ISSN 1560-4071 (print)
ISSN 2618-7620 (online)

РОССИЙСКИЙ КАРДИОЛОГИЧЕСКИЙ ЖУРНАЛ

Russian Journal of Cardiology

SCIENTIFIC, PEER-REVIEWED MEDICAL JOURNAL

RUSSIAN SOCIETY OF CARDIOLOGY

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IN FOCUS:

Cardiac surgery

№ 8 | 2021

РОССИЙСКОЕ
КАРДИОЛОГИЧЕСКОЕ
ОБЩЕСТВО

Russian Society of Cardiology

Scientific peer-reviewed medical journal

Mass media registration certificate № 017388 dated 06.04.1998

Periodicity — 12 issues per year
Circulation — 7 000 copies

The Journal is in the List of the leading scientific journals and publications of the Supreme Examination Board (VAK)

The Journal is included in Scopus, EBSCO, DOAJ

Russian Citation Index:
SCIENCE INDEX (2020) 3,408
Impact-factor (2020) 1,804

Complete versions of all issues are published:
www.elibrary.ru

Instructions for authors:
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Open Access

Printed: OneBook, Sam Poligraphist, Ltd.
129090, Moscow, Protopopovsky per., 6.
www.onebook.ru

RUSSIAN JOURNAL OF CARDIOLOGY

№ 26 (8) 2021
founded in 1996

Editorial office:
119049, Moscow,
ul. Shabolovka, 23-254
e-mail: cardiojournal@yandex.ru
Tel. +7 (985) 768 43 18

Publisher:
Silicea-Poligraf
e-mail: cardio.nauka@yandex.ru

https://russjcardiol.elpub.ru
doi:10.15829/1560-4071-2021-8

ISSN 1560-4071 (print)
ISSN 2618-7620 (online)

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MANUSCRIPT PUBLICATION RULES (2021)
http://russjcardiol.elpub.ru/jour/about/submissions#authorGuidelines

Dear colleagues,

If you are reading these lines, then you are opening the next issue of the Russian Journal of Cardiology. This issue considers topical problems of cardiology and cardiac surgery.

The main idea of the issue is to show the versatility of achievements in studying pathophysiology of diseases, diagnosis and treatment. Our colleagues, cardiologists, should not forget that no matter how successful the surgical myocardial revascularization is, atherosclerosis will progress without pathogenetic therapy. Novel technologies for minimally-invasive valve replacement are gaining ground more and more and occupy a worthy place in clinical practice, especially with resurgery.

The coronavirus disease 2019 (COVID-19) has significantly changed not only everyday life, but also the management of patients, since it complicates postoperative period, especially in open surgery, and increases mortality. Minimally invasive technologies in such a situation have a number of advantages, which is described in one of the works. Another work focuses on anticoagulant therapy in patients with arrhythmias in the context of COVID-19 pandemic.

Novel methods for assessing myocardial viability make it possible to more accurately choose the method of reconstructive heart surgery in postinfarction aneurysm. The study of effective treatment methods for diffuse coronary artery disease continues.

The journal also discusses techniques of coronary endarterectomy and drug prevention of thrombosis in the postoperative period.

Medical engineering continues to develop novel products, including heart valves that shows good hemodynamic performance and effectiveness. At the same time, novel drugs are created that have a multitarget effect on the pathological mechanisms of heart failure.

Cardiac tumors also have a significant effect on the pattern of heart disease. Due to the availability of highly effective imaging methods such as tomography and echocardiography, the proportion of heart tumors in cardiovascular morbidity structure and number of cardiac surgeries is increasing.

Case reports allows to broaden physicians' perspective to develop the correct algorithm for treating patients in a non-standard situation, while literature reviews and clinical guidelines allow to improve the quality of treatment.

The current team of authors of the Russian Journal of Cardiology hopes that this particular issue will become the most read and cited, as well as these materials will be of interest not only to cardiologists and cardiac surgeons, but also to other specialists and a wide range of readers.

Let me, on behalf of the entire team of authors and myself, to wish everyone health and success.

Alexander M. Chernyavsky, Doctor of Medical Science, Professor

Russian Journal of Cardiology 2021;26(8):4450
doi:10.15829/1560-4071-2021-4450
https://russjcardiol.elpub.ru

ISSN 1560-4071 (print)
ISSN 2618-7620 (online)

Calcification markers and long-term outcomes of coronary artery bypass grafting

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Aim. To assess the long-term outcomes of coronary artery bypass grafting (CABG) and their association with calcification biomarkers.

Material and methods. The study included 129 men (mean age, 61,5±7,5 years) with coronary atherosclerosis who were admitted for CABG surgery. Patients were divided into 2 groups: with favorable and unfavorable (death, myocardial infarction, stroke, surgery) 5-year prognosis after surgery. Before the surgery, the blood concentrations of calcification biomarkers (osteoprotegerin, osteopontin, osteonectin and osteocalcin) were determined in all patients.

Results. Long-term outcomes of myocardial revascularization were studied in 92 patients (71%). An unfavorable long-term 5-year period was identified in 28 men (30,4%). In men with an unfavorable 5-year prognosis, the blood osteocalcin level before CABG was 1,2 times higher than in men with a favorable one. Multivariate linear regression showed that the risk of a 5-year unfavorable prognosis for coronary atherosclerosis after myocardial revascularization was associated with the blood osteocalcin concentration, determined before CABG (B=0,018, R^2=0,285, p=0,008).

Conclusion. The data obtained indicate the relevance of continuing studies on osteocalcin, including with respect to its contribution to coronary atherosclerosis and calcification.

Keywords: coronary atherosclerosis, myocardial infarction, long-term outcomes, osteocalcin, osteoprotegerin.

Relationships and Activities. The work was carried out within the RFBR grant № 19-015-00055 and the State Assignment № AAAA-A17-117112850280-2.

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Received: 07.04.2021
Revision Received: 19.05.2021
Accepted: 13.06.2021

For citation: Stakhneva E. M., Kashtanova E. V., Kurguzov A. V., Maslatsov N. A., Polonskaya Ya. V., Murashov I. S., Chernyavsky A. M., Ragino Yu. I. Calcification markers and long-term outcomes of coronary artery bypass grafting. *Russian Journal of Cardiology*. 2021;26(8):4450. (In Russ.) doi:10.15829/1560-4071-2021-4450

Atherosclerosis is the pathomorphological basis of cardiovascular diseases (CVDs), including coronary atherosclerosis (CAS) and coronary artery disease (CAD). It is CVDs, in particular, CAD, that are the leading cause of death in the world today. Coronary artery bypass graft (CABG) surgery remains the most important method of myocardial revascularization. A large number of studies have been devoted to evaluating long-term outcomes after CABG. Significant factors affecting a poor prognosis are diabetes [1], smoking [2, 3], familial hypercholesterolemia [4]. The influence of sex and age on the short- and long-term survival of patients after CABG is also analyzed [5].

There is no doubt about the association of coronary artery calcification with CVD [6, 7]. In a multiethnic prospective cohort study, multislice computed tomography revealed an association of coronary artery calcification with an almost twofold increased risk of cardiovascular episodes independent of statin therapy [8].

Today, the following calcification biomolecules are being actively studied: osteoprotegerin, osteopontin, osteocalcin and osteonectin. It has been determined that osteoprotegerin and osteopontin are important factors in vascular remodeling and the progression of atherosclerosis.

The concentration of osteopontin in patients with coronary artery disease correlates with the severity of coronary atherosclerosis [9]. Associations were found between the concentration of osteopontin in the blood and the presence of coronary artery disease [10], as well as between the blood concentration of osteoprotegerin and CAD severity [11]. It has been shown that osteocalcin is a predictor of CAS severity [12]. A decrease in the blood concentration of osteocalcin is associated with a high risk of developing carotid atherosclerotic plaques in patients with type 2 diabetes [13]. The study of calcification biomolecules for assessing risk and predicting complications of atherosclerosis seems to be very relevant.

The aim of our study was to assess the long-term outcomes of CABG surgery in patients with CAS, as well as to search for associations of an unfavorable 5-year prognosis with the blood content of calcification biomarkers before surgery.

Material and methods

The study was carried out within joint research work of the Research Institute of Internal and Preventive Medicine — branch of the Federal Research Center Institute of Cytology and Genetics and the Meshalkin National Medical Research Center. The study was approved by the ethical committees of these centers. The study included 129 men aged 42-77 years (mean age, 61,5±7,5 years) with CAS verified by coronary angiography, with stable exertional angina, who were admitted for surgical treatment to the Meshalkin National Medical Research Center. All patients received standard CAD therapy before and after CABG surgery, including statins, antiplatelet agents, angiotensin-converting enzyme inhibitors, and β-blockers. The exclusion criteria were myocardial infarction (MI) <6 months old, acute and exacerbation of chronic infectious and inflammatory diseases, renal failure, active liver disease, cancer, hyperparathyroidism. All patients signed written informed consent. All 129 patients underwent CABG. The mean time of on-pump CABG was 50 minutes, while there was 3 grafts on average. Cardioplegia in CABG was performed with Custodiol solution. CABG was performed according to the standard technique.

Before CABG surgery, venous blood was received from all patients for basic biochemical tests, including assessing the concentration of calcification biomolecules. In the blood, the concentration of osteoprotegerin, osteopontin (ELISAs Bender MedSystems test systems), osteocalcin, osteonectin (ELISAs Immunodiagnostic Systems Ltd test systems) was determined using an ELISA Multiscan EX analyzer (Thermo, Finland). Also, following biomarkers of endothelial dysfunction were determined in blood by ELISA method: monocyte chemoattractant protein 1 (MCP-1), soluble vascular cell adhesion molecule (sVCAM), E-selectin (ELISAs Bender MedSystems test systems).

Long-term outcomes of myocardial revascularization were studied by us 5 years after CABG surgery. The following endpoints of an unfavorable long-term period were assessed: cardiovascular death, MI, stroke, additional surgical interventions (percutaneous transluminal coronary angioplasty, carotid endarterectomy, etc). To analyze the long-term outcomes, we used discharge summaries of patients who were undergoing reexamination and treatment at the Meshalkin National Medical Research Center. The direct telephone interviews were also used.

The statistical processing was performed using the SPSS software (17.0). The distribution normality was determined using the Kolmogorov-Smirnov test. The significance of differences was assessed using the Mann-Whitney test. In order to reveal the associations, multivariate linear regression was carried out. Differences were considered significant at $p<0,05$.

Results

Long-term outcomes of myocardial revascularization were studied 5 years after CABG in 92

Table 1

Comparison of blood concentration of calcification biomolecules between groups of men with different long-term prognosis of CAS (Me [25;75])

Parameters	Unfavorable prognosis, n=28	Favorable prognosis, n=64
Osteoprotegerin, pg/ml	51,4 [33,5; 79,3]	52,3 [34,2; 77,3]
Osteocalcin, ng/ml	14,0 [9,0; 21,8]*	11,8 [7,7; 15,1]
Osteopontin, ng/ml	20,2 [17,8; 49,8]	28,9 [16,0; 38,0]
Osteonectin, µg/ml	7,4 [9,2; 10,2]	8,8 [7,9; 10,9]
sVCAM, ng/ml	788,7 [627,4; 1058,6]	841,2 [697,0; 1038,1]
Е-селектин, ng/ml	49,9 [33,6; 62,1]	47,6 [33,2; 60,0]
MCP-1, pg/ml	443,5 [249,5; 537,3]	456,6 [322,1; 588,8]

Note: * — difference between groups at p=0,035

Abbreviations: MCP-1 — monocyte chemoattractant protein 1, sVCAM — soluble vascular cell adhesion molecule.

Table 2

Results of multivariate regression analysis of the association of blood concentration of calcification biomolecules with the risk of an unfavorable prognosis for CAS after myocardial revascularization

Parameters	B coefficient	R^2	p
Osteoprotegerin, pg/ml	0,013	0,296	0,053
Osteocalcin, ng/ml	0,018	0,285	0,008
Osteopontin, ng/ml	0,249	0,084	0,114
Osteonectin, µg/ml	0,213	0,116	0,095

patients, which is 71% of all patients included in the study. Within 5 years, 5 men (5,4%) had cardiovascular death (including 1 case of fatal MI), 6 (6,5%) — non-fatal MI, 5 (5,4%) — stroke, 12 — (13,0%) underwent additional surgery.

After analyzing the data, 2 groups of patients were formed: group 1 — 64 men (69,6%) with a favorable 5-year course of the disease, group 2 — 28 men (30,4%) with an unfavorable 5-year course of the disease.

Coronary artery calcification is associated with CVDs [6, 7]. Therefore, we searched for associations of an unfavorable 5-year prognosis of CAS after CABG with calcification biomolecules, which were measured in the blood before CABG. The results of a comparative intergroup analysis are presented in Table 1. We found that in men with an unfavorable 5-year prognosis of CAS, the blood level of osteocalcin before CABG was 1,2 times higher than in men with a favorable 5-year prognosis of the disease.

The following multivariate linear regression analysis with the dependent variable "favorable/unfavorable prognosis" and independent variables "biomarkers of calcification and endothelial dysfunction" also showed a significance of osteocalcin levels (Table 2).

We found that the risk of a 5-year unfavorable prognosis for CAS after myocardial revascularization is associated with the blood concentration of osteocalcin, determined before CABG (B=0,018, R^2=0,285, p=0,008).

Discussion

The relationship between the progression of CAS and the long-term disease prognosis remains poorly understood. We assessed the relationship between the poor prognosis of CAS and some biochemical markers. Diabetes [1], smoking [2], familial hypercholesterolemia [4] are often a risk factors (RFs) for CAS progression and an unfavorable prognosis.

It is known that the risk of coronary calcification increases with age. The progression of coronary artery calcification, analyzed over 10 years of follow-up using computed tomography, demonstrated a relationship with cardiovascular RFs. It has been proposed to use longitudinal coronary artery calcium progression to assess CVD RFs [6]. The limitation of our study is the lack of data on multislice computed tomography, which has a high sensitivity and specificity in the diagnosis and quantitative assessment of coronary calcification.

We analyzed the relationship between biochemical markers of calcification, which have been actively studied in recent years, with an unfavorable 5-year prognosis for CAS after myocardial revascularization.

Osteopontin and osteonectin are glycoproteins of a cell-matrix protein class known as regulators of metalloproteinase activity. Osteopontin is a multifunctional protein involved in the production of cytokines, regulation of cell migration, adhesion and differentiation of various cells, including macrophages, endothelial cells, smooth muscle cells, lymphocytes and fibroblasts [10]. Osteoprotegerin and osteopontin are one of the key factors in both vascular remodeling and the progression of atherosclerosis. It has been shown that in patients with CAD, the level of both osteoprotegerin and osteopontin is increased [14]. The concentration of osteopontin in patients with CAD correlates with CAD severity and parameters of left ventricular remodeling [9]. Osteoprotegerin is a glycoprotein from to the tumor necrosis factor receptor family, which inhibits osteoclastogenesis by acting as a decoy receptor for the receptor activator of nuclear factor-κB ligand. A direct relationship between osteoprotegerin and CAD severity was shown [11]. The relationship between the blood level of osteoprotegerin and coronary calcium has been demonstrated in patients with type 2 diabetes [15].

In our study, we did not find a significant relationship between the blood concentration of osteopontin, osteonectin, and osteoprotegerin and the 5-year prognosis of patients with CAS after myocardial revascularization. Perhaps this is due to the insufficient number of compared groups of men.

Osteocalcin is a hydroxyapatite-binding protein synthesized by osteoblasts, which contains 3 gamma-carboxyglutamic acid residues, which are responsible for the protein's calcium-binding properties. Osteocalcin, known as a bone turnover marker, is used in clinical practice to assess the efficacy and treatment of osteoporosis [16]. In addition, osteocalcin acts as a hormone that controls the metabolism of glucose and energy in the pancreatic β-cells, adipose and muscle tissues [17]. According to some reports, osteocalcin also acts as a permanent inhibitor of vascular calcification [15].

However, findings about the relationship between blood levels of osteocalcin and cardiac function are inconsistent. Clinical study data have shown that blood levels of osteocalcin correlate with heart function. The authors reported on the relationship between blood osteocalcin levels and left ventricular ejection fraction, finding that lower blood osteocalcin levels correlated with a higher risk of left ventricular systolic dysfunction [18]. Results have been published indicating that coronary calcification is independently associated with blood levels of osteocalcin [11].

In our study, we showed that in men with an unfavorable 5-year prognosis for CAS after myocardial revascularization, the blood level of osteocalcin before CABG was 1,2 times higher than in men with a favorable 5-year prognosis. In addition, we found that the risk of a 5-year unfavorable prognosis for in patients with CAS after myocardial revascularization was associated with the blood concentration of osteocalcin determined before CABG (B=0,018, R^2=0,285, p=0,008).

Conclusion

Our findings for osteocalcin are consistent with some studies but inconsistent with others. This reflects the contradictory data accumulated to date in literature on this calcification biomolecule. Since calcification biomolecules continue to be actively studied in the world today, it is undoubtedly relevant to continue research on the influence of these biomolecules on the prognosis of CVDs and their complications.

Relationships and Activities. The work was carried out within the RFBR grant № 19-015-00055 and the State Assignment № AAAA-A17-117112850280-2.

References

1. Ndrepepa G, Iijima R, Kufner S, et al. Association of progression or regression of coronary artery atherosclerosis with long-term prognosis. Am Heart J. 2016;177:9-16. doi:10.1016/j.ahj.2016.03.016.
2. Zeitouni M, Clare RM, Chiswell K, et al. Risk factor burden and long-term prognosis of patients with premature coronary artery disease. J Am Heart Assoc. 2020;9(24):e017712. doi:10.1161/JAHA.120.017712.
3. Collet JP, Zeitouni M, Procopi N, et al. Long-Term Evolution of Premature Coronary Artery Disease. J Am CollCardiol. 2019;74(15):1868-78. doi:10.1016/j.jacc.2019.08.1002.
4. Wang X, Cai G, Wang Y, et al. Comparison of long-term outcomes of young patients after a coronary event associated with familial hypercholesterolemia. Lipids Health Dis. 2019;18(1):131. doi:10.1186/s12944-019-1074-8.
5. Nuru A, Weltzien JAH, Sandvik L, et al. Short- and long-term survival after isolated coronary artery bypass grafting, the impact of gender and age. Scand Cardiovasc J. 2019;53(6):342-7. doi:10.1080/14017431.2019.1646430.
6. Gassett AJ, Sheppard L, McClelland RL, et al. Risk factors for long-term coronary artery calcium progression in the Multi-Ethnic Study of Atherosclerosis. J Am Heart Assoc. 2015;4(8):e001726. doi:10.1161/JAHA.114.001726.
7. Barbarash OL, Kashtalap VV, Shibanova IA, Kokov AN. Fundamental and practical aspects of coronary artery calcification. Russian Journal of Cardiology. 2020;25(3S):4005. (In Russ.) doi:10.15829/1560-4071-2020-4005.
8. Rifai MA, Blaha MJ, Patel J, et al. Coronary artery calcification, statin use and long-term risk of atherosclerotic cardiovascular disease events (from the Multi-Ethnic Study of Atherosclerosis). Am J Cardiol. 2020;125(6):835-9. doi:10.1016/j.amjcard.2019.12.031.
9. Barbarash OL, Kashtalap VV, Zykov MV, et al. The relationship of the concentration of osteopontin with the severity of coronary atherosclerosis and osteopenic syndrome in men with stable coronary heart disease. Atherosclerosis and dyslipidemia. 2016;4(25):40-8. (In Russ.)
10. Mohamadpour AH, Abdolrahmani L, Mirzaei H, et al. Serum osteopontin concentrations in relation to coronary artery disease. Arch Med Res. 2015;46(2):112-7. doi:10.1016/j.arcmed.2015.02.005.
11. Salari P, Keshtkar A, Shirani S, et al. Coronary artery calcium score and bone metabolism: a pilot study in postmenopausal women. J Bone Metab. 2017;24:15-21. doi:10.11005/jbm.2017.24.1.15.
12. Bao Y, Zhou M, Lu Z, et al. Serum levels of osteocalcinare inversely associated with the metabolic syndrome and the severity of coronary artery disease in Chinese men. ClinEndocrinol (Oxf). 2011;75(2):196-201. doi:10.1111/j.1365-2265.2011.04065.x.
13. Sheng L, Cao W, Cha B, et al. Serum osteocalcin level and its association with carotid atherosclerosis in patients with type 2 diabetes. CardiovascDiabetol. 2013;12:22. doi:10.1186/1475-2840-12-22.
14. Maniatis K, Siasos G, Oikonomou E, et al. Osteoprotegerin and osteopontin serum levels are associated with vascular function and inflammation in coronary artery disease patients. Curr Vasc Pharmacol. 2020;18(5):523-30. doi:10.2174/1570161117666191022095246.
15. Maser RE, Lenhard MJ, Sneider MB, et al. Osteoprotegerin is a better serum biomarker of coronary artery calcification than osteocalcin in type 2 diabetes. EndocrPract. 2015;21(1):14-22. doi:10.4158/EP14229.OR.
16. Kang J-H. Association of serum osteocalcin with insulin resistance and coronary atherosclerosis. J Bone Metab. 2016;23:183-90. doi:10.11005/jbm.2016.23.4.183.
17. Kanazawa I. Osteocalcin as a hormone regulating glucose metabolism. World J Diabetes. 2015;6(18):1345-54. doi:10.4239/wjd.v6.i18.1345.
18. Zhang X, Shen Y, Ma X, et al. Low serum osteocalcin levels are correlated with left ventricular systolic dysfunction and cardiac death in Chinese men. Acta Pharmacologica Sinica. 2019;40:486-91. doi:10.1038/s41401-018-0080-0.

ISSN 1560-4071 (print)
ISSN 2618-7620 (online)

First experience of transatrial transcatheter valve implantation in patients with bioprosthetic mitral valve dysfunction

Bogachev-Prokofiev A. V., Sharifulin R. M., Astapov D. A., Ovcharov M. A., Ovchinnikova M. A., Lavinyukov S. O., Sapegin A. V., Afanasyev A. V., Zheleznev S. I., Nazarov V. M., Chernyavsky A. M.

We present three cases of successful transatrial transcatheter valve-in-valve implantation in patients with bioprosthetic mitral valve dysfunction. Patients with a high surgical risk, with severe heart failure due to bioprosthetic mitral valve dysfunction, were implanted with transcatheter mitral prostheses using the transatrial approach. Transesophageal echocardiography and fluoroscopy-guided transcatheter mitral prosthetic valve positioning was performed. With a cardiac pacing at 180 bpm, a transcatheter valve was implanted. The transcatheter valves functioned properly after surgery. The patients were discharged in satisfactory condition.

Keywords: mitral valve, transcatheter valve implantation, valve-in-ring, valve-in-valve.

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Relationships and Activities: none.

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Received: 27.06.2021
Revision Received: 17.07.2021
Accepted: 30.07.2021

For citation: Bogachev-Prokofiev A. V., Sharifulin R. M., Astapov D. A., Ovcharov M. A., Ovchinnikova M. A., Lavinyukov S. O., Sapegin A. V., Afanasyev A. V., Zheleznev S. I., Nazarov V. M., Chernyavsky A. M. First experience of transatrial transcatheter valve implantation in patients with bioprosthetic mitral valve dysfunction. *Russian Journal of Cardiology*. 2021;26(8):4565. (In Russ.) doi:10.15829/1560-4071-2021-4565

The widespread use of bioprosthetic mitral valve (MV), which are less durable than mechanical ones, leads to a natural increase in the number of reoperations for its dysfunction [1].

Repeated on-pump heart valve replacement is still the preferred treatment for biological prosthesis dysfunction. Data on valve reoperation in elderly patients (80 years and older) showed poorer results compared with younger groups of patients, thus confirming that they have an increased risk of mortality and complications, despite well-performed surgery [2-5]. Therefore, minimally invasive technologies should be a priority when treating this group of patients. The development of transcatheter valve replacement opened up new frontiers in the treatment of elderly patients with severe comorbidities. In particular, transcatheter valve replacement in case of bioprosthetic valve dysfunction (valve-in-valve technique) is associated with a lower surgical risk. The valve-in-valve procedure in elderly multimorbid patients is regularly used in large centers with good clinical outcomes [6-8]. The valve-in-valve procedure can be performed by transapical or transseptal transfemoral approaches, but each of them is associated with a number of negative aspects. Novel and promising technique is the transatrial approach through the left atrial (LA) lateral wall through right minithoracotomy [9].

In this work, we present a case series of successful transcatheter valve replacement in patients with structural bioprosthetic mitral valve dysfunction using a transatrial approach.

Material and methods

Patients. First seventy-three-year-old patient was admitted with complaints of shortness of breath on exertion and sometimes at rest, lower limb edema, right upper quadrant pain. Eight years ago, bioprosthetic MV replacement was performed (UniLine № 28) due to mitral stenosis. In the postoperative period, myocardial infarction was recorded. Percutaneous transluminal coronary angioplasty with circumflex artery stenting was performed. According to postoperative echocardiography, left ventricular (LV) ejection fraction (EF) was 33%. Heart failure has progressed over the past 2 years. According to transthoracic echocardiography (Figure 1 A, B), the LA size is 5,0×6,3 cm; area — 30,0 cm^2. Mitral bioprosthesis. Prosthetic leaflets are thickened, sclerosed, and open with limitations. Signs of prosthesis dysfunction. Peak LA/LV diastolic gradient was 23 mm Hg, the mean — 12 mm Hg, opening area =1,0 sm^2. Grade 0-1 regurgitation. A decrease in global LV contractility (EF, 31%). Pulmonary hypertension (estimated systolic pressure, 68 mm Hg).

Second seventy-five-year-old patient was admitted with complaints of shortness of breath on exertion and sometimes at rest. For rheumatic MV disease, bioprosthetic MV replacement was performed (UniLine № 26). She has been feeling well for 10 years, but over the past year she has begun to notice a progressive decrease in exercise tolerance. According to echocardiography, at admission, the LA was significantly increased (6,3×6,8 cm). Peak LA/LV diastolic gradient was 27 mm Hg, the mean — 9-10 mm Hg, opening area =1,6-1,7 sm^2. Grade 2-3 mitral regurgitation. Diffuse LV myocardial hypokinesis (EF, 44%). Pulmonary hypertension (estimated systolic pressure, 63 mm Hg).

Third eighty-year-old patient was admitted with complaints of shortness of breath on exertion and sometimes at rest. For rheumatic MV stenosis, bioprosthetic MV replacement was performed (PERICARBON MORE № 28). After surgical treatment, an echocardiography was performed annually. Over the past four years, there was a progression of MV bioprosthetic stenosis and HF symptoms to functional class III-IV. According to echocardiography (Figure 1 C, D), pronounced dilatation of both atria (area, RA — 40 cm^2; LA — 79 cm^2; volume — 656 ml) and right ventricle, signs of prosthesis dysfunction. Prosthetic leaflets are compacted, inactive, grade 0-1 regurgitation. Peak LA/LV diastolic gradient — 13 mm Hg, the mean — 8 mm Hg, opening area =1,02 sm^2.

Upon admission to the department, the condition of patients was assessed as severe, due to circulatory decompensation. According to auscultation data, all patients have a characteristic pronounced blowing systolic murmur over the entire heart region.

Given the extremely high risk of repeated cardiac surgery (all patients had an STS score >8%) using a standard approach (median sternotomy), transcatheter MV replacement (using the valve-in-valve technique) using the transatrial approach.

Prosthesis selection. In order to select the required size of transcatheter prosthesis, all three patients underwent multislice computed tomography with measurement of the internal prosthesis diameter (UniLine № 28; UniLine № 26; PERICARBON MORE № 28) (Figure 2). In accordance with the obtained true internal diameters (first patient, 23,3 mm; second patient, 24,6 mm; third patient, 26,3 mm), the balloon-expandable prosthesis "MedLab CT" (NPP MedInzh, Penza, Russia) with a diameter of 23, 25, 27 mm was chosen. When selecting a prosthesis, we were guided by the recommendations, according to which the transcatheter prosthesis diameter should be 10-15% larger than the internal diameter of bioprosthesis. The risk of LV outflow

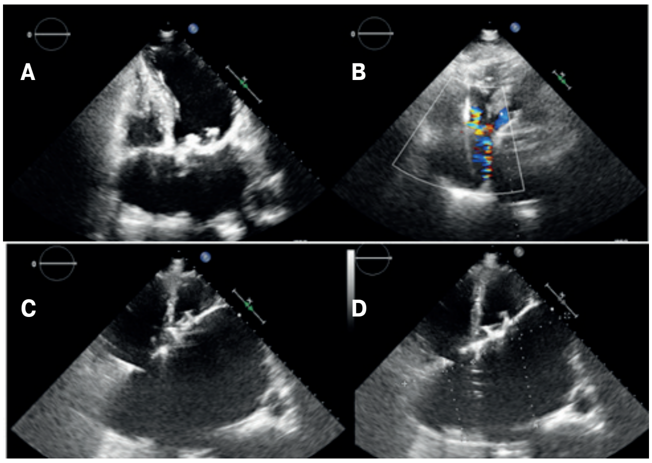


Figure 1. Echocardiography.
Note: A. Prosthetic leaflets are thickened, sclerosed, and open with limitations; **B.** Grade 0-1 regurgitation; **C.** Prosthetic leaflets are compacted; **D.** Dilation of both atria.

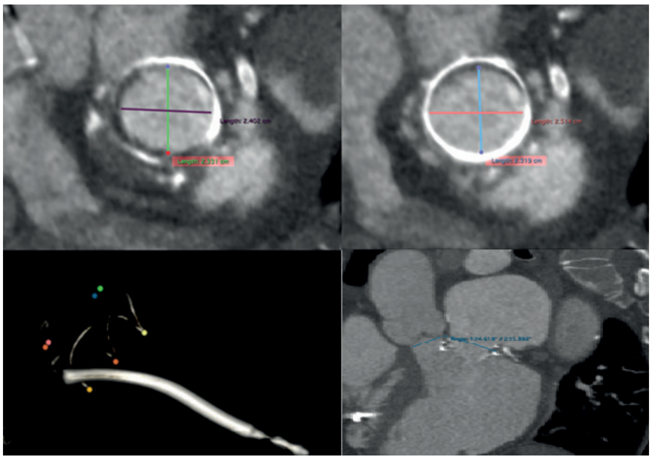
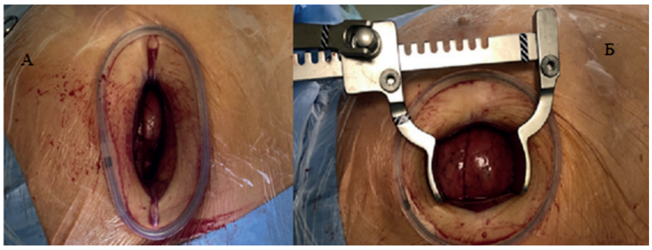


Figure 2. Computed tomography. Measurement of the inner bioprosthetic diameter and the mitral aortic angle.



A **B**
Figure 3. Access to LA roof.
Note: A — thoracotomy along the 4th right intercostal space. **B** — soft tissue retractor in the 4th right intercostal space.

tract obstruction was also assessed by measuring the mitral-aortic angle. All three patients had a mitral-aortic angle was >110 degrees. Therefore, the obstruction risk was low.

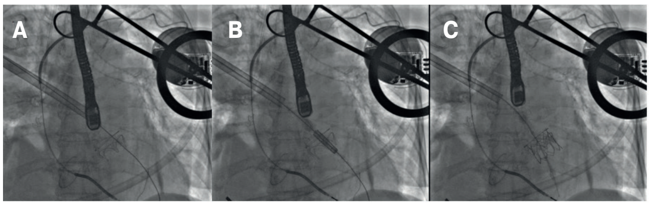


Figure 4. Transcatheter prosthetic valve implantation.
Note: A — fluoroscopy- and TEE-guided prosthetic valve placement; **B** — implantation of the MedLab CT prosthesis № 23; **C** — final view.
Abbreviation: TEE — transesophageal echocardiography.

Surgery stage. The operation was performed in a hybrid operating room. A small incision was made in the right fourth intercostal space, crossing the midaxillary line (Figure 3).

A soft tissue retractor and a standard minimally invasive retractor were used to access the surgical site. The pericardium was opened 3-4 cm above the phrenic nerve. A temporary pacing lead was placed through the jugular access to the right ventricular apex. A purse-string suture was applied to LA roof. LA puncture was performed using Seldinger technique with purse-string sutures. A 6 Fr introducer (Terumo, Belgium) was installed, through which a ZIPwire 0,035 in×180 cm hydrophilic guidewire (Boston Scientific, USA) was inserted into the LA cavity and then into the LV. Then a Pigtail Optitorque 6 Fr catheter (Terumo, Belgium) was inserted, through which a Amplatz Super-stiff 0,035 in×260 cm guidewire (Boston Scientific, USA) was inserted into the LA. The SuperStiff guidewire was passed through the mitral prosthesis into the LV (Figure 4 A). The MedLab CT prosthesis was inserted through the port, which was placed in MV prosthesis projection under the guidance of fluoroscopy and transesophageal echocardiography (TEE) (Figure 4 A, Figure 5 A, B, C). The stent-prosthesis was implanted with pacing a rhythm of 160 bpm (Figure 4 B, C, Figure 5 C, E, F). All patients had a port removed after TEE assessment. Purse-string sutures are tied.

Results

In the third patient, due to severe RA dilatation, the right LA contour isolation without using artificial circulation was impossible. The femoral vessels were cannulated. After the start of artificial circulation, LA isolation became technically possible.

In the first patient, TEE revealed a paraprosthetic fistula of 0,6×0,7 cm. After implantation of the prosthesis, the fistula was occluded with an Amplatzer Vascular PLUG II device (Abbott) with a good hemodynamic result (Figure 6).

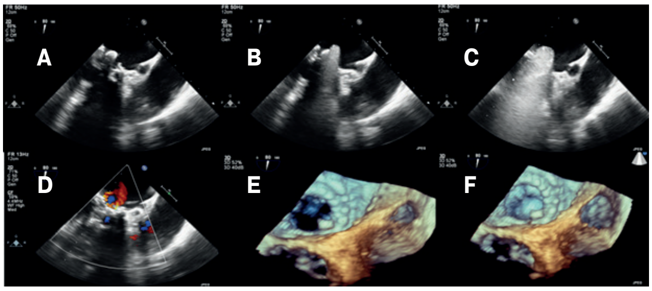


Figure 5. TEE during stent-prosthesis implantation.
Note: A, **B** — TEE-guided prosthesis placement; **C** — implantation of the MedLab CT prosthesis; **D** — regurgitation spreads in several streams with insignificant volume; **E**, **F** — stent-prosthesis in the mitral site, LA view (3D reconstruction).
Abbreviations: LA — left atrium, TEE — transesophageal echocardiography.

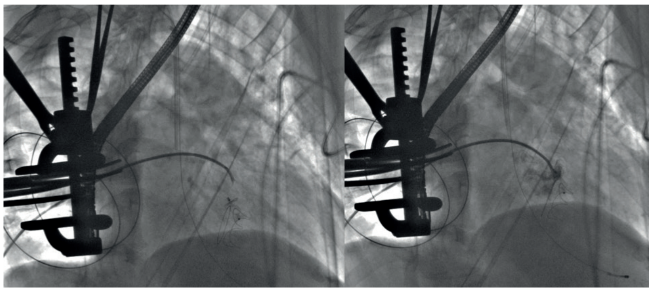


Figure 6. Fistula occlusion with Amplatzer Vascular PLUG II (Abbott).

According to TEE, the first patient has a peak gradient on the prosthesis of 8-9 mm Hg, the mean — 4-5 mm Hg. The mitral valve opening area according to Doppler ultrasound was 3,19 cm^2. Grade 1-2 regurgitation with insignificant volume.

In the second patient, immediately after the procedure, a peak gradient on the prosthesis was 8 mm Hg, the mean — 5 mm Hg. The mitral valve opening area according to Doppler ultrasound was 2,0 cm^2. Grade 1 regurgitation. The third patient also had a satisfactory immediate result of surgical treatment: peak LV/LA diastolic pressure gradient of 6-8 mm Hg, the mean — 3-5 mm Hg. Grade 1 regurgitation with insignificant volume.

Postoperative period

The early postoperative period was uneventful. Mechanical ventilation no more than 7 hours; vasotonic support during the first day. Patients were transferred from the intensive care unit on the second day after surgery. Warfarin was prescribed as antithrombotic therapy with the target international normalized ratio of 2,5-3,5. In the postoperative period, a significant improvement in the clinical condition of patients was noted: a decrease in edema, relief of heart failure. The body temperature did not rise. However, due to the high risk of infection, antibiotic therapy was carried out for 7 days (intravenous infusion of 2 g ceftrixon).

According to the echocardiography at discharge, in the third patient, LVEF was 41%. In the MV site with stent-prosthesis, peak diastolic gradient was 10 mm Hg, the mean — 6 mm Hg, the MV opening area according to Doppler ultrasound — 3,0 cm^2. Grade 1 regurgitation with insignificant volume. Grade 1 tricuspid regurgitation with insignificant volume. The estimated pulmonary artery systolic pressure was 39 mm Hg, while the mean pulmonary artery pressure — 26,3 mm Hg.

In the first patient, LVEF was 51% at discharge. In the MV site with stent-prosthesis, peak diastolic gradient was 9 mm Hg, the mean — 4 mm Hg, the MV opening area according to Doppler ultrasound — 2,9 cm^2. Grade 1 mitral regurgitation with insignificant volume. Grade 1 tricuspid regurgitation with insignificant volume. The estimated pulmonary artery systolic pressure was 39 mm Hg.

In the second patient, LVEF was 46% at discharge. In the MV site with stent-prosthesis, peak diastolic gradient was 9 mm Hg, the mean — 4 mm Hg, the MV opening area according to Doppler ultrasound — 2,7 cm^2. Grade 1 mitral regurgitation with insignificant volume. Grade 1 tricuspid regurgitation with insignificant volume.

Discussion

Repeated on-pump heart valve replacement is the method of choice in patients with dysfunction of bioprosthetic mitral valve and provides good immediate and long-term outcomes [1, 2].

The benefits of using biological or mechanical prostheses are still debated, and despite the development of novel valve types, bioprosthetic valves still have limited durability with a relatively high risk of reoperation [1, 3-7].

Nonetheless, bioprosthesis use has increased in the older age group over the past decade due to favorable clinical outcomes in the elderly, but despite all efforts to prevent structural valve degeneration and increase valve life, there is a risk of re-surgery. Recent publications on reoperations in elderly patients have shown higher mortality than in younger age groups, confirming that this population has an increased risk of surgical mortality and morbidity with a risk of poor outcome, despite well-performed surgery [2-5].

Transcatheter valve implantation has opened new frontiers in cardiac surgery, making it possible to implant stent valves with less surgical risk in elderly multimorbid patients with bioprosthetic dysfunction. The valve-in-valve procedure has been used with good clinical outcomes [6, 10].

Transapical transcatheter prosthetic implantation basically follows the same rules as the standard TAVI. However, there are several important points: first, the guidewire must be passed through the bioprosthesis and inserted into the LA or right inferior pulmonary vein with care so as not to damage the atrium and fragile pulmonary vessels. Second, valvuloplasty should not be performed due to the potential risk of calcium embolism [11]. The first successful transcatheter prosthetic implantation in a patient with mitral bioprosthetic dysfunction was performed in 2009 [12] using a transapical approach. However, the transapical approach has some specific technical limitations, as, for example, in the case of LV apex calcification as a result of prior surgery, as well as potential complications, including myocardial rupture, LV apical aneurysm, arrhythmias, LV apex hypokinesia or akinesia, especially in patients with initially low LVEF [12].

The technique of transcatheter implantation through a transfemoral venous access requires transesophageal echocardiography guided transseptal puncture. This method requires maximum flexion of catheter delivery system, and therefore there is a high risk of inferior vena cava rupture [13]. A common problem associated with transseptal puncture is the presence of a large atrial septal defect requiring an occluder.

At first, attempts of transcatheter implantation using the transatrial approach were unsuccessful due to the impossibility of placing transcatheter valve coaxially inside the bioprosthesis. However, since 2012 there have been works that describe cases of successful implantation [11]. We believe that this approach should have a number of advantages. The first is an antegrade passage, which eliminates the risk of thickened leaflets and calcium obstructing the device passage. From the same access, it is possible not only to perform a quick and safe artificial circulation in case of a failure of the transcatheter MV implantation with ventricular fibrillation. It is also theoretically possible to combine an on-pump transcatheter procedure and tricuspid valve repair, as successfully reported by Lee TC, et al. [14].

The results of using the transcatheter MV implantation were evaluated in two large international registries: Valve-in-valve international data registry (n=660) [15] and International multicentre registry of TMVR (n=322) [16].

Considering whether a valve-in-valve procedure or repeated open heart surgery can be challenging. All patients should be evaluated by a multidisciplinary team prior to the procedure, including interventional cardiologists, cardiac surgeons, cardiologist, anesthesiologist, and cardiac imaging specialist. The Euroscore and STS score systems can be used to estimate predicted mortality from surgery. The main inclusion and exclusion criteria for the valve-in-valve procedure are similar to those suggested for standard transcatheter aortic valve implantation (TAVI) [17, 18].

Hemodynamic diosorders (regurgitation or stenosis) have a significant impact on valve-in-valve outcomes [19]. In terms of valve size, bioprostheses with small bore diameter show a higher incidence of patient-prosthesis mismatch, which affects hemodynamic outcome and decreases survival [19-22].

During the valve-in-valve procedure in patients with frame-mounted bioprosthetic dysfunction, fixation is provided due to radial forces. Therefore, not only stenosis, but also insufficiency due to impaired prosthetic valve leaflets become treatable. In case of dysfunction of a frameless prosthetic dysfunction, the feasibility assessment of valve-in-valve procedure is carried out according to standard TAVI rules, when pronounced calcification is required for the procedure success. In the case of paravalvular fistulas, the valve-in-valve procedure should not be used because there is usually no significant change in regurgitation severity [19]. However, some case reports show possibility of paravalvular fistula reduction by implantation of separate devices (Edwards SAPIEN 3). Thrombosis and valvular infective endocarditis are contraindications to the valve-in-valve procedure because the affected tissue is not removed during the procedure. However, one successful case of a valve-in-valve procedure for endocarditis in an inoperable patient had a favorable outcome [20].

Preoperative evaluation of a bioprosthesis in a patient requires multimodal cardiac imaging. Echocardiography is used to assess the etiology and severity of stenosis or insufficiency, and to rule out paravalvular fistulas and active endocarditis.

The ideal transcatheter valve placement is influenced by the fluoroscopy image and the design of bioprosthesis. Angiography is not required and the procedure can be performed on patients with impaired renal function under TEE and fluoroscopic guidance.

The level of frame-mounted bioprosthetic ring during fluoroscopy should be used as a reference level for transcatheter valve fixation [23-25]. If, during implantation, fluoroscopy shows an hourglass shape, this may disrupt the operation of bioprosthetic valves and should be avoided [23]. It is easy to position the fluoroscopic device perpendicular to the frame-mounted bioprosthesis, since the metal frame of most existing prostheses is radiopaque. Although there may be differences in the radiopaque markings. Frameless prostheses do not have radiopaque landmarks and the procedure can be technically challenging and more similar to TAVI.

Currently, there are no guidelines for balloon valvuloplasty for prosthetic MV dysfunction during valve-in-valve procedures [26].

The risk of LV outflow tract obstruction during valve-in-valve procedures is not a major problem, since low-profile transcatheter valves are implanted into the bioprosthetic ring, and not into the native MV with the risk of anterior leaflet prolapse. The risks of obstruction the valve-in-valve procedure persist in the case of a small LV size, acute mitral-aortic angle, pronounced interventricular septal hypertrophy. The risk of LV outflow tract obstruction can be predicted using multislice computed tomography reconstruction (Figure 2).

With mitral valve-in-valve procedures, the risk of postoperative high gradients is lower compared to aortic valve-in-valve procedures because the bioprosthetic MV has a larger diameter. The presented case series confirms these conclusions.

Conclusion

Given the accumulated experience, transcatheter techniques may increasingly replace conventional procedures, reducing the need for open re-surgery, especially in high-risk patients. The cases we have described have demonstrated the technical feasibility and safety of this technology. Therefore, we consider transcatheter valve implantation as an alternative to standard reoperation after a comprehensive patient assessment.

Relationships and Activities: none.

References

1. Chan V, Malas T, Lapierre H, et al. Reoperation of left heart valve bioprostheses according to age at implantation. Circulation. 2011;124(11_suppl_1):75-80. doi:10.1161/CIRCULATIONAHA.110.011973.
2. Eitz T, Fritzsche D, Kleikamp G, et al. Reoperation of the aortic valve in octogenarians. Ann Thorac Surg. 2006;82:1385-91.
3. Balsam LB, Grossi EA, Greenhouse DG, et al. Reoperative valve surgery in the elderly: predictors of risk and long-term survival. Ann Thorac Surg. 2010;90:1195-200.
4. Maganti M, Rao V, Armstrong S, et al. Redo valvular surgery in elderly patients. Ann Thorac Surg. 2009;87:521-5.
5. Christiansen S, Schmid M, Autschbach R. Perioperative risk of redo aortic valve replacement. Ann Thorac Cardiovasc Surg. 2009;15:105-10.
6. Dvir D, Webb JG, Bleiziffer S, et al.; Valve-in-Valve International Data Registry Investigators. Transcatheter aortic valve implantation in failed bioprosthetic surgical valves. JAMA. 2014;312:162-70.
7. Dvir D, Webb JG. Transcatheter aortic valve-in-valve implantation for patients with degenerative surgical bioprosthetic valves. Circ J. 2015;79:695-703.
8. Walther T, Kempfert J, Borger MA, et al. Human minimally invasive off-pump valve-in-a-valve implantation. Ann Thorac Surg. 2008;85:1072-3.
9. Bruschi G, Barosi A, Colombo P, et al. Direct transatrial transcatheter SAPIEN valve implantation through right minithoracotomy in a degenerated mitral bioprosthetic valve. Ann Thorac Surg. 2012;93(5):1708-10.
10. Smith CR, Leon MB, Mack MJ, et al.; PARTNER Trial Investigators. Transcatheter versus surgical aortic-valve replacement in high-risk patients. N Engl J Med. 2011;364:2187-98.
11. Cheung A, Webb JG, Wong DR, et al. Transapical transcatheter mitral valve-in-valve implantation in a human. Ann Thorac Surg. 2009;87(3):e18-20.
12. Bouleti C, Fassa AA, Himbert D, et al. Transfemoral implantation of transcatheter heart valves after deterioration of mitral bioprosthesis or previous ring annuloplasty. JACC Cardiovasc Interv. 2015;8(1 Pt A):83-91. doi:10.1016/j.jcin.2014.07.026.
13. Bleiziffer S, Bauernschmitt R, Ruge H, et al. Kathetergestützte Aortenklappenimplantation aus chirurgischer Sicht [Transcatheter aortic valve implantation: surgeon's view]. Herz. 2009;34(5):374-80. (In German).
14. Lee TC, Desai B, Glower DD. Results of 141 consecutive minimally invasive tricuspid valve operations: an 11-year experience. Ann Thorac Surg. 2009;88(6):1845-50.
15. Gallo M, Sá MPBO, Doulamis IP, et al. Transcatheter valve-in-valve implantation for degenerated bioprosthetic aortic and mitral valves — an update on indications, techniques, and clinical results. Expert Rev Med Devices. 2021;Jun 15:1-12. doi:10.1080/17434440.2021.
16. Yoon SH, Whisenant BK, Bleiziffer S, et al. Outcomes of transcatheter mitral valve replacement for degenerated bioprostheses, failed annuloplasty rings, and mitral annular calcification. Eur Heart J. 2019;40(5):441-51. doi:10.1093/eurheartj/ehy590.
17. Maroto LC, Rodríguez JE, Cobiella J, Marcos P. Transapical off-pump aortic valve-in-a-valve implantation in two elderly patients with a degenerated porcine bioprosthesis. Eur J Cardiothorac Surg. 2010;37:738-40.
18. Pasic M, Unbehaun A, Dreysse S, et al. Transapical aortic valve implantation after previous aortic valve replacement: Clinical proof of the "valve-in-valve" concept. J Thorac Cardiovasc Surg. 2011;142:270-7.
19. Azadani AN, Jaussaud N, Matthews PB, et al. Aortic valve-in-valve implantation: impact of transcatheter-bioprosthesis size mismatch. J Heart Valve Dis. 2009;18:367-73.
20. Silva D, Stripling JH, Hansen L, Riess FC. Aortic valve replacement after transapical valve-in-valve implantation. Ann Thorac Surg. 2011;91:e5-7.
21. Connolly HM, Oh JK, Schaff HV, et al. Severe aortic stenosis with low transvalvular gradient and severe left ventricular dysfunction: result of aortic valve replacement in 52 patients. Circulation. 2000;101:1940-6.
22. He GW, Grunkemeier GL, Gately HL, et al. Up to 30-year survival after aortic valve replacement in the small aortic root. Ann Thorac Surg. 1995;59:1056-62.
23. Kempfert J, Van Linden A, Linke A, et al. Transapical off-pump valve-in-valve implantation in patients with degenerated aortic xenografts. Ann Thorac Surg. 2010;89:1934-41.
24. Nguyen C, Cheong AP, Himbert D. Valve-in-valve-in-valve: Treating endocarditis of a transcatheter heart valve. Catheter Cardiovasc Interv. 2015;86:E200-4.
25. Ferrari E. Transapical aortic 'valve-in-valve' procedure for degenerated stented bioprosthesis. Eur J Cardiothorac Surg. 2012;41:485-90.
26. Ferrari E, Marcucci C, Sulzer C, von Segesser LK. Which available transapical transcatheter valve fits into degenerated aortic bioprostheses? Interact Cardiovasc Thorac Surg. 2010;11:83-5.

Russian Journal of Cardiology 2021;26(8):4424
doi:10.15829/1560-4071-2021-4424
https://russjcardiol.elpub.ru

ISSN 1560-4071 (print)
ISSN 2618-7620 (online)

Risk assessment of contrast-induced acute kidney injury in patients with acute myocardial infarction after coronary angiography and percutaneous coronary intervention

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Aim. To assess the risk of contrast-induced acute renal injury (CI-AKI) in patients with acute myocardial infarction in a highly specialized hospital after coronary angiography.
Material and methods. The study sample included 502 patients who were treated in the cardiology department of a specialized hospital. CI-AKI was established by an increase in creatinine >26 µmol/L within 48 hours after percutaneous coronary intervention (PCI) with radiopaque contrast agents or an increase in creatinine >50% within a week after PCI. A multistage statistical analysis was used to search for possible predictors of CI-AKI.
Results. In total, CI-AKI was diagnosed in 57 (11,3%) patients. Based on the analysis performed, 3 significant predictors of CI-AKI were identified: patient's age, contrast medium volume (ml/kg) and anemia (presence/absence). An equation for assessing the risk of CI-AKI in patients after PCI has been created.
Conclusion. A simple scale for assessing the CI-AKI risk makes it possible to identify a category of patients who requires preventive measures to reduce iatrogenic complications and mortality.

Keywords: contrast-induced acute kidney injury, coronary angiography, acute myocardial infarction, radiopaque agents, predictors.

Relationships and Activities: none.

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Received: 25.03.2021
Revision Received: 10.04.2021
Accepted: 16.04.2021

For citation: Ursta A. A., Kharkov E. I., Petrova M. M., Kotikov A. R., Ursta O. V. Risk assessment of contrast-induced acute kidney injury in patients with acute myocardial infarction after coronary angiography and percutaneous coronary intervention. *Russian Journal of Cardiology*. 2021;26(8):4424. (In Russ.) doi:10.15829/1560-4071-2021-4424

Contrast-induced acute kidney injury (CI-AKI) is a dangerous complication of angiographic procedures due to the direct and indirect effect of iodine-containing contrast medium on the renal tissues, which are currently widely used in emergency and elective cardiology [1, 2]. The inpatient development of CI-AKI increases the patient's hospitalization period and also increases mortality [3, 4]. According to modern concepts, CI-AKI is diagnosed in the presence of one of the following indicators after the introduction of contrast medium: a) an increase in the serum creatinine level relative to the baseline value by 26 μmol/l or more in the period of 48 hours; b) an increase in the serum creatinine level by 50% or more relative to the baseline value in the period of 1 week; c) decrease in urine output >0,5 ml/kg/h in the period of 6 hours or more [5, 6]. Currently, three main pathophysiological mechanisms of CI-AKI development known as follows: a) medullary renal hypoxia due to a decrease in the level of vasodilators (prostaglandins, nitric oxide) and an increase in the level of vasoconstrictors (adenosine and endothelin); b) direct cytotoxic effect of a contrast medium on the proximal renal tubules, where the detrimental effect of free radicals and hyperoxia is emphasized; c) induction of apoptosis of renal tubular epithelial cells [7, 8].

Coronary angiography (CAG) and percutaneous coronary intervention (PCI) are vital manipulations in patients with acute myocardial infarction (AMI) in a highly specialized hospital. Recently, the number of PCI has increased in elderly patients, and the safety and outcomes of revascularization have improved [9]. This disease is relevant in modern medical literature. In particular, many researchers were looking for risk factors for CI-AKI, among which are the patient's age, female sex, anemia, diabetes, increased erythrocyte sedimentation rate, hypotension, congestive heart failure, volume of injected contrast agent, intra-aortic balloon counterpulsation, chronic kidney disease, etc. Based on the found risk factors, models have been created allowing to reveal patients at high risk of CI-AKI [10-13].

Given the urgency of the problem, we tried to reveal easily accessible predictors of CI-AKI in patients with AMI in a specialized hospital.

Material and methods

The study included 502 patients, who in 2014-2017 were treated in the cardiology department of the N.S. Karpovich Krasnoyarsk Interdistrict Clinical Emergency Hospital. CI-AKI was established based on a creatinine increase >26 μmol/L within 48 hours after PCI using contrast agents; another criterion for CI-AKI verification was a creatinine increase >50% within a week after PCI. The sample did not include patients with stage 5 chronic kidney disease, as well as patients who required investigations with contrast agents for reasons unrelated to PCI. The patients who were diagnosed with shock, decreased ejection fraction <40%, high central venous pressure >120 mm Hg were excluded. Upon admission, all patients underwent electrocardiography, laboratory tests, including a complete blood count, biochemical blood tests (creatinine, electrolytes, troponin, alanine aminotransferase, aspartate aminotransferase, lactate dehydrogenase, creatine kinase-MB, lipid profile, C-reactive protein, glucose). All patients were diagnosed with AMI, which is an indication for urgent CAG and consideration of further PCI. During the entire period of stay in the cardiac intensive care unit, urine output and serum creatinine levels (after 12 hours, 24 hours, 48 hours, 3, 5, 7 days and at discharge) were monitored. In cases of increased creatinine levels, hydration with low volume of 0,9% sodium chloride solution was performed under the monitoring of central venous pressure was performed.

Patients with verified CI-AKI who were included in the sample were randomly divided into 2 groups in a 4:1 ratio: training and testing, respectively. The search for predictors was initially based on univariate statistical analysis methods. The variables selected as a result of univariate methods from the general sample were included in the training group, from which, in turn, 100 samples were randomly generated, followed by logistic regression. For each of the generated samples, the predictors were evaluated step by step in order to be selected for the final model. The final sample included 3 variables that were significant (p<0,001) in more than 90% of the generated samples.

One of the selected variables is a categorical one with two values — "yes" and "no", while the other two are presented as the interval variables. To calculate the risk of CI-AKI, the obtained regression coefficients were used in combination with the corresponding values of predictors. Using logistic regression, the odds ratio (OR) was calculated with 95% confidence intervals for each predictor.

The adequacy of obtained regression model was confirmed by regression model adequacy tests (P>0,57) with random sample generation based on the available sample [14]. The sample size for presented logistic regression model can be considered acceptable based on numerous publications devoted to this problem [15]. Statistical analysis and data visualization were performed using the software package and the language "R". Normally distributed variables are presented as mean and standard deviation (s). Non-normally distributed variables

Table 1

Clinical characteristics of patients with verified CI-AKI

Factor	Patients (n=57)
Male sex	49%
Age (years)	72,2±9,1
Weight (kg)	74,5±7,8
Anemia	44%
Diabetes	83%
Hypertension	90%
Combination of diabetes and hypertension	85%
Congestive heart failure	13,9%
Prior myocardial infarction	33%
Myocardial infarction	75%
Dyslipidemia	39%
Diuretic use	70%
Peripheral arterial atherosclerosis	10%
Rheumatic heart disease	5%
Baseline creatinine value (μmol/L)	101,7±55,7
Intra-aortic balloon counterpulsation	4%
Contrast volume (ml)	136,2±57,9

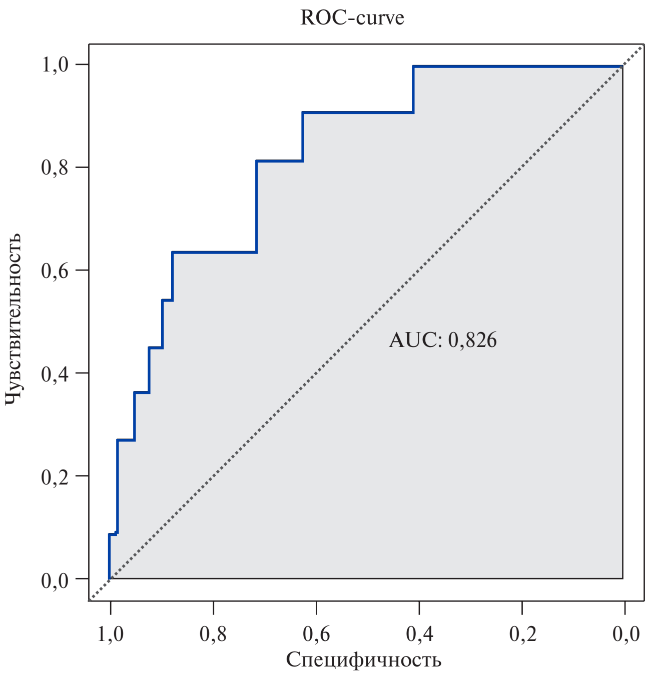

Figure 1. ROC-curve of logistic analysis of the risk for CI-AKI in patients with AMI.

are presented as a median (Me) and 25% and 75% quartiles (Q1; Q3).

The study was conducted in accordance with good clinical practice (GCP) standards The study was approved by the Local Ethics Committee of the V. F. Voino-Yasenetsky Krasnoyarsk State Medical University.

Results

The main clinical characteristics of patients with verified CI-AKI included in the sample are presented in Table 1. The mean age of patients in the group with established CI-AKI was 72,2 years, while 35 (63%) patients were over 70 years old. The distribution of male and female patients was approximately the same (Table 1). The average creatinine level on admission was 101,7 μmol/L.

In the study sample, 57 patients with CI-AKI were verified. Variables such as age, anemia, and contrast volume in milliliters per kilogram of body weight were identified as predictors. Variable "anemia" is presented as categorical, while other variables were used as continuous values. The Hosmer-Lemeshow test with χ^2 of 3,3 (p=0,2) confirmed the adequacy of created model.

C-statistics with the creating a ROC-curve showed a high proportion of objects with selected features (area under the ROC-curve =0,82) (Figure 1).

Based on the conducted multivariate study, we created a risk assessment scale for CI-AKI in patients with PCI, which includes 3 predictors as follows: age (OR, 0,06, p<0,01), anemia (OR, 2,23, p<0,01) and the volume of contrast medium per unit of body weight (ml/kg) (OR, 0,43, p<0,01). Table 2 shows that the largest proportion in the risk assessment scale for CI-AKI and the widest value of the confidence interval belongs to anemia, which is explained by the fact that this variable has a binomial character. In the group of patients with established CI-AKI, out of 52 patients, anemia was diagnosed in 23 patients (44%). In the group of patients without CI-AKI, the proportion of patients with anemia was 52% (n=163). The lower value of regression coefficient of the "age" variable is explained by its higher values in the interval value — 64,3±11,9. In addition, the average for sample of patients with CI-AKI was 72,2±9,1, while it was 63,2±11,9 in the rest of patients. The presented difference is significant, which is confirmed by the t-test of normally distributed samples (t=5,33, p<0,0001). The proportion of patients over 70 years old in the CI-AKI group was 63% (n=55), while in patients without CI-AKI — 26% (n=113). The contrast volume had the highest value of 4,6 ml/kg and the median of 1,4 (1; 2). The variable "contrast volume" was characterized by a deviation from the normal distribution with positive asymmetry both in the general sample and in the groups of patients with/

Table 2

Multivariate predictors of the risk for CI-AKI after PCI

Variable	Regression coefficient	Odds ratio	95% interval	P
Age	0,06	1,06	1,03-1,10	<0,01
Anemia	0,80	2,23	1,03-4,78	<0,01
Contrast volume (ml/kg)	0,43	1,55	1,01-2,35	<0,01

without CI-AKI, on the basis of which this variable is presented as a median (Me) and percentiles (Q1; Q3). In the group of patients with CI-AKI, the average value of contrast medium volume was 1,7 (1,2; 2,5), while in patients without CI-AKI — 1,4 (1,0; 1,9). The difference between the presented values is significant, which is confirmed by the Mann-Whitney U test (p=0,04).

Multivariate logistic regression revealed coefficients, on the basis of which the equation for assessing the risk of CI-AKI in patients with PCI was created:

dCI-AKI=1/(1+exp (7,613-0,43906*CV-0,06764**Age-0,80557*A)),

where dCI-AKI is the likelihood of developing CI-AKI, CV — contrast volume (ml/kg), A — anemia as follows: presence — 1, absence — 0.

The following scale is proposed for assessing the degree of risk for CI-AKI in patients with angiography and PCI.

- ⩽5% — Low risk
- 5,1%-15% — Moderate risk
- 15,1%-50% — High risk
- >50% — Very high risk

Discussion

There are some studies with certain predictors, on the basis of which models for assessing the risk of CI-AKI are created, while the set of CI-AKI predictors in different works is different [10-13].

In the present study, a number of significant variables were identified that allow assessing the risk of CI-AKI: anemia, age and contrast medium volume injected, depending on the patient's body weight. Numerous studies on the risk of CI-AKI considered the elderly and senile age of patients as a rather high risk for CI-AKI, which is confirmed by this work [11, 13]. In a number of studies, age >70 years was used as the threshold value for CI-AKI risk [10, 12]. The presented study confirms this statement by the fact that in the group of patients with established CI-AKI, the proportion of patients over 70 years old was 63%. It is known that the most common diseases of old age are a consequence of age-related weakening of defense mechanisms, which allows the action of exogenous factors to be realized. This study showed a relatively high probability of CI-AKI in patients over 80 years old, which was 22-33,5% in the range of 80-89 years, and in patients in the range of 90-92 years — 33,6-38,6%. The presented results undoubtedly require a special approach to patients of older age groups when using contrast-enhanced X-ray investigations. The volume of injected contrast agent is also considered in many works as a predictor of CI-AKI, while this parameter was presented differently: contrast volume per body surface area, contrast volume per mass unit, total volume of injected contrast [10-12]. Multivariate analysis in our study showed a significance of the variable of contrast volume per unit of body weight in ml/kg. It was also noted that if the contrast medium volume is >3,5 ml/kg in patients over 70 years old, the probability of CI-AKI is >25%, which makes it possible to classify these patients to a high-risk group. In contrast to the two above-mentioned predictors of CI-AKI, the variable "anemia" as a predictor of CI-AKI is presented comparatively less frequently in available publications. However, in the presented study, this variable was noted as a significant predictor of CI-AKI. In particular, on the basis of multivariate logistic regression, the presence of anemia in patients aged over 70 years of age with a volume of injected contrast medium >3,5 ml/kg increases the risk of CI-AKI up to 44%. The graphs presented show the risk of CI-AKI based on identified predictors (Figure 2a and 2b).

The presented risk assessment scale for CI-AKI in patients after CAG and PCI can be used to assign patients to a certain risk group, which will increase the potential for reducing the CI-AKI risk by applying appropriate treatment procedures. Despite the fact that multivariate analysis showed a high significance of the found CI-AKI predictors, it should be noted that due to the retrospective design of the study and a limited access to other possible predictors, it is very likely that we did not identify other important etiopathogenetic factors of CI-AKI development. It should also be noted that the current model for assessing the risk of CI-AKI was based on the CI-AKI criterion "an increase in creatinine levels within 48 hours and within a week", and cannot be used in relation to other criteria.

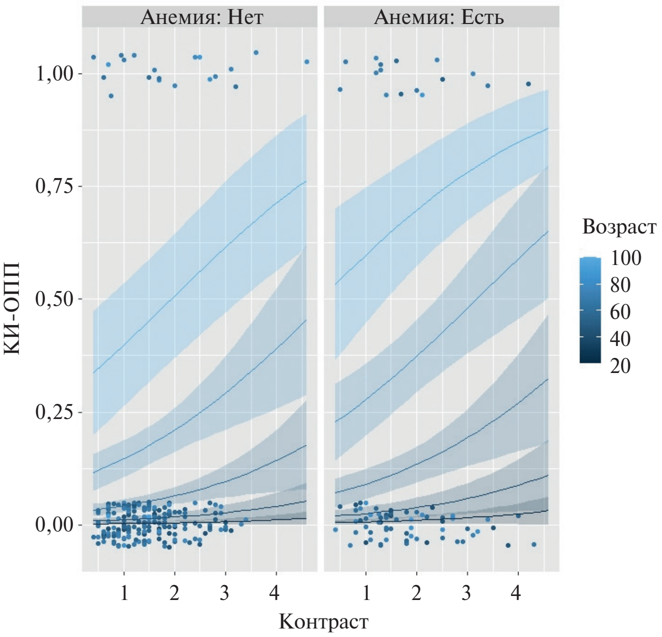

Figure 2a. The likelihood of developing CI-AKI depending on contrast volume (mg/ml), anemia and age.

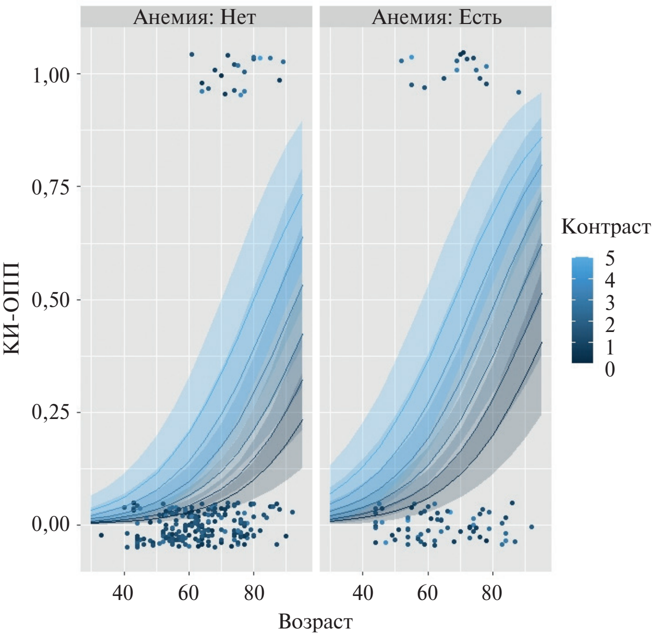

Figure 2b. he likelihood of developing CI-AKI depending on contrast volume (mg/ml) and anemia.

Conclusion

CI-AKI is a common complication of CAG in patients with AMI in a specialized hospital. A simple scale for assessing the CI-AKI risk makes it possible to identify a category of patients who require preventive measures to reduce iatrogenic complications and mortality.

Relationships and Activities: none.

References

1. Balashkevich NA, Dyusenova LB, Zhetpisbaev BA, et al. Comparative assessment of kidneys' functional state in patients with acute coronary syndrome. Russian Journal of Cardiology. 2019;(3):48-53. (In Russ.) doi:10.15829/1560-4071-2019-3-48-53.
2. Ronco F, Tarantini G, McCullough PA. Contrast induced acute kidney injury in interventional cardiology: an update and key guidance for clinicians. Rev. Cardiovasc. Med. 2020;21(1):9-23. doi:10.31083/j.rcm.2020.01.44.
3. Volgina GV. Contrast-induced nephropathy: pathogenesis, risk factors, prevention strategies. Nephrology and Dialysis. 2006;8(2):176-83. (In Russ.)
4. Demchuk OV, Sukmanova IA, Ponomarenko IV, Elykomov VA. Contrast-induced nephropathy in patients with acute coronary syndrome: clinical significance, diagnosis, prophylaxis. Cardiovascular Therapy and Prevention. 2020;19(2):2255. (In Russ.) doi:10.15829/1728-8800-2019-2255.
5. Morcos R, Kucharik M, Bansal P, et al. Contrast-Induced Acute Kidney Injury: Review and Practical Update. Clin. Med. Insights Cardiol. 2019;13:1179546819878680. doi:10.1177/1179546819878680.
6. Ozkok S, Ozkok A. Contrast-induced acute kidney injury: A review of practical points. World J. Nephrol. 2017;6(3):86-99. doi:10.5527/wjn.v6.i3.86.
7. Sekiguchi H, Ajiro Y, Uchida Y, et al. Oxygen pre-conditioning prevents contrast-induced nephropathy (OPtion CIN Study). J Am Coll Cardiol. 2013;62(2):162-3. doi:10.1016/j.jacc.2013.04.012.
8. Chandiramani R, Cao D, Nicolas J, Mehran R. Contrast-induced acute kidney injury. Cardiovasc Interv Ther. 2020;35(3):209-17. doi:10.1007/s12928-020-00660-8.
9. Dzgoeva FU, Remizov OV. Post-Contrast acute kidney injury. Recommendations for updated of the European Society of Urogenital Radiology Contrast Medium Safety Committee guidelines (2018). Part 1. Nephrology (Saint-Petersburg). 2019;23(3):10-20. (In Russ.)
10. Centemero MP, Sousa AGMR. Predicting contrast-induced nephropathy after percutaneous coronary intervention: Do we need formulas? a cardiological perspective. Rev Port Cardiol. 2018;37(1):37-9. doi:10.1016/j.repc.2017.11.003.
11. Naikuan Fu, Ximing Li, Shicheng Y, et al. Risk score for the prediction of contrast-induced nephropathy in elderly patients undergoing percutaneous coronary intervention. Angiology. 2013;64(3):188-94. doi:10.1177/0003319712467224.
12. Goldenberg I, Matetzky S. Nephropathy induced by contrast media: pathogenesis, risk factors and preventive strategies. CMAJ. 2005;172:1461-71. doi:10.1503/cmaj.1040847.
13. Mehran R, Aymong ED, Nikolsky E, et al. A simple risk score for prediction of contrast-induced nephropathy after percutaneous coronary intervention: development and initial validation. J Am Coll Cardiol. 2004;44:1393-9. doi:10.1016/j.jacc.2004.06.068.
14. Fitting a Regression Model. https://www.stat.umn.edu/geyer/aster/short/examp/reg.html.
15. Bujang MA, Sa'at N, Sidik TMITAB, Joo LC. Sample Size Guidelines for Logistic Regression from Observational Studies with Large Population: Emphasis on the Accuracy Between Statistics and Parameters Based on Real Life Clinical Data. Malays J Med Sci. 2018;25:122-130. doi:10.21315/mjms2018.25.4.12.

ISSN 1560-4071 (print)
ISSN 2618-7620 (online)

Comparative assessment of the diagnostic value of echocardiography and magnetic resonance imaging in determining myocardial viability

Kryukov N. A., Ryzhkov A. V., Sukhova I. V., Anan'evskaya P. V., Fokin V. A., Gordeev M. L.

Aim. To compare myocardial imaging methods in patients with complicated coronary artery disease with significantly decreased myocardial contractility.

Material and methods. This single-center retrospective study included 109 patients with complicated coronary artery disease who underwent surgical treatment between 2014 and 2020. All patients had indications for delayed contrast-enhanced cardiac magnetic resonance imaging (MRI) in order to determine myocardial viability due to a pronounced decrease in left ventricular contractility according to echocardiography (ejection fraction (EF) ≤30%).

Results. Impairment of local contractility according to MRI and echocardiography significantly correlates with depth of contrast accumulation (p=0,0000000018 and p=0,0000034, respectively). Delayed contrast-enhanced cardiac MRI with cine sequences allows to determine higher number of impaired contractility cases compared with echocardiography (p=0,000006).

Conclusion. MRI with cine sequence allowed to determine higher number of impaired contractility cases compared with echocardiography. Delayed contrast-enhanced MRI is a reliably more sensitive method than electrocardiography in detecting left ventricular scarring. The depth of contrast agent accumulation correlates with local contractility impairment detected by echocardiography and delayed contrast-enhanced cardiac MRI.

Keywords: cardiac MRI, coronary artery disease, myocardial viability, heart failure, ischemic cardiomyopathy, myocardial dysfunction.

Relationships and Activities: none.

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Received: 12.03.2021
Revision Received: 15.04.2021
Accepted: 19.04.2021

For citation: Kryukov N. A., Ryzhkov A. V., Sukhova I. V., Anan'evskaya P. V., Fokin V. A., Gordeev M. L. Comparative assessment of the diagnostic value of echocardiography and magnetic resonance imaging in determining myocardial viability. *Russian Journal of Cardiology*. 2021;26(8):4407. (In Russ.) doi:10.15829/1560-4071-2021-4407

Assessment of a viable myocardium in patients with coronary artery disease (CAD) complications is an important aspect in considering a direct myocardial revascularization [1]. Evaluation of the hibernating myocardium in the system of involved arteries depends on the accuracy of diagnostic methods [2].

Randomized studies to assess myocardial viability and its effect on prognosis were performed only using positron emission tomography. Delayed-enhancement magnetic resonance imaging (DE-MRI) allows to determine not only the presence of myocardial damage, as isotopic techniques, but also provides information about the depth of involvement [3]. These data suggest the need for new studies in order to determine the effectiveness of DE-MRI in identifying viable myocardium, as well as to establish the MRI role in the algorithm for selecting patients for coronary artery bypass grafting and assessing the prognosis of patients after the intervention [4, 5].

The aim of the study was to compare myocardial imaging methods in patients with CAD complications with significantly decreased myocardial contractility.

Material and methods

The retrospective study included 109 patients with CAD complications, who in the period from 2014 to 2020 underwent echocardiography before direct myocardial revascularization at the Almazov National Medical Research Center and had indications (ejection fraction (EF) ⩽30%) for cardiac MRI to determine the proportion of viable myocardium. This study was performed in accordance with the Good Clinical Practice standards. All patients signed informed consent. There were following exclusion criteria: acute myocardial infarction (MI) <30 days old, LV aneurysm requiring surgical intervention, heart valve disease. The initial clinical state of the patients is shown in Table 1.

According to electrocardiography (ECG), 66 (60,5%) of the subjects had signs of prior anterior wall MI, 11 (10,1%) — LV lateral wall MI, 17 (15,8%) — inferior posterior wall MI, 15 (13,7%) — no ECG signs and a history of MI. Direct coronary angiography revealed an involvement of three arteries in 97 (88,9%) patients and two arteries in 12 (11,1%) patients. In 82 (75,2%) patients, left main coronary artery stenosis >50% was revealed.

All patients underwent 12-lead ECG at rest. Grade III-V premature ventricular contraction according to B. Lown, M. Wolf, modified by M. Ryan (1975) was found in 69 (63,3%) patients.

Echocardiography was performed before the operation, on the day of the operation, before and after the artificial circulation, on the 7th day after the intervention, as well as in the long-term follow-up period using the Vivid 9 system (General Electric Corp., USA). The echocardiography protocol included the assessment of cardiac sizes and volumes, ventricular contractility, as well as heart valves' function.

DE-MRI was performed on a MAGNETOM Trio system (Siemens, Germany) with a magnetic flux density of 3 Tesla. DE-MRI was performed twice as follows: before surgery and after coronary artery bypass grafting in the long-term follow-up. The contrast agent used was gadolinium-containing gadobutrol. The study protocol assessed the cardiac sizes and volumes, global and segmental LV contractility, and contrast accumulation depth in different LV segments. Delayed contrast enhancement was assessed by the depth of contrast accumulation: from 1 to 24% of the wall thickness; from 25 to 49%; from 50 to 74%; from 75 to 100% [3]. The localization of scarring and local contractility disorders was assessed using a standard 17-segment model adapted by M. D. Cerqueira, 2002 [6].

The LV sizes, volumes and contractile function are presented according to echocardiography and cardiac MRI are presented in Table 2.

All patients with LV dilatation with a severe contractility decrease had indications for myocardial viability assessment. Stress tests for this group of patients are contraindicated due to absolute and relative contraindications: left main coronary artery stenosis, heart failure with a high functional class, high grade premature beats.

Statistical analysis of the data was carried out using the Statistica v. 10.0. (StatSoft Inc., USA). Results are presented as arithmetic mean and standard deviation (M±SD) for continuous variables. Categorical variables are presented as units and percentages (proportion). The significance

Table 1

Characteristics of the study group of patients

Parameters		Patients
Sex, n (%)	men women	98 (89,9%) 11 (10,1%)
Age, years		60,8±9,6
Angina FC, median [Q25;Q75]		3 [2;3]
HF FC (NYHA), median [Q25;Q75]		3 [3;3]

Note: data are presented as M±σ and median, 25th and 75th quartiles.

Abbreviations: HF — heart failure, FC — functional class, NYHA — New York Heart Association Functional Classification.

Table 2

Characteristics of LV function in the studied patients

	According to cardiac MRI	According to echocardiography	
		Simpson	Teicholz
EDV LV, ml	258,9±61,7	251,2±45,2	228,3±46,0
ESV LV, ml	180,7±62,6	181,3±43,8	149,5±41,6
LVEF, %	27,7±6,0	26,5±3,6	34,0±6,5

Note: data are presented as M±σ.

Abbreviations: EDV — end diastolic volume, ESV — end systolic volume, LV — left ventricle, MRI — magnetic resonance imaging, EF — ejection fraction.

Table 3

Distribution of patients depending on DE-MRI data

Contrast accumulation depth (%)	n, (%)
0	17 (15,6%)
<50%	30 (27,5%)
50-74%	40 (36,7%)
75-100%	22 (20,2%)

Table 4

The number of segments with impaired local contractility depending on diagnostic method used

Type of impaired local contractility	Diagnostic method		Discordance number	p
	Cardiac MRI[1]	Echocardiography[2]		
Moderate hypokinesis	142	321	179	$p^{1,2}$=0,000006
Severe hypokinesis	904	1108	204	
Akinesis	655	407	248	
Dyskinesis	45	8	37	

Note: p — Pearson χ^2 test.

Abbreviation: MRI — magnetic resonance imaging.

of differences between the groups was calculated using the chi-squared test (χ^2). Differences were considered significant at $p<0{,}05$.

Results

A detailed analysis of the ECG and DE-MRI data for LV fibrosis was carried out.

It was found that among patients who underwent Q-wave myocardial infarction according to ECG data, transmural scar was defined only in 20,2%. In 15,6% of cases, myocardial accumulation of contrast agent was not detected, and in 27,5% of patients, accumulation of contrast was found with a depth of up to 50% (Table 3).

MRI with cine sequence allowed to determine a higher number of impaired contractility cases compared with echocardiography (Table 4).

A significant relationship was established between the depth of myocardial damage and local contractility impairment according to echocardiography and MRI data (Tables 5, 6). With the accumulation of contrast by more than 50% of myocardial thickness, the number of hypokinetic segments decreases and the number of akinetic segments increases.

Pearson's χ^2 test discarded the hypothesis of the independence of local contractility disorders according to MRI and contrast accumulation depth according to MRI. Consequently, MRI local contractility abnormalities significantly depend on the MRI transmurality index (p=0,0000000018) (Table 5).

Pearson χ^2 test discarded the hypothesis of the independence of local contractility disorders according to echocardiography and contrast accumulation depth according to DE-MRI. Consequently, local contractility disorders according echocardiography significantly depend on the transmurality index according to MRI (p=0,0000034) (Table 6).

Pearson's χ^2 test discarded the hypothesis of the absence of difference between local contractility disorders according to echocardiography and MRI data, depending on the contrast accumulation depth according to MRI. Consequently, local contractility impairment according to echocardiography significantly depends on the transmurality index according to MRI (p<0,001) (Table 7).

Clinical case: Thirty-two-year-old male patient with a coronary artery disease, unstable (new-onset) angina pectoris (09.06.2016).

ECG: Sinus rhythm. Postinfarction abnormalities were not found.

Echocardiography: end-diastolic volume — 186 ml, end-systolic volume — 131 ml. LV ejection fraction (Simpson's method) — 29,5%. Diffuse hypokinesia.

Table 5

Contingency table of the lesion depth (cardiac MRI) and local contractility impairments (cardiac MRI). An example of one of the segments

Type of impaired local contractility according to MRI	Depth of contrast agent accumulation			p
	0	<50%	>50%	p=0,0000000018
Moderate hypokinesis	207	25	13	
Severe hypokinesis	695	137	69	
Akinesis	113	145	417	
Dyskinesis	3	11	18	

Note: p — Pearson χ^2 test.
Abbreviation: MRI — magnetic resonance imaging.

Table 6

Contingency table of the lesion depth (cardiac MRI) and local contractility impairments (echocardiography). An example of one of the segments

Type of impaired local contractility according to echocardiography	Depth of contrast agent accumulation			p
	0	<50%	>50%	p=0,0000034
Moderate hypokinesis	79	13	30	
Severe hypokinesis	841	174	270	
Akinesis	90	134	213	
Dyskinesis	1	4	4	

Note: p — Pearson χ^2 test.

Table 7

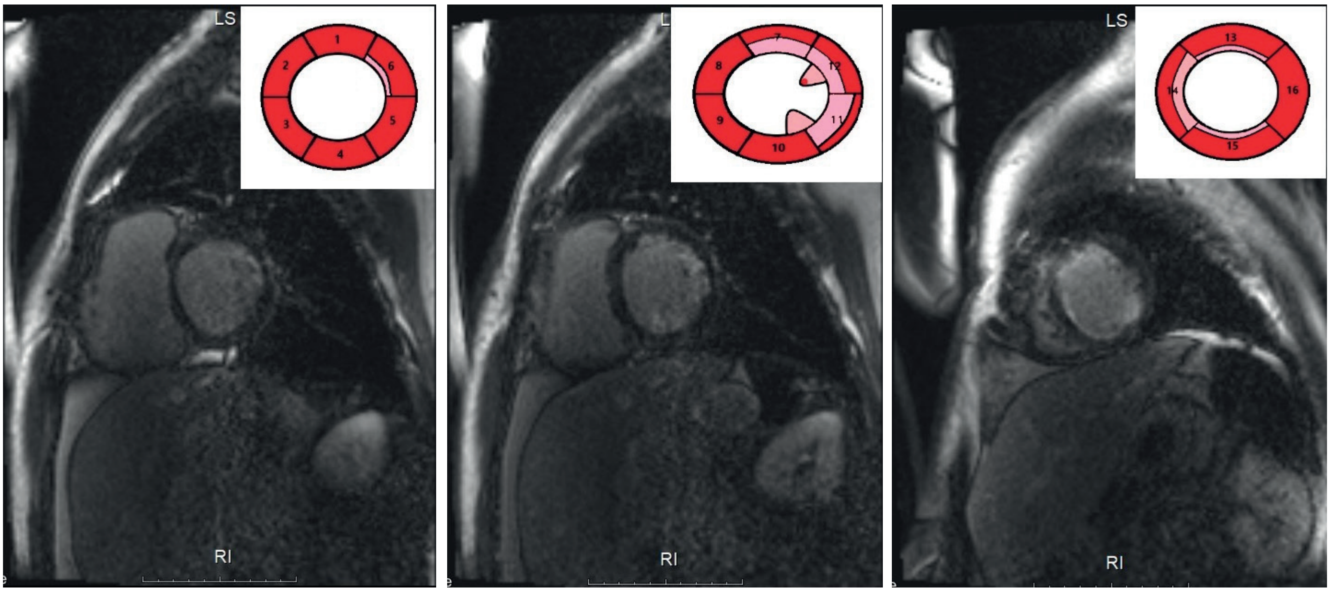
Contingency table of the lesion depth (cardiac MRI) and local contractility impairments according to cardiac MRI and echocardiography. An example of one of the segments

Summary Table: Expected Frequencies (Инд трасмурал и наруш сократимости отдельно
Marked cells have counts > 10
Pearson Chi-square: 327,535, df=28, p=0,00000

НЛС МРТ без 0 15	НЛС ЭХО 15	НЛС без 0 15 1	НЛС без 0 15 2	НЛС без 0 15 3	Row Totals
1	0	0,015487	0,15680	0,03872	0,2110
1	1	0,108408	1,09763	0,27102	1,4771
1	2	1,254440	12,70120	3,13610	17,0917
1	3	0,309738	3,13610	0,77435	4,2202
Total		1,688073	17,09174	4,22018	23,0000
2	0	0,035687	0,36133	0,08922	0,4862
2	1	0,249811	2,52933	0,62453	3,4037
2	2	2,890666	29,26799	7,22666	39,3853
2	3	0,713745	7,22666	1,78436	9,7248
Total		3,889908	39,38532	9,72477	53,0000
3	0	0,022220	0,22498	0,05555	0,3028
3	1	0,155542	1,57487	0,38886	2,1193
3	2	1,799848	18,22347	4,49962	24,5229
3	3	0,444407	4,49962	1,11102	6,0550
Total		2,422018	24,52294	6,05505	33,0000
Column Total		8,000000	81,00000	20,00000	109,0000

Note: p — Pearson χ^2 test.

Coronary angiography: left main coronary artery — 70% stenosis. Left anterior descending artery — subocclusion in the proximal third. Circumflex artery — stenosis before subocclusion in the middle third after the marginal branching. Right coronary artery — posterior interventricular artery stenosis (90%).



A B C

Figure 1. Delayed-enhancement MRI along the short LV axis with a lesion pattern by segments.
Notes: A — at the level of basal segments, the area of contrast accumulation in S6 is visualized up to 25% of segment thickness; **B** — at the level of median segments, the areas of contrast accumulation are visualized in S7 and S12 up to 50% of segment thickness, and S12 up to 50% of segment thickness, as well as in the papillary muscles; **C** — at the level of apical segments, areas of contrast accumulation are visualized in S13 and S15 up to 25% of segment thickness.
On the diagrams, LV segments are marked with numbers; the viable myocardium is indicated in red, the scarring — in pink.

Delayed-enhancement MRI: end-diastolic volume — 218 ml, end-systolic volume — 154 ml. LV ejection fraction (Simpson's method) — 29,3%. Akinesia in S15 with diffuse hypokinesia of the remaining LV segments. Delayed accumulation of contrast agent along the LV short axis with a lesion pattern by segments (Figure 1).

Discussion

ECG, echocardiography and coronary angiography are the main research methods in patients with CAD. However, in the case of diagnosing a pronounced LV contractility decrease and extensive areas of local contractility disorders, the state of dysfunctional myocardium should be assessed. The listed research methods do not make it possible to judge the size of the viable myocardium.

The presented study analyzed the results of myocardial imaging in patients after MI, complicated by a decrease in the global contractile function.

The MRI data made it possible to conduct a correlation analysis of the depth and prevalence of postinfarction cardiac fibrosis with impaired LV local contractility. It also made it possible to compare the data of cardiac MRI with echocardiography and ECG, once again proving the advantage of MRI in assessing local myocardial contractility decrease and in determining the postinfarction cardiac fibrosis.

The severity of postinfarction cardiac fibrosis in patients with CAD complications is an objective criterion for predicting the effectiveness of myocardial revascularization [7, 8]. When selecting treatment strategy, the volume of viable myocardium is taken into account, which makes it possible to obtain information on the number of myocardial segments [9], which, after revascularization, will restore their function, thereby improving the patient's condition.

All of the above emphasizes the fact that the verification of a viable myocardium should be carried out using the most modern diagnostic methods with high resolution, sensitivity and specificity. To confirm the myocardial ischemia in patients with CAD and heart failure, cardiac MRI is recommended by the European Society of Cardiology (2014 and 2018 guidelines) [2]. Given the data obtained, it is necessary to supplement the current guidelines. Also, this article relates to the fact that the current guidelines do not sufficiently describe the issue of diagnosing viable myocardium in patients who have contraindications to stress tests due to the high risk of complications [10-12].

Conclusion

1) MRI allows to determine a significantly higher number of segments with impaired local contractility

in comparison with echocardiography, and DE-MRI is a more sensitive method in detecting LV myocardial scarring than ECG.

2) The depth of contrast agent accumulation according to MRI correlates with the type of local contractility disorder: the higher the transmurality index, the higher the number of akinetic segments and the lower — hypokinetic segments.

3) DE-MRI makes it possible to assess the viable myocardium, which determines further treatment strategy, the effectiveness of revascularization and further prognosis.

Relationships and Activities: none.

References

1. Telen M, Erbel R, Kreitner KF, et al. Luchevye metody diagnostiki boleznei serdtsa. Translation from german. Editor Sinitsyna VE. Moscow: MEDpress inform, 2011. p. 408 (In Russ.)
2. Kwon DH, Hachamocitch R, Popovic ZB, et al. Survival in patients with severe ischemic cardiomyopathy undergoing revascularization versus medical therapy: association with end-systolic volume and viability. Circulation. 2012;(126):3-8. doi:10.1161/CIRCULATIONAHA.111.084434.
3. Patel H, Mazur W, Sr Williams KA, et al. Myocardial viability — State of the art: Is it still relevant and how to best assess it with imaging? Trends Cardiovasc Med. 2018;28(1):24-37. doi:10.1016/j.tcm.2017.07.001.
4. Windecker S, Kolh P, Alfonso F, et al. 2014 ESC/EACTS Guidelines on myocardial revascularization. Eur. Heart. J. 2014;(35):2541-619. doi:10.1093/eurheartj/ehu278.
5. Schulz-Menger J, Bluemke DA, Bremerich J, et al. Standardized cardiovascular magnetic resonance imaging (CMR) protocols, society for cardiovascular magnetic resonance: board of trustee's task force on standardized protocols. J Cardiovasc Magn Reson. 2013;15(1):35. doi:10.1186/1532-429X-15-35.
6. Souto ALM, Souto RM, Teixeira ICR, et al. Myocardial Viability on Cardiac Magnetic Resonance. Arq Bras Cardiol. 2017;108(5):458-69. doi:10.5935/abc.20170056.
7. Kokov AN, Masenko VL, Semenov SE, et al. MRI of the heart in the evaluation of postinfarction changes and its role in determining the tactics of myocardial revascularization. Complex problems of cardiovascular diseases. Kompleksnye problemy serdechno-sosudistykh zabolevanii. 2014;(3):97-102. (In Russ.) doi:10.17802/2306-1278-2014-3-97-102.
8. Mielniczuk LM, Toth GG, Xie JX, et al. Can Functional Testing for Ischemia and Viability Guide Revascularization? JACC Cardiovasc Imaging. 2017;10(3):354-64. doi:10.1016/j.jcmg.2016.12.011.
9. West AM, Kramer CM. Cardiovascular magnetic resonance imaging of myocardial infarction, viability, and cardiomyopathies. Curr Probl Cardiol. 2010 Apr;35(4):176-220. doi:10.1016/j.cpcardiol.2009.12.002.
10. Pontone G, Andreini D, Guglielmo M, et al. Computed tomography coronary angiography versus stress cardiac magnetic resonance for the management of symptomatic revascularized patients: a cost effectiveness study (strategy study). Journal of the American College of Cardiology, 2016;67(13):1572. doi:10.1016/S0735-1097(16)31573-X.
11. Quinaglia T, Jerosch-Herold M, Coelho-Filho OR. State-of-the-Art Quantitative Assessment of Myocardial Ischemia by Stress Perfusion Cardiac Magnetic Resonance. Magn Reson Imaging Clin N Am. 2019;27(3):491-505. doi:10.1016/j.mric.2019.04.002.
12. Schinkel AFL, Bax JJ, Poldermans D, et al. Hibernating myocardium: diagnosis and patient outcomes. Curr Probl Cardiol. 2007;32(7):375-410. doi:10.1016/j.cpcardiol.2007.04.001.

Russian Journal of Cardiology 2021;26(8):4598
doi:10.15829/1560-4071-2021-4598
https://russjcardiol.elpub.ru

ISSN 1560-4071 (print)
ISSN 2618-7620 (online)

Cardiac tumors: analysis of surgical treatment

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Aim. To analyze the preoperative status, intraoperative tumor characteristics and further clinical manifestations in patients after surgery for a cardiac tumor.

Material and methods. The study included 54 patients who were operated on for a heart tumor from 2014 to 2020. We assessed clinical performance, diagnostic investigations before and after (during hospitalization) surgery, tumor size and histological characteristics.

Results. Among patients operated on for cardiac tumors, women predominated (74%). Among comorbidities, hypertension (79,3%), chronic kidney disease (48,3%), and obesity (25,9%) were most common.

There were following clinical manifestations before surgery: shortness of breath — 47 (81%) patients, palpitations and heart rhythm disturbance — 26 (44,8%), chest pain — 25 (43,1%), chest discomfort — 28 (49,1%), edema — 6 patients (10,3%).

The predominant tumor localization was the left atrial fossa ovalis area (50%).

According to histological analysis, myxoma prevailed — 38 cases (86,4%).

After surgery, atrial fibrillation prevalence decreased from 8 patients before surgery to 6 after surgery (p=0,034), while left atrial size decreased by 0,6 mm (95% confidence interval, 4,39-6,2 mm) (p<0,001).

Conclusion. According to presented analysis over a 6-year period, cardiac neoplasms are more common in women (74,1%), while the mean age of patients is 59,7 years. Among comorbidities, hypertension prevails — 79,3%. Histological examination revealed a predominance of myxoma (86,4%). Predominant tumor location was the left atrial fossa ovalis area (50%).

Surgical treatment of neoplasms was effective. So, prevalence of atrial fibrillation decreased by 25%, while left atrial size decreased by 0,6 mm. Postoperative complications and in-hospital deaths were not registered.

Keywords: cardiac tumors, neoplasms, surgical treatment, myxoma, fossa ovalis, left atrium.

Relationships and Activities: none.

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Received: 17.07.2021
Revision Received: 23.07.2021
Accepted: 30.07.2021

For citation: Sakovich V.A., Drobot D.B., Chernova A.A., Gorbunov D.N., Buyankov D.I., Gross Yu.V., Verkhoturov M.K., Stavtseva M.A. Cardiac tumors: analysis of surgical treatment. *Russian Journal of Cardiology*. 2021;26(8):4598. (In Russ.) doi:10.15829/1560-4071-2021-4598

For a long time, cardiac tumors were characterized by a multiform clinical presentation and were detected more often at autopsies and extremely rarely during cardiac surgery [1-3].

An increase in life expectancy, the influence of pre-existing and novel factors contribute to an increase in the risk of cancer, including cardiac tumors. Many authors associate an increase in the detection rate of cardiac tumors with research and technological progress, which contributes to the improvement of preoperative diagnostics using modern investigations and with highly qualified specialists [4].

Identification of cardiac tumors remains a difficult task, since there are no pathognomonic signs and the disease can be asymptomatic for a long time. Therefore, when the patient first visits a doctor, the correct diagnosis is established only in 3-10% of cases [5].

Cardiac tumors are rare compared to other heart diseases. Primary cardiac tumors can be both benign and malignant and are 30 times less common than secondary (metastatic) tumors. According to autopsy data, the prevalence of primary cardiac tumors ranges from 0,001 to 0,03% [2, 6-10]. According to a 6-year continuous sample study, an echocardiography detected cardiac tumors in 54 patients (14 men and 40 women; mean age, 59,7 years). Despite the low prevalence, timely detection of tumors is very important, since there are effective methods of treatment. Therapy for benign cardiac tumors is surgical resection, and how urgently the intervention should be performed is determined by the patient's symptoms and the type of tumor.

The aim of the study was to analyze the preoperative status, intraoperative tumor characteristics and further clinical manifestations in patients after surgery for a cardiac tumor at the Federal Center of Cardiovascular Surgery from 2014 to 2020 (Krasnoyarsk).

Material and methods

This retrospective analysis included 54 case records of patients who underwent surgery for a cardiac tumor from 2014 to 2020. We studied clinical and investigational data before and after surgery during hospitalization, as well as assessed the size and histological characteristics of the tumor. Mathematical analysis of the data was performed using the IBM SPSS program. Quantitative variables were examined for distribution normality using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Data are presented as M±SD. Differences were considered significant at $p<0,05$.

Results

Among those operated on for cardiac tumors, women predominated (74%); 42,6% of patients were aged 55 to 64 years (Table 1). Among comorbidities, hypertension prevailed and was revealed in 79,3% of patients, chronic kidney disease — in 48,3%, and obesity — in 25,9% (Table 1). Heart failure (HF) was revealed in 55,2% of patients as a manifestation of the underlying disease and concomitant disorder. In most patients, there was class I-II HF.

There were following clinical manifestations of the disease before the operation (Figure 1): shortness of breath — 47 (81%) patients, palpitations and heart rhythm disturbance — 26 (44,8%), chest pain — 25 (43,1%), chest discomfort — 28 (49,1%), edema — 6 patients (10,3%) (Figure 1). Before surgery, 16 (27,6%) patients had atrial fibrillation (AF), 1 (1,7%) — atrial flutter. In 3 (5,2%) patients, premature beats were detected, while in 2 (3,4%) — coronary atherosclerosis.

Echocardiography was the main method for detecting cardiac tumors (Table 2).

There were following laboratory parameters before surgery: while blood cell count, $7,05\pm0,48\times10^9$/L; red blood cell count, $4,68\pm0,16\times10^{12}$/L; hemoglobin, $134,3\pm4,6$ g/L; erythrocyte sedimentation rate, $19,1\pm6,2$ mm/h. Anemia (hemoglobin <120 g/l) was observed in 9 (15,5%) patients.

In all patients, on-pump cardiac surgery was performed. Aortic cross-clamp time was $63,83\pm8,0$ min, and artificial circulation time — $89,7\pm9,5$ min. In most patients, tumor removal was performed with excision of underlying tissues, as well as with the

Table 1

Characteristics of the included patients

Parameter	Patients (n=54)
Mean age (SD), years	59,7
Male sex, n (%)	14 (25,9%)
Female sex, n (%)	40 (74,1%)
Age groups, years, n (%)	
<55	11 (20,4%)
55-64	23 (42,6%)
65-74	16 (29,6%)
≥75	4 (7,4%)
Comorbidities	
Hypertension, n (%)	46 (79,3%)
Diabetes, n (%)	6 (10,3%)
Chronic kidney disease, n (%)	28 (48,3%)
Obesity, n (%)	15 (25,9%)
Peripheral atherosclerosis, n (%)	3 (5,2%)
Psoriasis, n (%)	2 (3,4%)

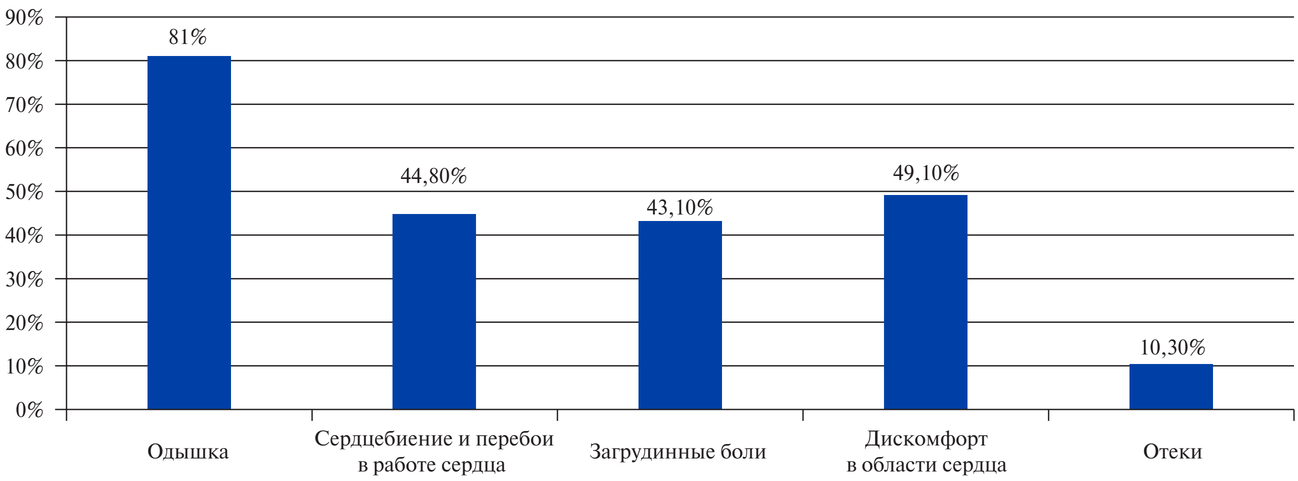

Figure 1. Clinical manifestations before surgery.

closure of atrial septal and endomyocardial defect and with a continuous locking stitch.

Tumor was located on the interventricular septum in 3 (5,5%) cases, left ventricular (LV) apex — 1 (1,9%), LV posterior-medial papillary muscle — 1 (1,9%), LV posterior wall — 1 (1,9%), left atrium (LA) (without specification) — 4 (7,4%), LA near pulmonary veins — 3 (5,6%), LA mitral-aortic contact — 1 (1,9%), LA fossa ovalis — 27 (50%), medial commissure — 1 (1,9%), anterior mediastinum — 1 (1,9%), anterior mitral leaflet — 1 (1,9%)), right atrium (RA) (without specification) — 3 (5,6%), RA fossa ovalis — 3 (5,6%), RA near inferior vena cava — 1 (1,9%), atrial surface of the posterior tricuspid leaflet — 1 (1,9%), LA appendage — 1 (1,9%), RA appendage — 1 (1,9%) (Figure 2).

The maximum size of the removed tumor, which was noted in this study, was 7,5×4,0 cm, while the minimum was 0,5×0,7 cm.

According to histological examination, the tumors were divided as follows: myxoma — 38 (86,4%), fibroelastoma — 1 (2,3%). A cyst was found in one case (2,3%). The diagnosis was not confirmed in one (2,3%) case — pathological examination revealed a thrombus. Necrotic areas were detected once (2,3%) (Figure 3).

AF prevalence decreased after surgery decrease as follows: from 8 cases before surgery to 6 after surgery (p=0,034). LA size decreased by 0,6 mm (95% confidence interval, 4,39-6,2 mm) (p<0,001). In 54 (100%) patients, the postoperative period was without adverse events and there was no in-hospital mortality.

Table 2

Echocardiographic data before surgery

Parameter	Data
Right atrium, cm	5,08±0,74
Left atrium, cm	5,86±0,84
Right ventricle, cm	3,77±0,61
Mitral valve orifice area, cm	3,52±0,39
Tricuspid valve orifice area, cm	3,39±0,35
LV end diastolic dimension, cm	4,57±0,33
LV end systolic dimension, cm	36,3±9,88
LV end diastolic volume, cm	83,11±13,32
LV ejection fraction, %	56,67±9,09

Abbreviation: LV — left ventricle.

Discussion

This 6-year analysis revealed that cardiac tumors are more common in women (74,1%), while the mean age of patients is 59,7 years. Among comorbidities, hypertension prevails, which was detected in 79,3% of patients. The most frequent clinical manifestation of pathology before surgery was shortness of breath in 81% of patients.

Before the operation, laboratory blood parameters in the vast majority of patients was within normal range. Anemia was noted in 15,5% of patients.

According to histological examination, myxoma prevails, which was detected in 86,4% of the operated patients. The predominant tumor location was observed in LA fossa ovalis (50% of patients).

Surgical treatment of tumors led to favorable results as follows: AF prevalence decreased by 25%; according to echocardiography, the LA size decreased by 0,6 mm; postoperative complications and in-hospital mortality were not recorded.

According to literature data, the treatment of cardiac tumors is an urgent issue that has been studied for a long time. Soloviev G. M. et al. (2000) describe the period from 1981 to 1999, during which

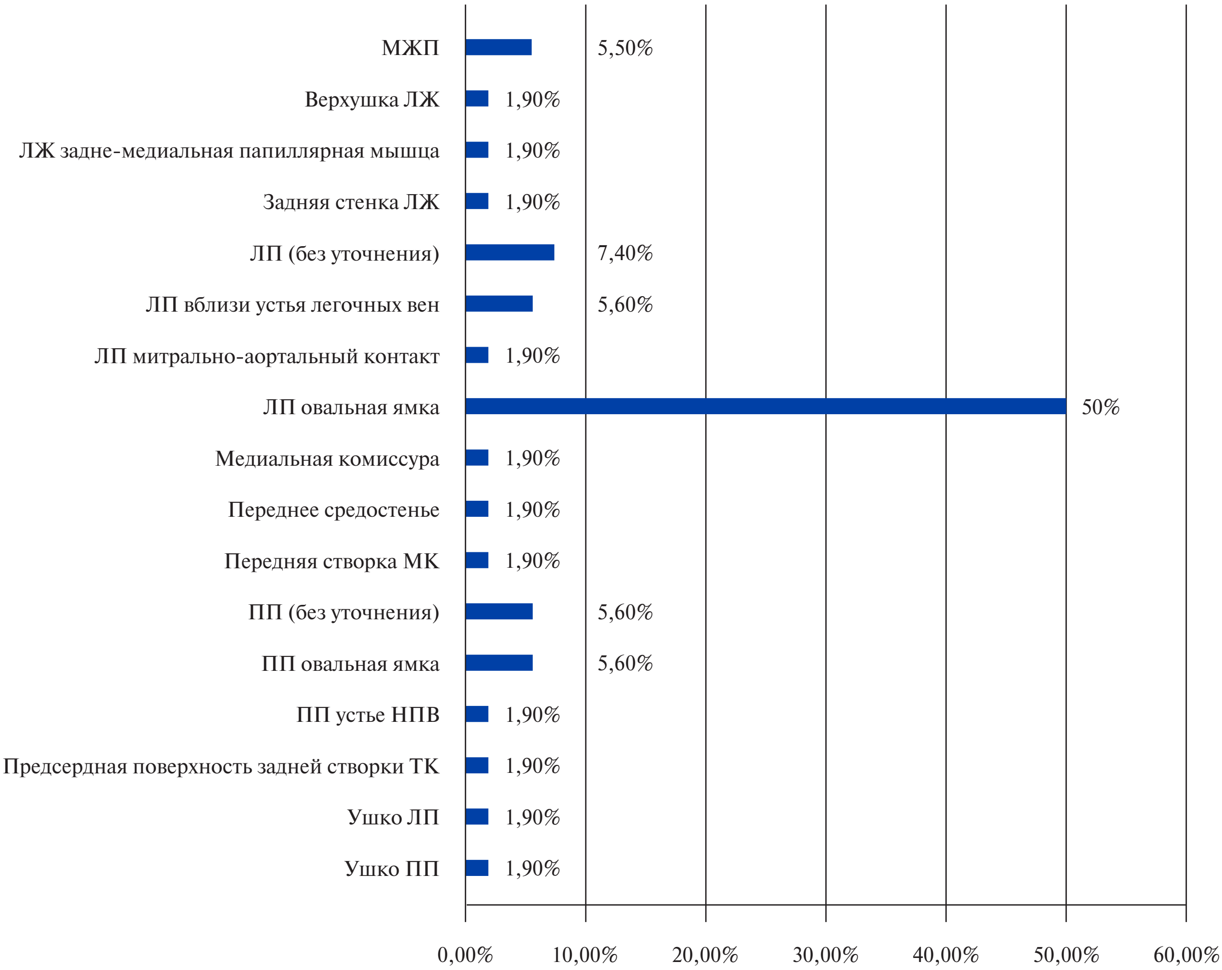

Figure 2. Tumor location.

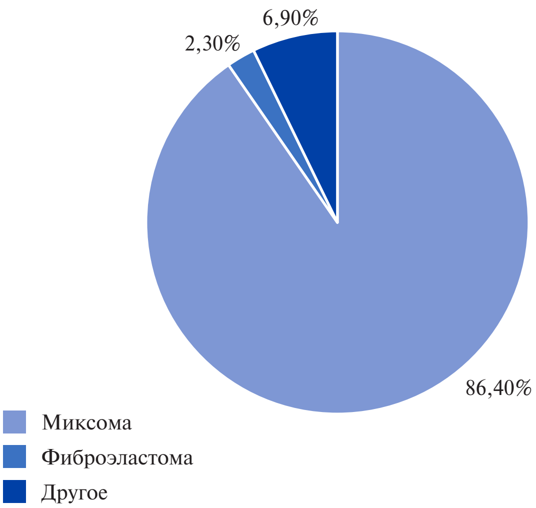

Figure 3. The pattern of cardiac tumors according to histological examination (%).

36 patients were operated on for heart tumors. The age of patients ranged from 17 to 57 years. According to histological examination, myxomas were detected in 33 cases, 75-80% of which were localized in the LA. One female patient had 2 prior embolisms with tumor fragments into the lower limb vessels. Reembolism involved coronary arteries and led to acute myocardial infarction. In 8 cases, signs of systemic and pulmonary circulatory decompensation were noted. Within 18 years after surgical removal of the tumor, not a single recurrence case was revealed, which allows the authors to consider it possible to remove the atrial myxomas without septum excision. There were only off-pump operations with normothermic perfusion. In the early postoperative period, two severe patients died due to acute cardiovascular failure.

Nuzhdin M. D. et al. (2011) analyze 30-year (1981-2011) experience of cardiac tumor surgery in the Chelyabinsk Regional Clinical Hospital, which involved 129 patients aged 1-78 years. There were 111 patients with benign tumors, and 18 with malignant ones. The most common benign tumor was myxoma (78,3%). In 96,9% of patients, the indication for surgery was HF and arterial embolism. There were on-pump operations with normo- and hypothermia, as well as with pharmaco-cold cardioplegic protection. The most frequent postoperative complications were paroxysmal arrhythmias (27,9%), of which ~50% were due to AF. There were following risk factors for malignant tumors: disease duration <8 months in combination with stage 2b HF or with RA tumor location. In-hospital mortality rate was 6,2% (n=8), 4 of which occurred in the period from 1981 to 1983, when the on-pump technique was being mastered.

Case report

We report a case of a rare myxoma location — at the LV apex, which, according to the literature, occurs in 1%.

On may 2, 2017, female patient was admitted to the cardiac surgery department of the Federal Center of Cardiovascular Surgery in Krasnoyarsk with a following diagnosis: LV tumor. Stage 2A, class II heart failure. Background: stage III hypertension, very high risk. Hemodynamically insignificant head-and-neck artery atherosclerosis. Concomitant diagnosis: stage 1 discirculatory encephalopathy of atherosclerotic and hypertensive genesis with mild cognitive impairment, vestibulocerebellar syndrome.

The patient has been working as a teacher at school for 30 years, undergoes medical examinations every year. Previously, no cardiac pathology has been detected. Since 2012, the patient noted shortness of breath during household exertion, increased fatigue, pain in chest and under the left shoulder blade not related with physical activity but with relief at rest, blood pressure increase up to 200/100 mm Hg. Since 2016, she began to note episodes of severe weakness during hypertensive crisis, periodic presyncope episodes, and a significant decrease in body weight. In March 2016, she was hospitalized in the Abakan Central District Hospital with a hypertensive crisis, where an echocardiography revealed a LV tumor. In April 2017, repeated echocardiography was performed (06.04.2017): end-diastolic dimension (EDD) — 4,8 cm, ejection fraction (EF) — 60%, end-diastolic volume (EDV) — 85 ml, RA — 4,5 cm, LA — 4,9 cm, right ventricle (RV) — 3,4 cm. In the LV apex region, an additional hyperechoic pedunculated (0,4x0,8 cm) formation ~2,2x2,0 cm with a clear contour at the border of 7 and 13 LV segments was revealed. Mixoma. She was consulted by a cardiac surgeon, who revealed indications for surgical treatment. On April 7, 2017, coronary angiography was performed (no coronary artery pathology was revealed). On May 4, 2017, the operation was performed by Gross Yu.V. The aorta was opened with a transverse aortotomy approach. The LV cavity was revised by transaortic approach. Near LV apex, pedunculated (3-4 mm) tumor-like spherical filamentous formation attached along the posterior wall up to 2 cm in diameter was identified. The tumor was excised in a single block with a part of the adjacent septal trabecula. The attachment point has been processed with radiofrequency energy. The diagnosis of myxoma was confirmed with histological examination.

The postoperative period was uneventful. There are following postoperative echocardiographic characteristics (15.05.2017): EDD — 4,8 cm, EF — 56%, EDV — 70 ml, RA — 4,3 cm, LA — 4,9 cm, RV — 3,4 cm. Mitral regurgitation was not recorded. There was no pericardial effusion. On the 13^{th} day, she was discharged in satisfactory condition.

A year after the surgery, the patient feels good, has no complaints and works in her specialty. There is following data from the control echocardiography (10.05.2018): EDD — 4,7 cm, EF — 59%, EDV — 74 ml, PP — 4,2 cm, LA — 4,7 cm, RV — 3,5 cm. Mild mitral and tricuspid regurgitation (0-I). There is no pericardial effusion. Twenty-four-hour Holter ECG monitoring did not reveal life-threatening arrhythmias.

This case report describes the symptoms of myxoma, diagnostic algorithm, surgery types and good long-term outcomes of surgical treatment.

Conclusion

The presented retrospective 6-year analysis of cardiac tumor surgery is consistent with the literature data. Myxomas (86,4%) predominated in the tumor pattern. Postoperative complications and in-hospital deaths were not registered.

Relationships and Activities: none.

References

1. Sakovich VA, Grinstein YuI, Bobrovsky OA, Chernyavsky AM. Malignant tumors of the heart and pericardium: series. Krasnoyarsk Medical Academy. Krasnoyarsk: IPK Platina. 2004. p. 119 (In Russ.) ISBN: 5-8417-0021-9.
2. Shonbin AN, Mizintsova MA, Mirolyubova OA, Antonov AB. Cardiac tumors: an analysis of surgical treatment. Cardiology and cardiovascular surgery. 2016;9(4):39-42. (In Russ.) doi:10.17116/kardio20169439-42.
3. Leontyeva KA, Shchukin MM. Clinical case of tumor of the right ventricle of the heart. Collection: Actual problems of theoretical, experimental, clinical medicine and pharmacy. Materials of the 53rd Annual All-Russian Conference of Students and Young Scientists dedicated to the 90th anniversary of Doctor of Medical Sciences, Professor, Corresponding Member of the Russian Academy of Natural Sciences Anatoly Shulimovich Byshevsky. Tyumen, March 27-28, 2019. Tyumen: RIC "Iveks", 2019. 430 p. (In Russ.)
4. Muratov RM, Amiragov RI, Sachkov AS, et al. Surgical method for treating various types of heart tumors for 15 years. Bulletin NTSSSH them. A. N. Bakuleva RAMS. Cardiovascular diseases. 2019;20(S11):32. (In Russ.)
5. Kadyrova MV, Stepanova YuA, Grinberg MS, et al. Tumors of the heart: classification, clinical picture, characteristics, radial signs. Medical visualization. 2019;23(4):24-41. (In Russ.) doi:10.24835/1607-0763-2019-4-24-41.
6. Kvashnin AV, Sagatov IE, Dosmailov NS, et al. Our experience of surgical treatment of primary cardiac tumors. Bulletin of Surgery of Kazakhstan. 2017;2(51):45-50. (In Russ.)
7. Mutema ACh, Mironenko VA. Primary cardiac tumors: a modern approach. News of cardiovascular surgery. 2017;1(3-4):123-32. (In Russ.)
8. Mukharyamov MN, Dzhordzhikia RK, Kaipov AE, et al. Experience of surgical treatment of cardiac tumors. Bulletin of the N. N. A. N. Bakuleva RAMS. Cardiovascular diseases. 2016;17(S6):222. (In Russ.)
9. Shakirova GKh, Kraeva TV, Demina AS, Fomina TF. Tumors of the heart. Clinical observations. Ugra health care: experience and innovations. 2017;3(12):17-24. (In Russ.)
10. Yurochko BM, Burlakova LI, Romanov SN. Tumors of the heart. Literature review and clinical case. Family Medicine. 2019;2(82):113-9. (In Russ.)