AND OBESITY

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Аннотация

Сердечно-сосудистые заболевания остаются ведущей причиной смертности и инвалидизации взрослого населения. Коронарный кальциноз (КК) рассматривается как важный маркер атеросклеротического поражения коронарных артерий. Целью исследования явился анализ распространенности и выраженности КК у пациентов с ишемической болезнью сердца (ИБС) и ожирением. В исследование включены 134 пациента в возрасте 45–74 лет (78 мужчин и 56 женщин). Для диагностики и количественной оценки кальциноза применялась мультиспиральная компьютерная томография с расчетом индекса Агатстона. Коронарный кальциноз выявлен у 91,7% обследованных. Отмечена тенденция к более высокой частоте КК у мужчин по сравнению с женщинами. С возрастом частота кальциноза увеличивалась в обеих группах, однако достоверных гендерных различий и значимой корреляции с возрастом не выявлено. У женщин чаще регистрировались минимальные значения КК, у мужчин — умеренные формы. Установлено, что кальциноз имеет двойственную роль: с одной стороны, он может стабилизировать бляшку, с другой — повышает риск её разрыва. Наличие даже небольших кальцинатов ассоциировано с неблагоприятным прогнозом и повышением риска сердечно-сосудистых осложнений.

Ключевые слова: коронарный кальциноз, ишемическая болезнь сердца, ожирение, атеросклероз, индекс Агатстона, МСКТ.

Annotatsiya

Yurak-qon tomir kasalliklari kattalar o‘rtasida o‘lim va nogironlikning asosiy sabablaridan biri bo‘lib qolmoqda. Koronar kalsinoz (KK) koronar arteriyalar aterosklerotik shikastlanishining muhim belgisi hisoblanadi. Tadqiqotning maqsadi yurak ishemik kasalligi (YIK) va semizlik bilan og‘rigan bemorlarda KK tarqalishi va og‘irlik darajasini tahlil qilishdan iborat edi. Tadqiqotga 45–74 yoshdagi 134 bemor (78 erkak va 56 ayol) kiritildi. Koronar kalsinozni aniqlash va baholash uchun ko‘p kesimli kompyuter tomografiya hamda Agatston indeksi qo‘llanildi. Koronar kalsinoz 91,7% bemorda aniqlangan. Erkaklarda ayollarga nisbatan KK ko‘proq uchrash tendensiyasi kuzatildi. Yoshi oshishi bilan ikkala guruhda ham kalsinoz chastotasi ortdi, biroq jinslar o‘rtasida statistik jihatdan ahamiyatli farq va yosh bilan bog‘liqlik aniqlanmadi. Ayollarda ko‘proq minimal, erkaklarda esa o‘rtacha darajadagi kalsinoz qayd etildi. Koronar kalsinoz ikki tomonlama ahamiyatga ega ekani aniqlandi: u blyashkani barqarorlashtirishi mumkin, biroq uning yorilish xavfini ham oshiradi. Hatto kichik kalsinatlar ham noxush prognoz bilan bog‘liq.

Kalit so‘zlar: koronar kalsinoz, yurak ishemik kasalligi, semizlik, ateroskleroz, Agatston indeksi, MSKT.

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Abstract

Cardiovascular diseases remain the leading cause of mortality and disability in the adult population. Coronary calcification (CC) is considered an important marker of coronary atherosclerotic disease. The aim of this study was to analyze the prevalence and severity of CC in patients with coronary artery disease (CAD) and obesity. The study included 134 patients aged 45–74 years (78 men and 56 women). Multislice computed tomography with Agatston scoring was used for the diagnosis and quantitative assessment of coronary calcification. Coronary calcification was detected in 91.7% of examined patients. A higher prevalence of CC was observed in men compared to women. The frequency of calcification increased with age in both groups; however, no statistically significant gender differences or correlation with age were found. Women more often demonstrated minimal calcification, whereas men showed moderate forms more frequently.

It was found that coronary calcification has a dual role: it may stabilize atherosclerotic plaques but also increases the risk of plaque rupture. Even minimal calcification is associated with an unfavorable prognosis and increased risk of cardiovascular events.

Keywords: coronary calcification, coronary artery disease, obesity, atherosclerosis, Agatston score, MSCT.

Introduction

Cardiovascular diseases (CVDs) have consistently remained the leading causes of mortality, disability, and reduced quality of life among the adult population for many years [11]. According to the World Health Organization, more than three-quarters of deaths attributable to CVDs occur in low- and middle-income countries. At the same time, even in highly developed nations, these conditions continue to rank among the primary causes of death [5].

The persistently unfavorable trend in mortality from ischemic heart disease (IHD) in our country is due to a combination of contributing factors. These include delayed detection of early and subclinical forms of the disease, insufficient use of pharmacological therapies aimed at slowing the progression of atherosclerosis at the outpatient stage, and the limited implementation of preventive myocardial revascularization strategies. It is important to note that approximately 40% of IHD cases initially present as myocardial infarction or sudden cardiac death without preceding angina symptoms. In addition, a considerable proportion of patients have diffuse and distal coronary artery involvement that is not amenable to surgical intervention, particularly in the presence of comorbid conditions such as diabetes mellitus, obesity, and severe post-infarction left ventricular dysfunction [3].

Clinical manifestations of coronary atherosclerosis typically appear between the ages of 50 and 60 years; however, structural vascular changes develop much earlier. Autopsy studies have demonstrated that approximately 15% of individuals who died between the ages of 10 and 20 years already exhibit intima–media thickening, indicating an early onset of atherogenesis [17].

Subclinical coronary atherosclerosis may develop in men as early as 30–40 years of age, coinciding with the initial formation of calcified lesions in the coronary arteries. A more pronounced распространение coronary calcification is observed in men over 50 years and in women after the age of 60, while by the age of 70, these sex-related differences tend to diminish [16].

Coronary artery calcification (CAC) is recognized as an important marker reflecting both the presence and progression of coronary atherosclerosis. It is well established that atherosclerotic plaques typically contain calcium deposits of varying sizes, ranging from microscopic inclusions to large calcified areas. Notably, calcification processes may begin at the early stages of atherosclerotic lesion development within the vascular wall [16,18].

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From this perspective, the assessment of coronary artery calcification is of particular interest as an integral component of the atherosclerotic process. Although CAC is widely recognized as a hallmark of atherogenesis, its clinical interpretation remains controversial. Specifically, it is still debated whether coronary calcification reflects plaque stability or, conversely, indicates an increased propensity for plaque rupture and subsequent atherothrombosis. Nevertheless, CAC serves as a reliable marker of coronary atherosclerotic burden and can be visualized using noninvasive imaging modalities, making it a valuable tool in clinical practice.

Currently, there is no universally accepted standard for imaging coronary calcification. Available methods include computed tomography (CT), electron beam tomography, contrast-enhanced coronary angiography, and intravascular ultrasound performed during invasive coronary angiography. Among these, non-contrast multislice computed tomography with quantitative assessment of coronary calcium (calcium scoring) is one of the most accessible and widely used techniques for clinical screening. The Agatston scoring method is commonly applied, allowing stratification of patients into the following categories: 0; 1–10; 11–99; 100–399; 400–999; and ≥1000 units [14].

A growing body of evidence supports the prognostic value of CAC assessment in predicting long-term adverse cardiovascular outcomes in asymptomatic individuals. It has been shown that higher calcium scores are associated with an increased prevalence of traditional cardiovascular risk factors, including arterial hypertension, smoking, diabetes mellitus, and advanced age [6,13].

Meta-analyses have demonstrated a strong association between cardiovascular risk estimated using the Framingham Risk Score and the extent of coronary calcification measured in Agatston units. Individuals with CAC scores of 11–100 units exhibit approximately a twofold increase in cardiovascular risk compared to those without calcification, while scores of 101–400 units are associated with a fourfold increase. A tenfold increase in risk has been reported in patients with CAC scores ≥1000 units. Correspondingly, the incidence of myocardial infarction and cardiovascular mortality rises proportionally with the severity of coronary calcification. [4,12].

Large-scale clinical studies have confirmed the utility of CAC scoring in primary prevention, particularly when used in conjunction with established risk assessment tools such as the Framingham Risk Score and the SCORE system, as well as biochemical markers including lipid profiles and C-reactive protein levels [15].

Long-term follow-up studies indicate that elevated CAC scores are associated with older age, male sex, arterial hypertension, diabetes mellitus, dyslipidemia, and smoking. While the Framingham Risk Score is effective in estimating the 10-year risk of cardiovascular events in asymptomatic individuals, CAC scoring provides additional prognostic value over longer periods (15 years or more), including prediction of all-cause mortality [15].

Findings from epidemiological studies, including the ESSE-RF program, demonstrate a strong direct relationship between the volume of calcium deposits and the overall burden of atherosclerotic lesions in the coronary arteries [10]. However, the association between calcium quantity and the degree of luminal stenosis remains relatively weak [9]. Nevertheless, the observed correlation between calcification severity and total atherosclerotic burden supports the use of CAC as a reliable indicator of atherosclerosis.

According to the 2013 clinical guidelines of the European Society of Cardiology for the management of patients with stable coronary artery disease, multislice computed tomography (MSCT) is considered the gold standard for detecting coronary calcification, as it allows quantitative assessment of calcium deposits within coronary arteries [20]. Due to the high

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radiographic density of calcium, the examination can be performed without contrast agents, thereby reducing radiation exposure and minimizing the need for repeated scans. Furthermore, MSCT for CAC assessment has no absolute contraindications, which broadens its applicability in clinical practice.

Aim

The aim of the present study was to evaluate the prevalence of coronary artery calcification in patients with chronic coronary artery disease associated with obesity.

Methods

The study included patients diagnosed with coronary artery disease and obesity: men (n = 78) and women (n = 56) aged 45–74 years. The mean age of the participants was 58.9±0.71 years, including 57.61±0.59 years in men and 59.18±0.45 years in women.

According to the World Health Organization age classification, participants were divided into two groups: Group I (n = 58; 43.2%) included middle-aged individuals (45–60 years), while Group II (n = 76; 56.8%) consisted of elderly patients (61–74 years). No statistically significant age differences were observed between men and women (p = 0.3).

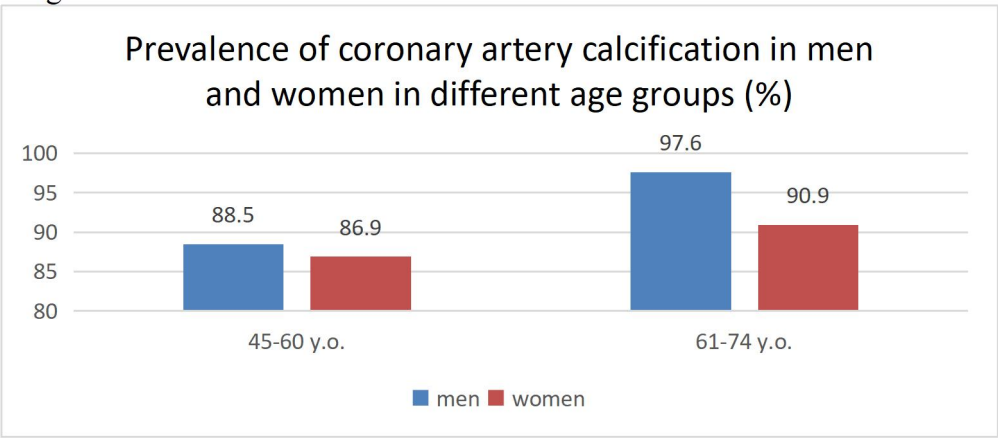
All participants underwent multislice computed tomography to detect coronary calcification and determine its severity. Quantitative assessment was performed using the standard Agatston score. Based on the obtained values, the following categories were defined: no calcification (0), minimum (1–10), moderate (11–100), medium (101–400), and massive calcification (>400 units).

Results and Discussion

According to CT findings, coronary artery calcification was identified in 91.7% of participants (123 patients), including 73 men and 50 women. In the overall sample, there was a tendency toward a higher prevalence of CAC in men compared to women (93.5% vs. 89.2%), although this difference did not reach statistical significance (p = 0.5).

Age-stratified analysis revealed that in the 45–60-year group, CAC was detected in 31 of 35 men (88.5%) and 20 of 23 women (86.9%). In the older age group (61–74 years), the prevalence increased to 97.6% in men and 90.9% in women. However, the age-related increase in CAC prevalence was not statistically significant for either sex p = 0.82 and p = 0.61, respectively (diagram 1).

Diagram 1



Correlation analysis between age and CAC severity showed no gender-specific differences. No significant association was found between age and calcification severity in either men (r = 0.04) or women (r = 0.02). Analysis of the distribution of CAC severity according to the Agatston scale across the two age groups demonstrated (table 1) that minimum calcification was more frequently observed in middle-aged patients (45–60 years), whereas moderate calcification

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predominated in older individuals. Minimum CAC values in Group I were more common among women, while moderate calcification in both age groups was slightly more frequent in men; however, these differences were not statistically significant.

Table 1

Prevalence of severe coronary artery calcification in men and women of different age groups

Groups	I Men (n = 31)	I Women (n = 20)	II Men (n = 42)	II Women (n = 30)
Minimum (1–10)	10 33,2%	8 40%	1 2,3%	3 10%
Moderate (11–100)	8 25,8%	7 35%	25 59,5%	20 66,7%
Medium (101–400)	8 25,8%	3 15%	10 23,8%	6 20%
Massive (>400)	5 16,2%	2 10%	6 14,4%	1 3,3%

For a long time, coronary artery calcification was considered a stabilizing factor for atherosclerotic plaques, as it was thought to strengthen the fibrous cap and reduce the likelihood of plaque rupture. However, current evidence suggests a more complex, dual nature of this process. Specifically, the interface between calcified regions and the intima creates zones of increased mechanical stress due to differences in tissue stiffness, which may elevate the risk of plaque disruption [8]. Moreover, even small calcifications within early or “young” plaques are regarded as unfavorable prognostic indicators associated with an increased risk of atherothrombotic events. Therefore, progression of calcification may be linked to a higher risk of cardiovascular complications [1,19].

Male sex is traditionally considered a non-modifiable risk factor for coronary artery disease. Accordingly, coronary calcification, as a component of the atherosclerotic process, is reported to occur more frequently in men. For instance, in the Multi-Ethnic Study of Atherosclerosis (MESA) conducted in the United States, the prevalence of CAC among men in the general population reached up to 70%. Similar findings were reported in the Framingham Study and the Cardiovascular Health Study [7].

Conclusion

Overall, analysis of a representative sample of patients with coronary artery disease and obesity demonstrated that the prevalence of pathological coronary calcification was 33.9%. Additionally, there was a clear tendency toward a higher frequency and greater severity of calcification among men, consistent with previously reported data.

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