ORIGINAL ARTICLE

CONTENTS

Association between the severity of anatomical damage to the coronary arteries and clinical indicators and Holter electrocardiogram monitoring indicators

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ABSTRACT

Aim: To determine the association between the severity of anatomical damage to the coronary arteries and clinical and Holter electrocardiogram monitoring results.
Materials and Methods: A total of 60 patients were examined; the mean age was 61.67 ± 7.72 years. All patients had stage II hypertension and chronic ischemic heart disease, with or without frequent ventricular premature beats. The nature of the anatomical lesions of the coronary arteries was determined for all patients based on data from coronary ventriculography, which was performed in 3 groups: group 1—all examined patients (n = 60), Group 2 — patients with frequent ventricular extrasystoles (n = 30), Group 3 — patients without frequent ventricular extrasystoles (n = 30) with chronic ischemic heart disease.
Results: In patients with chronic ischemic heart disease, frequent ventricular premature beats (a sign of myocardial electrical instability) are associated with more severe atherosclerotic multivessel disease of the coronary arteries (56.7% of cases), the development of subocclusions and occlusions (100% of cases), as well as with a significantly higher total severity score for anatomical lesions of the coronary arteries based on coronary ventriculography (an average of 5.3 points).
Conclusions: A high total score for the severity of anatomical coronary artery disease and more severe anatomical coronary artery disease in patients with chronic coronary artery disease are associated with male gender, a higher functional class of angina, a longer history of ventricular extrasystoles, the presence of allorhythmia, and an increase in the number of supraventricular and ventricular extrasystoles per day as determined by Holter electrocardiogram monitoring.

KEYWORDS: chronic coronary disease, Holter electrocardiogram monitoring, myocardial electrical instability, premature ventricular contraction

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INTRODUCTION

Coronary heart disease (CHD) is one of the leading causes of death, accounting for 7.4 million deaths worldwide [1]. In approximately half of all patients with CHD, the cause of death is sudden cardiac death (SCD), the main mechanism of which is ventricular arrhythmias (in 84% of cases) [2].

Chronic coronary syndrome, formerly known as stable CHD [3], is associated with stable angina [4]. The severity of atherosclerotic lesions of the coronary arteries (CA) and myocardial changes is an important risk factor for SCD [5].

Ventricular extrasystole (VE) is associated with the risk of SCD [6] and is a marker of electrical instability of the heart [7]. VE are found in 0.7–1% of clinically healthy individuals during standard electrocardiogram (ECG) recording and in 50% during 24-hour Holter ECG monitoring (HM ECG) [8].

Frequent VE can occur in 1–4% of the general population and can provoke life-threatening (malignant) arrhythmias, such as polymorphic ventricular tachycardia or ventricular fibrillation, which are usually associated with structural heart disease [9]. In addition, in people without symptoms and without suspected heart disease, exercise-induced VE has been associated with mortality [10].

Given the above, timely diagnosis of CHD and prevention of the risks of SCD, in particular frequent VE, are important factors in prolonging the life expectancy and improving the quality of life of the population.

AIM

The aim is to determine the association between the severity of anatomical damage to the coronary arteries and clinical and Holter electrocardiogram monitoring results.

MATERIALS AND METHODS

PARTICIPANTS

Sixty individuals with stage II hypertension and concomitant chronic coronary disease (CCD) with and without frequent VE were examined. Among the examined patients, there were 46 (76.7%) men and 14 (23.3%) women. The average age was 61.67±7.72 years.

Inclusion criteria for the study: patients aged 30 to 75 years, stage II hypertension, concomitant coronary artery disease (CAD) limited to a single clinical presentation—exertional angina of functional class II–III (FC), symptomatic frequent premature beats (optional inclusion criterion) (>30 episodes of premature beats during any hour of the study), and the patient's informed consent to participate in the study.

Exclusion criteria: patients younger than 30 or older than 75 years of age, stage I and III hypertension, symptomatic hypertension, acute forms of coronary artery disease (unstable angina, acute myocardial infarction), history of myocardial infarction and stable exertional angina, Class IV according to the New York Heart Association, chronic heart failure Stage D according to the Heart Failure Society of America, left ventricular ejection fraction < 50% as determined by echocardiography, NYHA Class III–IV and Strazhesko-Vasilenko Stages 2–3 (Recommendations of the ESC, 2023 [11] and the All-Ukrainian Association of Cardiologists of Ukraine on the Diagnosis, Treatment, and Prevention of Chronic Heart Failure, 2024 [12]), cardiopathy, acute or previous myocarditis, clinically significant congenital and acquired heart defects, complete bundle branch block, second- or third-degree sinoatrial or atrioventricular block, need for implantation or an implanted pacemaker, diabetes mellitus, severe and clinically significant comorbid conditions with organ dysfunction, mental disorders and alcohol abuse, lack of informed consent, and the patient's unwillingness to participate in the study.

Based on the presence or absence of frequent PE, three groups of patients were identified: Group 1 (overall) – all patients with CHF (n=60); Group 2 – patients with CHF and frequent PE (n=30); Group 3 – patients with CHF without frequent PE (n=30). Male patients predominated (26 men in Group 2 and 20 in Group 3).

Taking into account the presence or absence of frequent VE, three groups of patients were identified: group 1 (general) – all patients with CCD (n=60), group 2 – with CCD and frequent VE (n=30), group 3 – with CCD without frequent VE (n=30). Male patients predominated (26 men in the 2nd group and 20 in the 3rd group).

RESEARCH METHODS

Stage II hypertension was determined in accordance with the recommendations of the European Society of Hypertension 2023 [13] and the clinical protocol for primary and specialised medical care 'Hypertensive disease (arterial hypertension) [14]. Concomitant CCD was verified instrumentally (stress tests) and/or by coronary ventriculography (CVG), which included only exertional angina of functional classes II-III (FC) according to the recommendations of the European Society of Cardiology 2024 [15] and the unified clinical protocol 'Stable ischaemic heart disease' [16]. Cardiac rhythm disturbances were determined using HM ECG [17].

STATISTICAL ANALYSIS

Statistical analysis of the study results was performed using methods of variational statistics with Microsoft Excel (2019) and Statistica 12.0 (Statsoft, USA), in accordance with the recommendations of 'Statistical Analysis in Medical Research' (2019) of the Department of Medical Statistics of the P.L. Shupyk National Medical Academy of Postgraduate Education [18].

Quantitative values were presented as the median and interquartile range (25th and 75th percentiles) due to the abnormal distribution of values in the sample, which was determined by the W-test (Shapiro-Wilk criterion).

The frequency of the trait in the sample was reflected using relative values and presented as percentages (%). The intergroup reliability of the results between quantitative values was calculated using the Kruskal-Wallis ANOVA & median test, and between relative values (%) using the $\chi 2$ criterion for independent samples. Results were considered statistically significant at $p \leq 0.05$.

The relationship between individual parameters was determined using Spearman's nonparametric rank correlation analysis (Spearman Rank Order Correlations, 'Nonparametric Statistics' module of the StatSoft 'Statistica' v. 12.0 package) [19].

ETHICS

The study protocol was developed in accordance with the ethical standards of the Declaration of Helsinki and approved by the local ethics committee of National Pirogov Memorial Medical University, Vinnytsya (protocol No. 8 of 5 October 2017). The patient gave informed consent to participate in the study.

AI STATEMENT

The author states that no AI tools were used in writing this article.

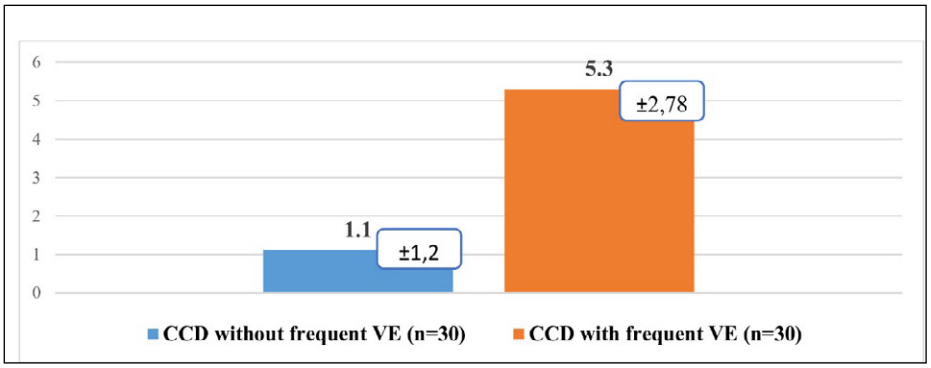


Fig. 1. Total severity score for anatomical lesions of the coronary arteries based on the presence or absence of frequent ST-segment elevation (mean scores ± standard deviation are shown)
Legend: CCD – chronic coronary disease; VE – ventricular extrasystole.
Picture taken by the authors
Picture taken by the authors

RESULTS

In 100% of patients in the 2nd (median value - 1721; interquartile range - 942 and 2435 episodes per day) and 70.0% of the 3rd (median value - 192; interquartile range - 56 and 411) clinical groups, supraventricular extrasystole (SVE) was recorded, which was not a criterion for excluding patients from the study. In the group of patients with frequent VE (group 3), the frequency of SVE per day was significantly higher compared to the group without frequent VE (group 2) (192 vs. 1721, p <0.0001).

In patients in group 2, according to HM ECG data, frequent VE were recorded (> 30 episodes at least during 1 hour of the study within 24 hours). Isolated VE was not a criterion for exclusion from the study and were recorded in 9 (30.0%) patients in group 3. This group was the comparison group in relation to the group with frequent VE (group 2, respectively). Thus, in the 3rd group, a small number of episodes of VE per day were determined (median value - 14; interquartile range - 12 and 18), compared with the 2nd group (median value - 2474; interquartile range - 1663 and 3592). Therefore, the statistical significance of the results obtained was determined (14 vs. 2474 episodes, p<0.0001).

Only 23% (n=7) of patients in group 2 had constant feelings of arrhythmia and used constant antiarrhythmic therapy.

In patients with CCD II and III FC, angina pectoris occurred with equal frequency (41.7% vs. 58.3%, p=0.19). All patients with CCD were diagnosed with the nature of anatomical damage to the CA based on CVG data.

In group 3, compared with group 2 patients, the proportion of cases with atherosclerotic lesions (presence of atherosclerotic plaques of any size) of the main trunk of the left CA was much higher (40.0% vs. 16.7%, p=0.04). We also determined the accuracy of the diagnosis of occlusion (CA stenosis ≥ 90%) of the left CA trunk based on the percentage (10.0% vs. 0%, p = 0.07). In addition, in the second group (with frequent VE), compared with the third group (without frequent VE), we also determined a significantly higher percentage of: 1) occlusions of the middle section of the left anterior descending (interventricular) CA (13.3% vs. 0, p=0.04); 2) atherosclerotic lesions, occlusions and subocclusions (stenosis 60-90%) of the first diagonal branch of the left anterior descending (interventricular) CA (50.0% vs. 20.0%, p=0.01; 16.7% vs. 0, p=0.02 and 20.0% vs. 3.3%, p 0.04, respectively); 3) atherosclerotic lesions of the second diagonal branch of the left anterior descending (interventricular) CA (16.7% vs. 0, p=0.02) and the proximal section of the circumflex branch of the left CA (43.3% vs. 20.0%, p=0.05); 4) atherosclerotic lesions and occlusions of the middle section of the circumflex branch of the left CA (60.0% vs. 33.3%, p=0.03 and 33.3% vs. 3.3%, p=0.003, respectively); 5) atherosclerotic lesions, occlusions and subocclusions of the obtuse edge branch of the left circumflex artery (40.0% vs. 16.7%, p=0.04; 16.7% vs. 0, p=0.02 and 5.0% vs. 0, p=0.07, respectively); 6) occlusions of the proximal section of the right CA (23.3% vs. 0, p=0.005); 7) atherosclerotic lesions of the middle section of the right CA (63.3% vs. 36.7%, p=0.04); 8) atherosclerotic lesions and occlusions of the distal right CA (33.3% vs. 10.0%, p=0.03 and 23.3% vs. 0, p=0.005, respectively).

An analysis was also performed depending on the number of affected CA, which included only patients with haemodynamically significant CA stenoses (CA occlusions and subocclusions). Discrepancies were determined only by the frequency of multivessel disease (lesions of 3 or more vessels) — in the group with CCD and frequent VE, compared with the group without frequent VE, multivessel lesions were determined significantly more often (56.7%, n=17 versus 10.0%, n=3, p=0.0001). This indicates more severe CA lesions in patients with frequent VE and the presence of a certain association between multivessel CA lesions and electrical myocardial instability. A high statistical significance was determined in the percentage difference (p=0.0001) between the groups in terms of the frequency of obstructive CHD (at least one occlusion or subocclusion of the CA): in 100% of cases (n=30) in patients in group 2, this variant of CCD

Table 1. Associations between the severity of anatomical coronary artery disease and clinical parameters and ECG parameters (Spearman's rank correlation)

Indicators associated with the severity of CA damage	R Spirman	P
Male gender (yes -1, no – 0)	0.28	0.03
FC of angina pectoris (FC II -2, FC III – 3)	0.33	0.01
Duration of VE in years	0.71	<0.00001
Presence of persistent VE - bigeminy, trigeminy (Yes -1, No -0)	0.27	0.03
Number of SVE per day	0.54	<0.00001
Number of VE per day	0.63	<0.00001

Legend: CA – coronary arteries; VE – ventricular extrasystole; SVE – supraventricular extrasystole
Source: compiled by the authors of this study

was determined, while in group 3, there were 60.0% (n=18) such cases.

To assess the nature of the anatomical lesion of the CA based on CVG data, we determined the total severity index of the CA lesion, which was calculated as the sum of the lesions of all CA, where subocclusion was 1 point and CA occlusion was 2 points, respectively. In the general group of patients (n=60), a variance analysis of the obtained index was performed, the range of values of which varied from 0 to 11 and averaged 3.22±3.0 points (median index – 3; interquartile range – 1 and 5). Therefore, it was reasonable to assume that half of the patients with CCD had a total score for the severity of anatomical CA lesions ranging from 1 to 5 points. In 25% of patients, it was less than 1 point, i.e. these patients had non-obstructive CCD, and in another 25% it was higher than 5 points, indicating the presence of multivessel (multifocal) coronary artery disease. The data shown in Fig. 1 indicate that in patients with CCD and frequent VE (group 2), compared to the group without frequent VE (group 3), there was a significant increase in the total score of anatomical CA lesions according to CVG data – 5.3 versus 1.1 points, $p<0.0001$ according to the t-test for independent samples (Fig. 1).

After calculating the total score for the severity of anatomical damage to the CA, we performed a non-parametric Spearman's rank correlation analysis to determine the associations between this score and various clinical indicators and HM ECG parameters (Table 1). The table included only those indicators that showed a statistically significant ($p<0.05$) correlation with the initial parameter.

It was determined that the total indicator of the severity of anatomical damage to the CA had a positive correlation with male gender (R=0.28; p=0.03), higher FC of angina pectoris (R=0.33; p=0.01), duration of history of VE in years (R=0. 71; $p<0.00001$), the presence of constant extrasystole - bigeminy, trigeminy (R=0.27; p=0.03) and the number of both SVE (R=0.54; $p<0.00001$) and VE per day (R=0.63; $p<0.00001$).

Thus, a higher total score and, accordingly, more severe anatomical damage to the CA according to CVG should be expected in men with high FC of angina pectoris (> FC II), with a long history of VE (on average 2.1 years with a total score > 3 points), in the presence of arrhythmia and an increased number of SVE (on average 1667 episodes) and VE (2864 episodes with a total score > 3 points) per day according to HM ECG data.

DISCUSSION

We have, for the first time, determined the total coronary artery (CA) lesion score based on coronary angiography (CAG) data in patients with hypertension and concomitant coronary artery disease (CAD), and identified the association between the severity of anatomical CA lesions and clinical parameters and ECG parameters in these patients. Our use of a total score for the severity of coronary artery disease was driven by the need to derive an integrated parameter of the entire coronary bed, taking into account the most problematic segments of the coronary arteries. We considered only subocclusions and occlusions of large vessels in points (1 and 2 points, respectively) and summed them.

V. Maslovskyi et al. [20, 21] proposed a scale for assessing the severity of atherosclerotic coronary artery stenosis in patients with non-ST-segment elevation myocardial infarction (NSTEMI). The authors scored atherosclerotic CA stenosis as follows: 0 points for the absence of atherosclerotic plaques in the CA, 1 point for the presence of hemodynamically insignificant stenosis (up to 50%), 2 – the presence of hemodynamically significant stenosis (50% to 90%), and 3 points – the presence of hemodynamically significant stenosis (90% to complete occlusion). Researchers determined the total severity score of CA disease as the sum of the severity scores for the left CA's diagonal branch/anterior interventricular branch, circumflex branch, and right coronary artery.

Given the above, the timely diagnosis of coronary heart disease and the prevention of risks associated with cardiovascular disease, particularly recurrent myocardial infarction, are crucial for extending life expectancy and improving the quality of life of the population.

CONCLUSIONS

It has been demonstrated that in patients with CHD, frequent premature VE (a sign of myocardial electrical instability) on an HM ECG are associated with more severe anatomical coronary artery lesions as determined by coronary angiography.

It has been shown that signs of myocardial electrical instability in patients with CHD are associated with a significantly higher frequency of multivessel disease and obstructive CHD, as well as a significantly higher total score for the severity of anatomical CAD lesions based on coronary angiography.

It was found that a higher total score of the severity of anatomical CAD lesions, and, accordingly, more severe anatomical CAD lesions in patients with CHD, is associated with male gender, a higher functional class of angina (> Class II), a longer history of angina, the presence of arrhythmias, and an increased number of premature beats and angina episodes per day as determined by Holter ECG monitoring.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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