CARDIOLOGY

CONTEMPORARY ALGORITHMS FOR DIAGNOSING OBSTRUCTIVE CORONARY ARTERY DISEASE IN REAL CLINICAL PRACTICE

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ABSTRACT

Background. *Despite the high evidence level of the currently existing international recommendations on stable coronary heart disease (CHD) and chronic coronary syndrome, their implementation in domestic clinical practice is insufficient.*
The aim of the work. *To analyze the choice of diagnostic tactics (non-invasive and invasive) in patients with suspected obstructive coronary heart disease in real clinical practice.*
Methods. *The study included outpatients with suspected obstructive CHD, in whom the pre-test probability (PTP) of obstructive CHD was determined; if PTP = 5–15 %, clinical probability was assessed based on CHD risk factors. Based on the results of coronary angiography, the following groups were identified: group I – obstructive lesion of the coronary arteries (≥ 70 %) (n = 50); group II – non-obstructive lesion of the coronary arteries (< 70 %) (n = 32); group III – intact coronary arteries (n = 40).*
Results. *According to the results of coronary angiography, the frequency of detection of obstructive lesion of the coronary arteries was 42 % (in patients without past medical history of myocardial infarction – 31 %). Before performing coronary angiography, non-invasive tests were performed in 2.5 % of cases. Pain in the chest was represented by typical angina in 74 % of patients, with no difference in frequency in all groups. PTP values were statistically significantly higher in the group with obstructive CHD (median – 32 %), however, in the other two groups, PTP values corresponded to a high risk of obstructive CHD (median – 27 % and 21 %, respectively). PTP was an independent predictor for obstructive CHD and subsequent myocardial revascularization.*
Conclusion. *In the cohort of outpatients with suspected coronary heart disease we examined during invasive coronary angiography, the frequency of obstructive lesion of the coronary arteries remains low. Non-invasive tests were performed in isolated cases, while PTP was an independent predictor for obstructive CHD and subsequent myocardial revascularization. To increase the frequency of detection of obstructive coronary heart disease, we should adhere to the diagnostic algorithms of the European Society of Cardiology and make wider use of non-invasive imaging tests.*

Key words: *chronic coronary syndrome, pre-test probability, clinical probability, coronary angiography, clinical practice, diagnostic algorithm*

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СОВРЕМЕННЫЕ АЛГОРИТМЫ ДИАГНОСТИКИ ОБСТРУКТИВНОЙ ИШЕМИЧЕСКОЙ БОЛЕЗНИ СЕРДЦА В РЕАЛЬНОЙ КЛИНИЧЕСКОЙ ПРАКТИКЕ

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РЕЗЮМЕ

Обоснование. *Несмотря на высокий доказательный уровень существующих на сегодняшний день международных рекомендаций по стабильной ишемической болезни сердца (ИБС) и хроническому коронарному синдрому, их внедрение в отечественную клиническую практику является недостаточным.*

Цель работы. *Провести анализ выбора диагностической тактики (неинвазивной и инвазивной) у пациентов с подозрением на обструктивную ишемическую болезнь сердца в реальной клинической практике.*

Методы. *В исследование включены амбулаторные пациенты с подозрением на обструктивную ИБС, у которых определяли предтестовую вероятность (ПТВ) обструктивной ИБС; при ПТВ = 5–15 % оценивали клиническую вероятность на основе факторов риска ИБС. По результатам коронароангиографии (КАГ) были выделены: группа I – обструктивное поражение коронарных артерий (КА) (≥ 70 %) (n = 50); группа II – необструктивное поражение КА (< 70 %) (n = 32); группа III – интактные КА (n = 40).*

Результаты. *По данным КАГ частота выявления обструктивных поражений КА составила 42 % (у больных без инфаркта миокарда в анамнезе – 31 %). Перед проведением КАГ неинвазивные тесты выполнены в 2,5 % случаев. Болевой синдром в грудной клетке был представлен типичной стенокардией у 74 % больных, не различаясь по частоте во всех группах. Значения ПТВ были статистически значимо выше в группе обструктивной ИБС (медиана – 32 %), однако и в двух других группах значения ПТВ соответствовали высокому риску наличия обструктивной ИБС (медиана – 27 % и 21 % соответственно). ПТВ была независимым предиктором обструктивной ИБС и последующей реваскуляризации миокарда.*

Заключение. *В обследованной нами когорте амбулаторных больных с подозрением на ИБС при проведении инвазивной КАГ частота выявления обструктивных поражений коронарных артерий остаётся невысокой. Неинвазивные тесты были проведены в единичных случаях, в то же время ПТВ была независимым предиктором обструктивной ИБС и последующей реваскуляризации миокарда. Для увеличения частоты выявления обструктивной ИБС следует придерживаться диагностических алгоритмов Европейского общества кардиологов, шире использовать неинвазивные визуализирующие тесты.*

Ключевые слова: *хронический коронарный синдром, предтестовая вероятность, клиническая вероятность, коронарная ангиография, клиническая практика, диагностический алгоритм*

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INTRODUCTION

In the diagnostics of coronary heart disease (CHD), the following contradiction is currently unresolved: on the one hand, early detection of obstructive lesions of the coronary arteries (CA) is possible for carrying out possible myocardial revascularization procedures; on the other hand, with invasive coronary angiography (ICA) in patients with stable CHD, the frequency of detection of such lesions remains low [1–4]. Thus, according to data from a foreign national registry study, obstructive lesions of the CA were detected in 37.6 % of cases [1], while in domestic publications the results vary greatly depending on the cohort of patients examined [2] and the criteria for coronary obstruction [5]. In general, throughout Russia, only about 50 % of ICAs end in myocardial revascularization [6], but it should be taken into account that both emergency and planned ICAs are considered, therefore the diagnostic effectiveness of planned ICA in domestic centers apparently does not differ from foreign data [2]. At the same time, in foreign countries, diagnostic algorithms in real clinical practice differed (wide use of non-invasive tests – both functional, with detection of myocardial ischemia, and anatomical) from those used in most Russian clinics (clinical assessment and electrocardiographic (ECG) stress test). Although attempts were made in Russian centers to expand the range of non-invasive assessment in patients with suspected coronary heart disease, they were not very successful, and the frequency of such examinations remained low [7, 8].

Apparently, the adoption of a new diagnostic algorithm for CHD, presented in the 2019 European Society of Cardiology (ESC) guidelines [9], can change this situation. In any case, the recently published results of the EURECA (European Registry of Cardiac Arrest) showed that when these recommendations are followed, the frequency of detection of obstructive coronary artery lesions increases [10]. Several Russian centers also took part in this study, but these data have not yet been published. Meanwhile, it is interesting to compare the extent to which new diagnostic algorithms are currently used. This served as the basis for this study, and the purpose was to analyze the choice of diagnostic tactics (non-invasive and invasive) in patients with suspected obstructive coronary heart disease in real clinical practice.

MATERIALS AND METHODS

In this cohort retrospective study, 133 patients with suspected obstructive coronary artery disease were selected using the continuous sampling method. They visited the outpatient clinic of the Research Institute for Complex Issues of Cardiovascular Diseases in 2022 and were selected by cardiologists for ICA.

All patients underwent pain assessment (presence of typical, atypical angina or non-anginal pain), as well as dyspnea, assessed as equivalent to angina. Based on the results of pain assessment, age and gender, pretest probability (PTP) of obstructive coronary artery disease was determined in patients according to the table proposed by the ESC experts [9]. In case of intermediate PTP values (5–15 %), clinical probability of obstructive coronary artery disease was assessed in patients based on the presence or absence of coronary artery disease risk factors (dyslipidemia, arterial hypertension, diabetes mellitus, smoking, heredity) [11]. Some patients underwent non-invasive tests (stress echocardiography (stress ECHO) with physical activity or computed tomography (CT) angiography of the coronary artery) at the discretion of the attending physician.

Ten patients (7.2 %) refused ICA; in one case (0.7 %) the patient died before ICA. As a result, ICA was performed in 122 patients, which constituted 91.7 % of the entire sample. All patients underwent invasive assessment of the coronary bed using an INNOVA 3100 angiographic apparatus (USA) using the standard technique. Based on the ICA results, three groups of patients were identified depending on the hemodynamic significance of the coronary artery lesion: group I – obstructive coronary artery lesion (≥ 70 %; n = 50 – 36.0 %); group II – non-obstructive coronary artery lesion (< 70 %; n = 32 – 23.0 %); group III – intact coronary arteries (n = 40 – 28.8 %).

The choice of surgical treatment tactics was carried out by a multidisciplinary team (cardiovascular surgeon, endovascular surgeon, cardiologist) based on clinical and instrumental data, the significance of coronary atherosclerosis, existing clinical guidelines and internal algorithms of the institution.

The groups were compared based on initial clinical and anamnestic data, the nature of chest pain syndrome, the results of PTP assessment, and clinical probability. We also studied the chosen tactics of surgical treatment of obstructive coronary artery lesions and/or other cardiac pathology.

The study is conducted in accordance with the fundamental topic of the Research Institute for Complex Issues of Cardiovascular Diseases "Development of innovative models for managing the risk of developing diseases of the circulatory system taking into account comorbidity based on the study of fundamental, clinical, epidemiological mechanisms and organizational technologies of medical care in the industrial region of Siberia" (state registration No. 122012000364-5 dated January 20, 2022). The study was carried out in compliance with the principles of the World Medical Association Declaration of Helsinki; the study protocol and the informed consent form were approved by the local Ethics Committee (LEC) of the institution (LEC protocol No. 20191121 dated November 21, 2019).

Statistical processing of the material was performed using the Statistica 10.0 software package (StatSoft Inc., USA). The distribution of quantitative data was checked using the Shapiro – Wilk criterion. Considering that the distribution of all quantitative features differed from normal, they are presented as median,

upper and lower quartiles (Me (Q25; Q75). The Kruskal – Wallace, Mann – Whitney, and χ^2 criteria were used to compare groups. With a small number of observations, Fisher's exact test with Yates' correction was used. The Bonferroni correction was used to solve the problem of multiple comparisons. Multiple logistic regression analysis (Forward Stepwise LR method) was performed to assess the factors associated with the presence of obstructive coronary artery disease and subsequent myocardial revascularization. The independent variables included in the models were risk factors, gender, age, and chest pain symptoms, presence of comorbid pathology, PTP values, and noninvasive test data. Calculations were performed both for the entire examined cohort and separately for patients without myocardial infarction in medical history. The ability of various indicators to predict the presence of obstructive coronary lesions was assessed using ROC-analysis. The level of statistical significance (p) was taken to be 0.05.

RESULTS

When assessing the clinical and demographic parameters (table 1), the groups were comparable in age (p = 0.798), prevalence of arterial hypertension, presence of hypercholesterolemia, obesity, and stroke in medical history. In group I (obstructive coronary artery disease), men prevailed (72 %), in group III (intact coronary arteries), there were more women (67.5 %), and in group II (non-obstructive coronary artery disease), men accounted for 53.1 % ($p < 0.001$ for trend).

Patients with obstructive coronary artery disease were statistically significantly more likely to smoke (50 %) compared to patients in groups II (34.4 %) and III (25.6 %), but this difference did not reach statistical significance (p = 0.065). Patients in group I were more likely to have myocardial infarction in medical history (46 %; $p < 0.001$ for trend), but in the other two groups (non-obstructive coronary artery disease and intact

TABLE 1

COMPARATIVE CHARACTERISTICS OF THE MAIN CLINICAL AND DEMOGRAPHIC INDICATORS IN THE STUDIED GROUPS

Indicators	Group I: obstructive CA (*n = 50*)	Group II: non-obstructive CA (*n = 32*)	Group III: intact CA (*n = 40*)	*p*
Age (years), Me (LQ; UQ)	66.0 (61.0; 71.0)	67.0 (61.0; 73.0)	66.0 (60.5; 72.0)	0.798
Men, *n* (%)	32 (72.0)	17 (53.1)*	13 (32.5)*; #	< 0.001
Smoking, *n* (%)	25 (50.0)	11 (34.38)	9 (25.7)	0.065
Obesity, *n* (%)	14 (28.0)	10 (31.3)	13 (32.5)	0.891
Hypercholesterolemia, *n* (%)	50 (100.0)	30 (93.75)	38 (95.0)	0.227
PIC in medical history, *n* (%)	23 (46.0)	8 (25.0)*	3 (7.5)*; #	< 0.001
AH in medical history, *n* (%)	50 (100.0)	32 (100.0)	38 (95.0)	0.124
CVA in medical history, *n* (%)	8 (16.0)	5 (15.6)	4 (10.0)	0.681
DM in medical history, *n* (%)	5 (10.2)	6 (19.4)	10 (25.0)	0.179
PCI in medical history, *n* (%)	12 (24.0)	8 (25.0)	0	0.032
CABG in medical history, *n* (%)	4 (8.0)	3 (9.4)	0	0.157
CE in medical history, *n* (%)	1 (2.0)	0	0	0.483
AFib in medical history, *n* (%)	8 (16.0)	7 (21.9)	15 (37.5)	0.057
CHFpEF in medical history, *n* (%)	2 (4.0)	3 (3.13)	0	0.458
CKD in medical history, *n* (%)	3 (6.0)	2 (6.25)	0	0.279
AL BCA in medical history, *n* (%)	10 (20.0)	5 (15.6)	5 (12.5)	0.627
MFA in medical history, *n* (%)	10 (20.0)	5 (15.6)	0	0.013

Note. PIC – postinfarction cardiosclerosis; AH – arterial hypertension; CVA – acute cerebrovascular accident; DM – diabetes mellitus; PCI – percutaneous coronary intervention; CABG – coronary artery bypass grafting; CE – carotid endarterectomy; AFib – atrial fibrillation; CHFpEF – chronic heart failure with preserved ejection fraction; CKD – chronic kidney disease; AL BCA – atherosclerotic lesion of the brachiocephalic arteries; MFA – multifocal atherosclerosis; * – $p < 0.05$ compared to group I; # – $p < 0.05$ compared to group II.

coronary arteries), postinfarction cardiosclerosis was also noted (in 25 % and 7.5 % of cases, respectively).

According to clinical symptoms (table 2), typical angina was more often present in patients of group I with obstructive coronary artery disease (in 90 % of cases), while in groups II and III – only in 75 % of cases. Atypical pain prevailed in groups II and III (in 18.8 % and 17.5 % of cases, respectively), while in group I – only in 9.0 % of patients. Nevertheless, the differences between the groups in the nature of the pain syndrome did not reach statistical significance. Patients with dyspnea were equally common in all groups of subjects.

The analysis of clinical probability (table 3) did not show statistically significant differences between the groups, and it was 14.0 in each group. The pre-test probability of CHD was higher in group I with obstructive coronary artery disease and averaged 32 %; in the group with non-obstructive coronary artery disease – 27 %, in the group with intact coronary arteries – 21 % ($p < 0.001$ for trend).

Patients with PTP less than 5 % were not referred for invasive examination – there were no such patients in our cohort; there were also no patients with PTP from 5 % to 15 % in group I. Statistically significantly more patients with PTP = 5 – 15 % were in the group of intact coronary arteries (20 %) than in the group of non-obstructive coronary artery disease (6.25 %; $p = 0.002$). PTP was more than 15 % in all patients with obstructive coronary artery disease, in 93.75 % of patients with non-obstructive coronary artery disease, and in 80 % of patients with intact coronary arteries ($p = 0.0024$). Non-invasive tests before ICA were performed only in 2.5 % of patients; in these patients, despite the positive test, the coronary arteries were intact.

Percutaneous coronary intervention was performed in 76 % of patients with obstructive coronary lesions (table 4); coronary artery bypass grafting was not performed in the examined patients. Carotid endarterectomy was performed in 3 (6.0 %) patients from the group with obstructive coronary lesions. Radiofrequency

TABLE 2

CLINICAL SYMPTOMS IN COMPARISON WITH THE RESULTS OF CORONARY ANGIOGRAPHY

Indicators	Group I: obstructive CA (*n* = 50)	Group II: non-obstructive CA (*n* = 32)	Group III: intact CA (n = 40)	*p*
Typical pain, *n* (%)	45 (90.0)	24.0 (75.0)	30 (75.0)	0.125
Atypical pain, *n* (%)	3 (6.0)	6 (18.8)	7 (17.5)	0.071
Non-anginal pain, *n* (%)	3 (6.0)	1 (3.13)	2 (5.0)	0.923
Dyspnea, *n* (%)	2 (4.0)	1 (3.13)	1 (2.5)	0.953

TABLE 3

ASSESSMENT OF THE PRE-TEST PROBABILITY OF CORONARY HEART DISEASE DEPENDING ON THE DEGREE OF CORONARY ARTERY STENOSIS

Indicators	Group I: obstructive CA (*n* = 50)	Group II: non-obstructive CA (*n* = 32)	Group III: intact CA (*n* = 40)	*p*
PTP (%), Me (LQ; UQ)	32.0 (27.0; 44.0)	27.0 (18.0; 44.0)*	21.0 (16.0; 27.0)*,#	< 0.001
PTP < 5 %, *n* (%)	0	0	0	–
PTP = 5–15 %, *n* (%)	0	2 (6.25)	8 (20.0)#	0.002
PTP > 15 %, *n* (%)	50 (100.0)	30 (93.75)*	32 (80.0)*,#	0.0024
Clinical probability (%), Me (LQ; UQ)	14.0 (11.0; 14.0)	14.0 (14.0; 19.0)	14.0 (10.0; 14.0)	0.551
Non-invasive tests, *n* (%)	0	0	1 (2.5)	0.355

Note. * – $p < 0.05$ compared to group I; # – $p < 0.05$ compared to group II.

catheter ablation was performed in 2 (4.0 %) patients from the obstructive coronary lesions group and in 1 (3.13 %) patient in the non-obstructive coronary lesions group. A pacemaker was installed only in 1 (3.13 %) patient in the non-obstructive coronary lesions group.

In the binary logistic regression model, the independent factors associated with the presence of obstructive coronary lesions in the entire cohort of patients examined were myocardial infarction in medical history and PTP values (table 5). This logistic regression model was statistically significant ($\chi^2(2) = 24.936$;

TABLE 4

TACTICS OF SURGICAL TREATMENT DEPENDING ON THE DEGREE OF CORONARY ARTERY STENOSIS

Indicators	Group I: obstructive CA (*n* = 50)	Group II: non-obstructive CA (*n* = 32)	Group III: intact CA (n = 40)	*p*
PCI, *n* (%)	38 (76.0)	0	0	< 0.001
CABG, *n* (%)	0	0	0	–
CE, *n* (%)	3 (6.0)	0	0	0.109
RFCA, *n* (%)	2 (4.0)	1 (3.13)	0	0.457
PM, *n* (%)	0	1 (3.13)	0	0.242
Heart valve replacement, *n* (%)	0	1 (3.13)	0	0.242

Note. PCI – percutaneous coronary intervention; CABG – coronary artery bypass grafting; CE – carotid endarterectomy; RFCA – radiofrequency catheter ablation; PM – pacemaker.

TABLE 5

FACTORS ASSOCIATED WITH OBSTRUCTIVE CORONARY HEART DISEASE AND SUBSEQUENT MYOCARDIAL REVASCULARIZATION ACCORDING TO BINARY LOGISTIC REGRESSION ANALYSIS (FORWARD STEPWISE LR METHOD)

Factors	B	S.E.	Wald	df	Sig.	Exp(B)
Obstructive coronary artery disease (entire cohort of subjects)						
Myocardial infarction in medical history	1.454	0.469	9.612	1	0.002	4.280
PTP	0.057	0.019	9.429	1	0.002	1.059
Constant	–2.504	0.629	15.866	1	0.000	0.082
Obstructive coronary artery disease (patients without myocardial infarction in medical history)						
PTP	0.088	0.025	12.322	1	0.000	1.092
Carotid artery atherosclerosis	1.672	0.711	5.537	1	0.019	5.324
Constant	–3.749	0.872	18.504	1	0.000	0.024
Conducting myocardial revascularization after ICA (the entire cohort of subjects examined)						
Myocardial infarction in medical history	1.242	0.451	7.591	1	0.006	3.463
PTP	0.071	0.019	13.452	1	0.000	1.073
Constant	–3.658	0.713	26.353	1	0.000	0.026
Conducting myocardial revascularization after ICA (patients without myocardial infarction in medical history)						
Obesity	1.850	0.690	7.191	1	0.007	6.360
PTP	0.101	0.030	11.258	1	0.001	1.107
Multifocal atherosclerosis	2.769	1.228	5.084	1	0.024	15.947
Constant	–5.629	1.256	20.074	1	0.000	0.004

$p < 0.001$). The model explained 26.4 % (Nagelkerke R2) of the variance in obstructive coronary lesions and correctly classified 71.1 % of cases. In the cohort of patients without myocardial infarction in medical history, PTP and the presence of carotid artery atherosclerosis were precursors of obstructive coronary lesions ($\chi^2(2) = 20.646$; $p < 0.001$; Nagelkerke R2 = 31.7 %; correct classification in 74.1 % of cases). In patients undergoing myocardial revascularization, predictors of obstructive coronary artery disease were PTP, obesity, and multifocal atherosclerosis ($\chi^2(3) = 24.878$; $p < 0.001$; Nagelkerke R2 = 37.3%; correct classification in 87.2 % of cases).

According to the ROC analysis (fig. 1), in patients without CHD in medical history, the PTP values to the greatest extent predicted the presence of obstructive coronary artery disease (AUC = 0.747), in contrast to other studied indicators (gender, age, nature of chest pain, risk factors).

DISCUSSION

The present study yielded several interesting results. First, the frequency of detection of obstructive coronary lesions remains low (42 % overall among all examined patients and 31 % in patients without CHD in medical history). Second, non-invasive tests are still performed episodically. Third, the determination of PTP is used in the practice of cardiologists, which indicates the absence of patients with PTP < 5 % among those referred for ICA. In addition, PTP assessment remains the most informative indicator in predicting the presence of obstructive CHD.

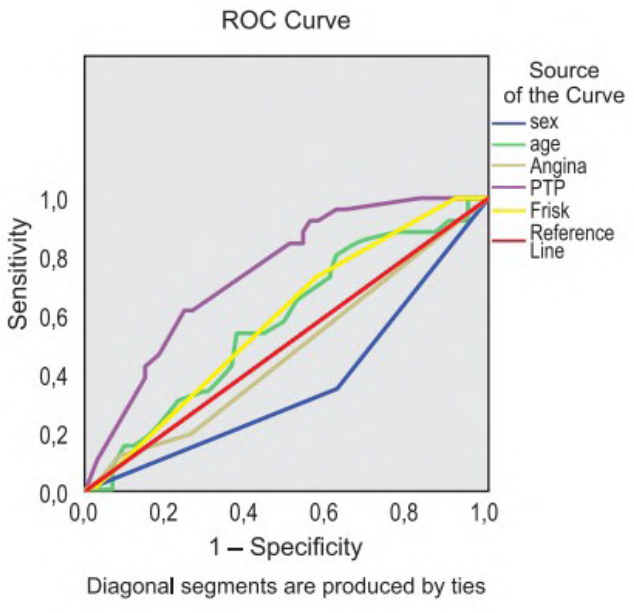

FIG. 1.
ROC-analysis: using various indicators in the detection of obstructive lesion of the coronary arteries in coronary angiography

According to the KUGH registry (South Korea), over a ten-year period (2004–2014), obstructive CHD was detected in 41.4 % of cases during ICA [4]. Obstructive coronary artery lesions were detected somewhat more frequently in the study by M. Gonçalves et al. [3] – in 46 % of cases. However, this work had some peculiarities in referring patients for ICA (only patients with angina were included, excluding possible angina equivalents, changes in resting ECG or ECHO were not considered as a positive test), which contributed to the formation of a more selective sample of patients. In the EURECA, the overall incidence of obstructive CHD in the examined cohort of patients during ICA was 45 % (the percentage was increased due to the fact that the examination algorithm proposed by the ESC was followed during the examination of some patients). According to our clinic, the frequency of detection of obstructive CHD in the specified registry was 43.3 %, which is quite comparable with the data of the present study.

However, the implementation of non-invasive tests for the diagnosis of CHD in our country differs significantly from foreign countries. Thus, in the EURECA, stress ECG was performed in 32 % of patients, and most often it was performed in patients with PTP ≤ 5 % (in 50 % of cases), progressively decreasing in groups with higher PTP, with left ventricular ejection fraction (LVEF) < 50 % and with previous CHD. Among non-invasive imaging tests, CT angiography of the CA was performed in 24 % of patients, more often in patients with normal left ventricular function and without previous CHD. Stress imaging was performed in 41 % of patients, mainly using single-photon emission CT (SPECT) or echocardiography (23 % and 16 %, respectively), and its use gradually increased from groups with lower PTP to groups with higher PTP, LVEF < 50 %, and/or previous CHD. ICA was performed in 29 % of patients, and in a significant proportion (17 %) as the first imaging test [10]. The choice of diagnostic tests was determined by several factors (PTP, EF, and CHD in medical history), and based on these factors optimal diagnostic algorithms were proposed according to previously proposed guidelines [9]. Only 20 % of patients did not undergo imaging tests (non-invasive or invasive). According to our clinic, in this registry, bicycle ergometry was performed in 7.5 % of patients, stress ECHO in 1 %, SPECT in 11.5 %, and CT angiography of the CA in 0.5 %. When analyzing the registries of patients who underwent hospital examination and treatment in 2017–2019 for CHD in several large cardiac surgery centers of the Russian Federation, the frequency of stress ECG was 4.88 %, stress ECHO in 0.19 %, and CT angiography in 0.05 % [8]. It can be noted that in domestic registry studies, non-invasive tests before coronary artery disease are rather an exception, while in foreign countries, on the contrary, such an exception is the failure to perform non-invasive tests.

It is obvious that in domestic clinical practice it is necessary to focus on clinical symptoms and assessment of PTP [8, 12]. In the present study it was shown

that the nature of the pain syndrome did not differ in groups with different degrees of coronary artery disease. At the same time, the median PTP value was statistically significantly higher in the obstructive CHD group compared to the other two groups; PTP also had an independent association with the detection of obstructive CHD. Nevertheless, focusing only on PTP in the diagnosis of CHD has its limitations. As can be seen from our data, the median PTP values in groups with insignificant coronary artery disease and their absence was within the high risk of the presence of CHD. As a result, the overall frequency of obstructive CHD detection turned out to be relatively low. However, a paradox is revealed: despite the minimal number of non-invasive tests in domestic studies, the frequency of detection of obstructive coronary artery lesions is comparable with the data of foreign studies, where these tests are carried out in the overwhelming majority of cases. Therefore, a logical question arises: how then is it possible to increase the productivity of ICA in detecting obstructive CHD?

A recent analysis showed that among non-invasive imaging methods for detecting myocardial ischemia, stress magnetic resonance imaging and positron emission tomography were the most effective [13]. However, the widespread use of these methods in routine clinical practice will not happen anytime soon. At the same time, the results of the EURECA study showed that following the algorithm proposed in the ESC recommendations [9] allows achieving the following results: a decrease in the number of ICAs performed (from 48 % in patients not following the diagnostic algorithm to 15 % in the group following it) and an increase in the number of detected obstructive changes in the coronary arteries (from 39 % to 60 %, respectively) and subsequent myocardial revascularizations (from 37 % to 54 %, respectively) [10]. However, adherence to the recommendations varies greatly depending on the region. Thus, in Western European countries it was 87 %, and in Eastern European countries – 48 % [10]. According to our clinic, which also participated in the study, adherence to the algorithm was only 23.4 % (Shcheglova A.V., report at the Congress of the Russian Society of Cardiology, 2021). Therefore, one of the ways to improve the diagnosis of obstructive CHD is to increase adherence to the proposed diagnostic scenarios. Apparently, multispiral computed tomography CA should be used more widely. Firstly, the assessment of the calcium index allows more than half of patients to be classified in the low clinical risk category in the CACS-CL (Coronary Artery Calcium Score – Clinical Likelihood) model, which does not require further non-invasive or invasive examination [11]. Secondly, the use of CT angiography of the CA allows to reduce the number of ICA [14], while significantly improving the detection rate of obstructive coronary lesions [14, 15]. Interestingly, in the article by J.R. Weir-McCall et al. [14] the results of the implementation in the UK of the diagnostic approach proposed in the NICE (National Institute for Health and Care Excellence) CG95 guidelines were analyzed [16]. The essence of this algorithm is to refuse to assess the PTP, and in patients with typical and atypical angina, CT coronary angiography should be immediately performed, and if it is uninformative, non-invasive functional tests should be immediately performed [17]. That is, at the moment, real clinical practice has confirmed the effectiveness of two algorithms for diagnosing obstructive CHD (European Society of Cardiology 2019 and NICE CG95) [18]. Therefore, a prospective randomized study OPERATE is currently planned in China, which plans to compare the ability of these algorithms to identify low-risk patients (which will be additionally verified by CT angiography data) [19].

In addition, the diagnostic algorithms should take into account the results of the ISCHEMIA study [20, 21], which did not demonstrate an improvement in prognosis from the primary invasive strategy for patients with stable CHD and moderate to high risk stress test results compared with optimal drug therapy. As a result, there are proposals not to use non-invasive tests, in particular, which showed their ineffectiveness as a "gatekeeper" in the recent study by J. Jo et al. [22]. When analyzing these results, it is proposed to discuss the following tactics for managing patients with suspected CHD: starting not with the choice of tests, but with the treatment of modifiable risk factors, including consideration of the appointment of antiplatelet therapy and statins. The decision on the need for testing or its postponement is made after assessing the effectiveness of drug therapy. Changes in angina symptoms, quality of life, and coronary artery disease test results will allow the clinician to modify drug therapy and consider the need for revascularization [23]. Without a doubt, the application of this paradigm is possible only after comparing it with the traditional approach in randomized clinical trials.

This study has a number of limitations that should be taken into account when interpreting its results. First, the study included a small number of patients. Nevertheless, despite this, we were able to obtain statistically significant results. In addition, our data are quite consistent with the results of previous studies in our center [2], as well as large multi-thousand registries – both domestic [8] and foreign [1, 4, 10]. Secondly, this study is a single-center study, so its results cannot be translated into the CHD diagnostics in other regions. Nevertheless, we tried to level out this limitation by analyzing our experience of participation in the international EURECA. Thirdly, we included patients referred for ICA in the analysis. In the case of assessing coronary artery disease using coronary artery CT angiography, the frequency of detection of obstructive lesions could be significantly lower, as shown by recent studies [24].

CONCLUSION

In the cohort of outpatients with suspected CHD, the frequency of detection of obstructive coronary

artery lesions during ICA remains low. Non-invasive tests were performed in isolated cases, while PTP was an independent predictor of obstructive CHD and subsequent myocardial revascularization. To increase the frequency of detection of obstructive coronary artery disease, it is necessary to adhere to the diagnostic algorithms of the European Society of Cardiology and to use non-invasive imaging tests more widely.

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Conflicts of interest

No potential conflict of interest relevant to this article reported.

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