Translated by E.V. Trushina

Case Report

https://doi.org/10.23934/2223-9022-2025-14-2-437-447

Extracorporeal Membrane Oxygenation in Patients With Acute Myocardial Infarction and Critical Multivessel Coronary Artery Disease Involving the Trunk of the Left Coronary Artery

M.V. Vatsik-Gorodetskaia[1, 2], E.V. Reznik[3], L.M. Titkin[3] ✉, G.N. Golukhov[1], D.E. Emelyanovich[1], A.G. Zlatovratsky[1], I.S. Korotkov[1], D.I. Malyuk[1, 2], E.N. Platonova[1], D.V. Puzenko[3, 4], A.A. Khachaturov[1]

Department of Cardiology with Resuscitation and Intensive Care Units
[1] Academician G.M. Savelyeva Municipal Clinical Hospital No. 31
Lobachevsky Str. 42, Moscow, Russian Federation 119415
[2] Patrice Lumumba Peoples' Friendship University of Russia, Medical Institute
Miklukho-Maklaya Str. 6, Moscow, Russian Federation 117198
[3] Pirogov Russian National Research Medical University
Ostrovityanova Str. 1, Moscow, Russian Federation 117513
[4] N.N. Blokhin National Medical Research Center of Oncology
Kashirskoe shosse 24, Moscow, Russian Federation 115522

✉ **Contacts:** Leonid M. Titkin, 2nd year Resident in the specialty of "Cardiology", Pirogov Russian National Research Medical University. Email: titkin.leonid@yandex.ru

ABSTRACT Critical coronary stenosis involving the trunk of the left coronary artery (LCA) is one of the most severe factors of coronary artery disease, especially in cases of acute myocardial infarction. The lesion of the LCA trunk, often detected by coronary angiography, is the reason for the refusal of stenting due to the high risk of life-threatening complications, especially in cases of so-called "unprotected" stem lesion (in the presence of occlusion of the right coronary artery). In this case, an emergency operation of direct myocardial revascularization using the coronary artery bypass grafting is preferable. However, in the absence of the possibility of emergency coronary artery bypass grafting and/or prohibitive risks of its performance, percutaneous coronary intervention (PCI) under extracorporeal membrane oxygenation (ECMO) may become the method of choice for the treatment of acute myocardial infarction in this category of patients.

This article presents two successful clinical cases of stenting of left coronary artery trunk stenosis (one of which is unprotected) with a transition to the anterior interventricular artery (AIVA) under veno-arterial ECMO in patients with acute myocardial infarction.

We present the data of two patients: a 92-year-old patient with recurrent myocardial infarction, LCA trunk stenosis up to 75%, AIVA stenosis from the mouth to 95%, and chronic occlusion of the RCA, and a 64-year-old patient with acute myocardial infarction, stenosis in the terminal segment of the left coronary artery by 90% with transition to the mouth of the left circumflex coronary artery and the AIVA.

The early postoperative period in both patients was uneventful, and the first six months of follow-up were favorable. Stenting of critical lesions of the LCA trunk in patients with acute myocardial infarction to reduce the risk of intra- and postoperative complications can be effectively and safely performed in conditions of auxiliary veno-arterial ECMO (VA ECMO).

Keywords: extracorporeal membrane oxygenation (ECMO), left main coronary artery stenting, unprotected trunk of the LCA, high-risk percutaneous coronary intervention

For citation Vatsik-Gorodetskaia MV, Reznik EV, Titkin LM, Golukhov GN, Emelyanovich DE, Zlatovratsky AG, et al. Extracorporeal Membrane Oxygenation in Patients With Acute Myocardial Infarction and Critical Multivessel Coronary Artery Disease Involving the Trunk of the Left Coronary Artery. *Russian Sklifosovsky Journal of Emergency Medical Care*. 2025;14(2):437–447. https://doi.org/10.23934/2223-9022-2025-14-2-437-447 (in Russ.)

Conflict of interest Authors declare lack of the conflicts of interests

Acknowledgments, sponsorship The study had no sponsorship

Affiliations

Maria V. Vatsik-Gorodetskaia	Candidate of Medical Sciences, Deputy Chief Physician for Anesthesiology and Resuscitation, Academician G.M. Savelyeva Municipal Clinical Hospital No. 31; Associate Professor, Department of Anesthesiology and Resuscitation, Medical Institute, Patrice Lumumba Peoples' Friendship University of Russia; https://orcid.org/0000-0002-6874-8213, m.vatsyk@gmail.com; 20%, organization of work, provision of examination materials, editing of the article
Elena V. Reznik	Associate Professor, Doctor of Medical Sciences, Head, Department of Internal Medicine Propaedeutics, Faculty of Medicine, Institute of Clinical Medicine, Pirogov Russian National Research Medical University; Physician-Therapist, Cardiologist, Physician of Functional Diagnostics, Ultrasound Diagnostics, Clinical Pharmacologist, Academician G.M. Savelyeva Municipal Clinical Hospital No. 31; http://orcid.org/0000-0001-7479-418X, elenaresnik@gmail.com; 20%, formulation of the idea of the article, manuscript editing

Leonid M. Titkin	2nd year Resident in the specialty of "Cardiology", Pirogov Russian National Research Medical University; https://orcid.org/0009-0009-3092-4670, titkin.leonid@yandex.ru; 20%, description of clinical cases, writing of the article, intraoperative monitoring of vital functions
Georgy N. Golukhov	Doctor of Medical Sciences, Corresponding Member of the Russian Academy of Sciences, President, Academician G.M. Savelyeva Municipal Clinical Hospital No. 31; Deputy Chairman, Public Council under the Moscow City Health Department; https://orcid.org/0000-0002-0161-005X, 5696272@mail.ru; 5%, organization of work, general management, provision of examination materials, article editing
Dmitry E. Emelyanovich	Candidate of Medical Sciences, Head, Department of Cardiology with Resuscitation and Intensive Care Units, Academician G.M. Savelyeva Municipal Clinical Hospital No. 31; https://orcid.org/0009-0004-3388-7071, dmitryemel@mail.ru; 5%, patient management, intraoperative monitoring of vital functions, connection and control of the ECMO apparatus, formulation of the idea of the article, text editing
Anton G. Zlatovratsky	Candidate of Medical Sciences, Head, Department of X-ray Surgical Diagnostic and Treatment Methods, Academician G.M. Savelyeva Municipal Clinical Hospital No. 31; https://orcid.org/0000-0003-2439-3104, antozla@rambler.ru; 5%, puncture arterial and venous access of the ECMO apparatus, PCI with stenting of the coronary arteries, text editing
Ivan S. Korotkov	Head, Department of Anesthesiology and Resuscitation No.# 2, Academician G.M. Savelyeva Municipal Clinical Hospital No. 31; https://orcid.org/0009-0005-3526-5206, ivan_korotkov@mail.ru; 5%, patient management, intraoperative monitoring of vital functions, connection and control of the ECMO apparatus, text editing
Dmitry I. Malyuk	Anesthesiologist-Resuscitator, Department of Anesthesiology and Resuscitation No. 2, Academician G. M. Savelyeva Municipal Clinical Hospital No. 31; Assistant, Department of Anesthesiology and Resuscitation, Medical Institute, Patrice Lumumba Peoples' Friendship University of Russia; https://orcid.org/0009-0004-7502-6536, dr.dmitriy97@internet.ru; 5%, participation in text writing
Elena N. Platonova	Candidate of Medical Sciences, Deputy Chief Physician for Medical Affairs, Academician G.M. Savelyeva Municipal Clinical Hospital No. 31; https://orcid.org/0000-0001-5198-9531, platonicha@mail.ru; 5%, organization of work, provision of examination materials, editing of the article
Dmitry V. Puzenko	Candidate of Medical Sciences, Cardiovascular Surgeon of the Highest Qualification Category, Head, Department of Cardiovascular Surgery, Pirogov Russian National Research Medical University; Head, Department of Cardiovascular Surgery, N.N. Blokhin National Medical Research Center of Oncology; http://orcid.org/0000-0002-2607-3895, dpuzenko@yandex.ru; 5%, editing of the article
Alexander A. Khachaturov	Candidate of Medical Sciences, Surgeon of X-ray endovascular diagnostic and treatment methods, Academician G. M. Savelyeva Municipal Clinical Hospital No. 31; https://orcid.org/0009-0009-8862-2747, xa41@yandex.ru; 5%, puncture arterial and venous access of the ECMO apparatus, PCI with stenting of coronary arteries, editing of the article

AIVA — anterior interventricular artery
APV — artificial pulmonary ventilation
BP — blood pressure
CA — circumflex artery
CAG — coronary angiography
CPK — creatine phosphokinase
EchoCG — echocardiography
ECMO — extracorporeal membrane oxygenation
$EtCO_2$ — end-tidal carbon dioxide
HiR PCI — high-risk percutaneous coronary intervention
HR — heart rate
LCA — left coronary artery
LDL — low-density lipoproteins
MAC — minimum alveolar concentration
MI — myocardial infarction
PCI — percutaneous coronary intervention

RCA — right coronary artery
RR — respiratory rate
SpO_2 — blood oxygen saturation level
TLBA — transluminal balloon angioplasty
US — ultrasound examination
VA ECMO — veno-arterial extracorporeal membrane oxygenation

INTRODUCTION

Extracorporeal membrane oxygenation (ECMO) is a method of complete or partial replacement of the pumping and oxygenation function of the heart-lung complex, providing extracorporeal support to patients with severe respiratory and (or) heart failure. The procedure of veno-arterial extracorporeal membrane oxygenation (VA ECMO) involves collecting blood from the central venous system, oxygenating and returning it to the arterial circulation. This procedure provides complete or partial replacement/support of blood circulation and gas exchange. When performing percutaneous coronary intervention (PCI), peripheral connection with cannulation of the femoral artery and vein is used [1, 2].

According to the Russian Society of ECMO Specialists, in patients over 60 years of age with respiratory or heart failure, the proportion of hospital survival after successful disconnection from ECMO is 36%, and in the case of simultaneous cardiac and pulmonary failure - 23.8% [3].

In patients with multivessel coronary artery disease, the decision to choose between PCI with transluminal balloon angioplasty (TLBA) and stenting or coronary artery bypass grafting is made by a local multidisciplinary team consisting of cardiologists, anesthesiologists-resuscitators, endovascular surgeons and cardiac surgeons, who carefully evaluate the potential benefits and risks associated with PCI and coronary artery bypass grafting [4].

Among patients with ischemic heart disease, there is a cohort of patients for whom the choice of treatment tactics is extremely difficult. This is due not only to a severe comorbid background (obesity, musculoskeletal diseases, chronic cardiac and respiratory failure, diabetes mellitus, other endocrine pathologies, coagulopathies, combined oncological pathology), but also to other polymorbid conditions. The combination of the above factors often limits the possibility of performing both coronary artery bypass grafting and PCI in these patients due to the extremely high risks of perioperative complications, including death. Conducting PCI in such patients for emergency or urgent indications is a high-risk intervention (HiR PCI). To ensure hemodynamic stability, successful and safe revascularization in such cases, mechanical circulatory support devices are increasingly used, which have conventionally been used only in acute heart failure. According to the work of R.A. Kornelyuk (2021), in comparison with intra-aortic balloon counterpulsation, HiR PCI under the conditions of VA ECMO is accompanied by a lower incidence and severity of organ damage and multiple organ failure, i.e. VA ECMO has a better organoprotective effect [5, 6].

In the PubMed database, a query on the use of VA ECMO for stenting hemodynamically significant stenoses of the left coronary artery (LCA) trunk revealed 14 publications. One of them described 10 patients with occlusion of the LCA trunk and significant stenosis of the right coronary artery (RCA). Three patients (33.3%) developed ventricular fibrillation during PCI, and one patient (10%) had an episode of asystole. The patients' existing cardiac rhythm and conduction disorders before revascularization did not recur after restoration of coronary blood flow during ECMO [7]. Another article also presents successful stenting of the LCA trunk during ECMO [8]. The remaining 12 publications describe the use of ECMO in combination with intra-aortic balloon counterpulsation in cardiogenic shock and congenital heart defects, as well as the use of ECMO in mechanical obstruction of the LCA trunk in infective endocarditis.

We present two clinical cases of successful stenting of a critical lesion of the LCA trunk (one of which was unprotected) with the transition to the anterior interventricular artery (AIVA) under conditions of using auxiliary VA ECMO in patients in the acute stage of myocardial infarction (MI).

Clinical observation No. 1

Patient G., 92 years old, was admitted to the emergency department on 12/28/2023 with complaints of discomfort behind the sternum not related to physical exertion, a feeling of interruptions in the work of the heart, rapid heartbeat, shortness of breath at rest, which increases in a horizontal position. History: MI without ST segment elevation on July 21, 2023, multivessel coronary artery disease, uncontrolled arterial hypertension.

During physical examination, attention was drawn to swelling of the lower extremities, jugular vein distention, a moderate amount of moist, voiceless, fine-bubble rales in the lower sections on both sides during auscultation of the lungs, respiratory rate (RR) 20 breaths per minute, saturation 97%, heart rate (HR) 95 beats per minute, blood pressure (BP) 125/70 mm Hg, moderate liver enlargement (protruded from under the edge of the costal arch by 2 cm).

Laboratory examination data: an increase in the blood level of total cholesterol to 4.14 mmol/l and low-density lipoproteins (LDL) to 3.03 mmol/l; the content of troponin I on admission 0.73 (0–1) ng/ml (hereinafter, the range of normal values is given in brackets), after surgery - 1.89 ng/ml; lactate on admission - 2.8 (0.3–1.5) mmol/l, after surgery - 2.4 mmol/l; creatinine - 163.1 (73–120) μmol/l.

According to the instrumental examination data, electrocardiography (ECG) recorded wide-complex tachycardia with a HR of 136 beats per minute with changes in the terminal part of the ventricular complex (ST elevation in III, avR, V1, ST depression in I, II, avL, V2-6) (Fig. 1).

During emergency diagnostic coronary angiography, critical stenosis of the AIVA ostium with involvement of the LCA trunk (Fig. 2) was revealed against the background of chronic occlusion of the RCA (unprotected trunk) (Fig. 3).

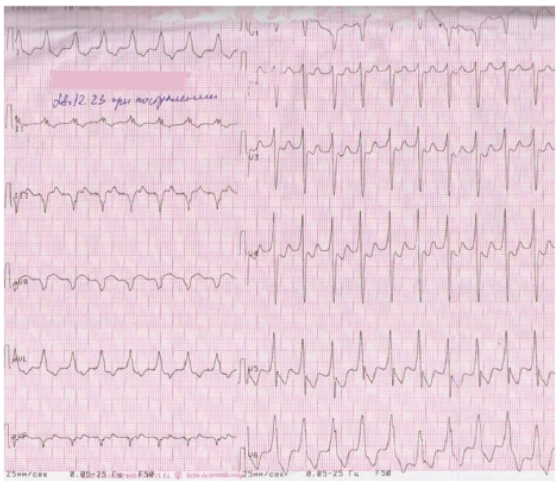

Fig. 1. Clinical observation No. 1. Electrocardiogram of patient G. upon admission

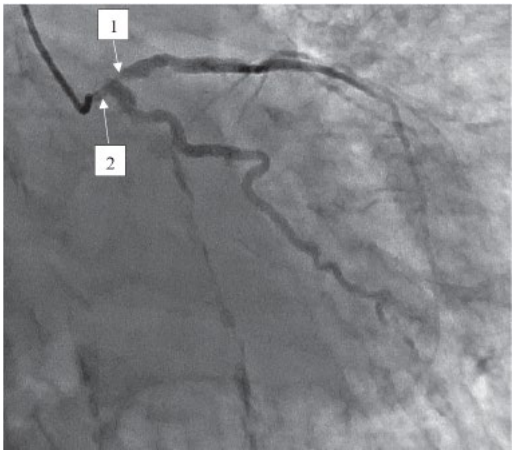

Fig. 2. Clinical observation No. 1. Coronary angiogram of patient G. at the 5th minute of surgery; 1 — stenosis of the AIVA orifice, 2 — stenosis of the LCA trunk

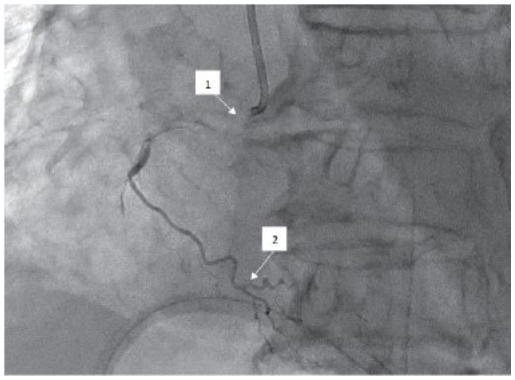

Fig. 3. Clinical observation No. 1. Coronary angiogram of patient G. 1 — chronic occlusion of the RCA, 2 — the distal bed of the RCA is filled through intersystem collaterals

Taking into account the signs of venous congestion in the pulmonary circulation and increasing dyspnea in the horizontal position identified upon admission, an interdisciplinary consultation was held. The risk of direct PCI was assessed as extremely high, given the impossibility of direct open myocardial revascularization and extremely high (prohibitory) risks of its performance (log EuroSCORE over 80%). It was decided to perform AIVA stenting with transition to the LCA trunk under conditions of auxiliary peripheral VA ECMO and general anesthesia with artificial pulmonary ventilation (APV). Anesthesia was induced with propofol 1.5 mg/kg and fentanyl 0.1 mg, myoplegia was provided by rocuronium 0.6 mg/kg; anesthesia was maintained with sevoflurane at 1.8–2 MAC using a Maquet Flow-i anesthesia and respiratory apparatus in Volume Control Ventilation mode. The ECMO circuit was connected via peripheral cannulation of the common femoral artery on the left - 18 Fr and the common femoral vein on the right - 24 Fr. The Medos Deltastream ECMO performance was 1.5 L/min at 1000 rpm.

A JL 4.0 6 Fr guiding catheter was inserted into the LCA ostium. Two coronary guidewires were inserted into the distal sections of the circumflex artery (CA) and the AIVA (Fig. 4). TLBA was performed using a 2.0×20 mm balloon catheter on a clamped guidewire with stenting of the AIVA ostium and transition into the LCA trunk using a 3.0×15 mm Xience Alpine stent (estimated burst pressure 15 atm) (Fig. 5, 6). The endovascular intervention lasted 75 minutes.

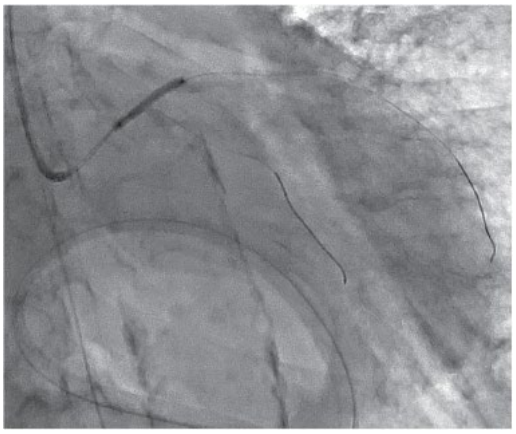

Fig. 4. Clinical observation No. 1. Coronary angiogram of patient G. at the 15th minute of surgery

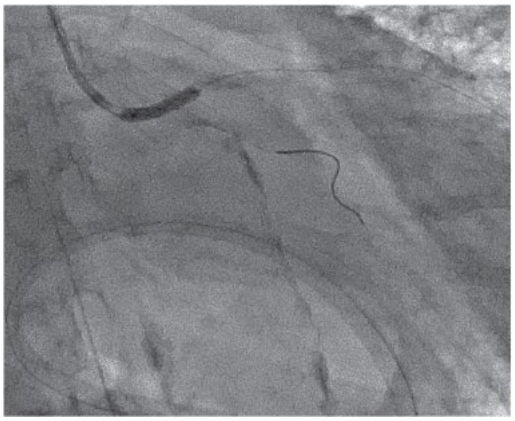

Fig. 5. Clinical observation No. 1. Coronary angiogram of patient G. at the time of transluminal balloon angioplasty (TLBAP) with stenting of the LCA trunk

Intraoperative monitoring: BP 110/70–154/102 mmHg, HR 88–124 beats per minute, SpO2 97–99%. Hemodynamics were stable, without vasopressor and cardiotonic support. Loading dose of acetylsalicylic acid was 250 mg, ticagrelor was 180 mg, activated partial thromboplastin time was 70 seconds. A "sinus rhythm" on a cardiac monitor. A urinary diuresis of 600 ml via catheter.

During coronary angiography (CAG) and PCI, irregular heartbeat was recorded twice in the form of two unstable paroxysms of ventricular tachycardia lasting 3 and 6 seconds – during balloon angioplasty of the AIVA ostium with transition into the LCA trunk and subsequent stent implantation in the same area. Paroxysms of ventricular tachycardia stopped on their own, while hemodynamics remained stable, no increase in ECMO performance was required. An infusion of 600 mg amiodarone was administered to prevent the development of life-threatening rhythm disorders in the future.

After PCI, the ECMO session was completed. Total duration was 170 minutes, hemodynamic and gas exchange parameters were unchanged. The arterial cannula was removed, hemostasis was achieved by suturing. The venous cannula was removed, hemostasis was achieved by compression.

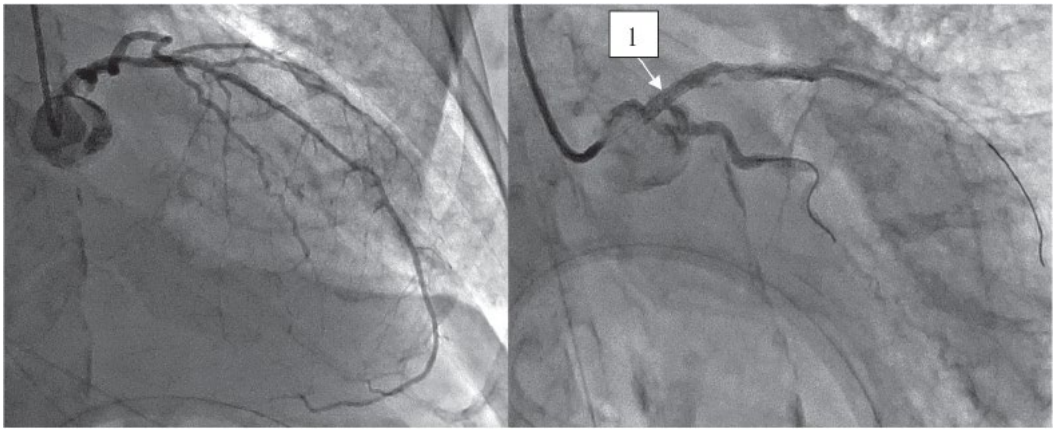

Fig. 6. Clinical observation No. 1. Coronary angiogram of patient G. 1 - A stent was implanted in the LCA trunk with transition to the AIVA

ECG in the early postoperative period: sinus rhythm, heart rate 65 beats per minute. Deviation of the electrical axis of the heart sharply to the left. Signs of blockade of the anterior branch of the left bundle branch of the His bundle. Intraventricular conduction delay. Supraventricular extrasystole. Diffuse changes in the myocardium of the left ventricle (Fig. 7).

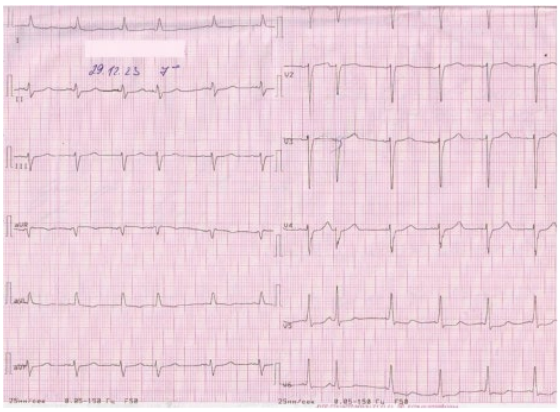

Fig. 7. Clinical observation No. 1. Electrocardiogram of patient G. one day after stenting of the LCA trunk

The patient was awakened and transferred to spontaneous breathing 1 hour after the intervention in the intensive care unit of the cardiology department; monitoring and intensive care were continued.

EchoCG (1 day after surgery) revealed compaction of the aorta, aortic and mitral valve cusps, calcifications in the aortic and mitral valve cusps, limited opening of the aortic valve without signs of stenosis, left ventricular myocardial hypertrophy, hypoakinesis of the anterior and septal walls at the level of the middle and apical segments, hypokinesis of the inferior wall along the entire length, apical segment of the lateral wall of the left ventricle; left ventricular ejection fraction 34%, grade 3 mitral regurgitation, grade 2 aortic regurgitation, grade 2 tricuspid regurgitation, grade 2 pulmonary regurgitation, pericardium without features, moderate pulmonary hypertension.

The patient was observed in the intensive care unit for 2 days, where he received dual antiplatelet therapy with acetylsalicylic acid, 100 mg once daily; and ticagrelor, 90 mg twice daily; diuretic therapy; monitoring and correction of glycemia, electrolyte imbalance; preventive antiulcerogenic therapy, early rehabilitation, breathing exercises using the inspiratory and expiratory components of the Acapella respiratory trainer. Then he was transferred to the cardiology department, and on the 13th day he was discharged from hospital. ECG (before discharge from hospital): sinus rhythm with a heart rate of 85 beats per minute. Deviation of the electrical axis of the heart sharply to the left. Frequent supraventricular extrasystole of the bigeminy type. Diffuse changes in the myocardium of the left ventricle (Fig. 8)

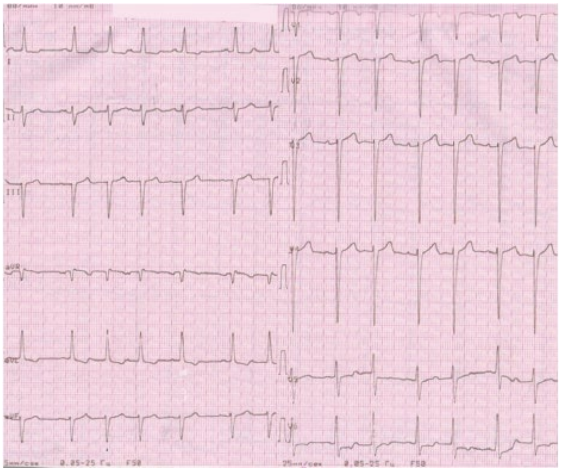

Fig. 8. Clinical observation No. 1. Electrocardiogram of patient G. before discharge from hospital

According to the Unified Medical Information System of the City of Moscow, 6 months after discharge the patient feels satisfactory, is correctly oriented in space, place and time, is active within the room, eats independently, follows the recommended therapy, denies recurrence of angina pain and clinical signs of decompensation of chronic heart failure. The patient was diagnosed with functional class III heart failure according to the New York classification.

Clinical observation No. 2

Patient M., 64 years old, was admitted to the Clinic with complaints of discomfort behind the sternum, general weakness, dyspnea of a mixed nature, which arose and worsened over the course of 1 hour. The patient had a history of type 2 diabetes mellitus, arterial hypertension; he did not regularly monitor glycemia and blood pressure levels, and was not adherent to therapy.

On admission, the patient was conscious. Auscultation of the lungs revealed harsh breathing over the entire surface. Respiratory rate 20 breaths per minute. SpO2 - 97%. Heart rate 60 beats per minute. Blood pressure 135/85 mm Hg. During the observation process, a tendency towards arterial hypotension was noted, in connection with which vasopressor support with norepinephrine 0.15 mcg/kg/min was connected.

Instrumental examination (echoCG, ultrasound examination of the lungs, assessment of venous congestion using the VExUS protocol) did not reveal any signs of congestion in the systemic or pulmonary circulation. According to laboratory tests, the blood level of troponin I was 18.4 (0–1) ng/ml, lactate was 2.1 (0.3–1.5) mmol/l, AST was 67 IU/l (10–40), and ALT was 92 IU/l (10–40).

ECG on admission: sinus rhythm with heart rate of 82 beats per minute. Deviation of the electrical axis of the heart sharply to the left. Intraventricular conduction delay. No increase in the r wave in leads V1-V6. ST elevation in aVR. Diffuse changes in the myocardium of the left ventricle (Fig. 9).

Fig. 9. Clinical observation No. 2. Patient M. Electrocardiography on admission

Taking into account the extremely high risk of developing fatal intraoperative complications, acute left ventricular failure, and increasing encephalopathy with motor excitation according to the Richmond Agit Sedat Scale (RASS) +1, as well as impossibility of emergency coronary artery bypass grafting against the background of extremely high risks of its performing (log EuroSCORE more than 30%), the council decided to carry out PCI of the LCA trunk under conditions of auxiliary peripheral VA ECMO and general anesthesia with mechanical ventilation. For induction of anesthesia, propofol at a dose of 1.5 mg/kg and fentanyl, 0.1 mg, were used; myoplegia - rocuronium, 0.6 mg/kg; maintenance of anesthesia – sevoflurane; 1.8–2 MAC using the Maquet Flow-i anesthesia and respiratory apparatus in Volume Control Ventilation mode.

The ECMO circuit was connected via peripheral cannulation of the common femoral artery on the left — 18 Fr, and the common femoral vein on the right — 24 Fr. Cannulation of vessels and positioning of cannula tips were performed under ultrasound navigation (Mindray TE7 ultrasound machine was used), cannula fixation — with a ligature. A distal perfusion bridge was not inserted due to the expected short duration of the procedure. On the Medos ECMO device with a Deltastream III centrifuge head and a HILITE LT oxygenator, the performance was 1.5 l per minute at 1500 rpm. Diagnostic CAG revealed stenosis in the terminal segment of the LCA trunk up to 90% with transition to the CA and AIVA orifices. The AIVA: stenosis from the orifice to the middle segment with a maximum value at the orifice and proximal segment of 80%, stenosis in the middle and distal segments up to 75%. The CA: stenosis at the orifice of 60% (Fig. 10).

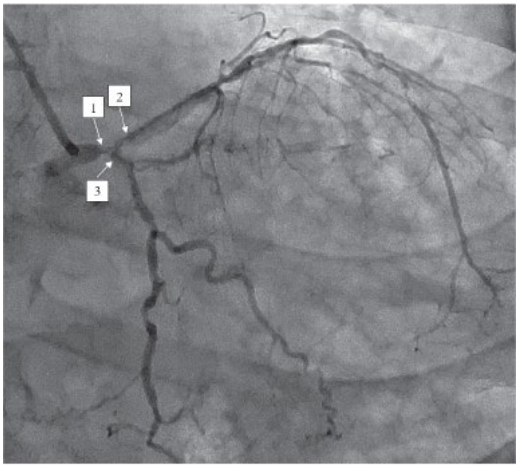

Fig. 10. Clinical observation No. 2. Coronary angiogram of patient M. at the 5th minute of surgery. 1 — stenosis of the LCA trunk up to 90%, 2 — stenosis of the AIVA up to 80%, 3 — stenosis of the circumflex artery (CA) up to 60%

The RCA is diffusely altered throughout its entire length: uneven contours, stenoses in the proximal, middle and distal segments up to 70%. (Fig. 11).

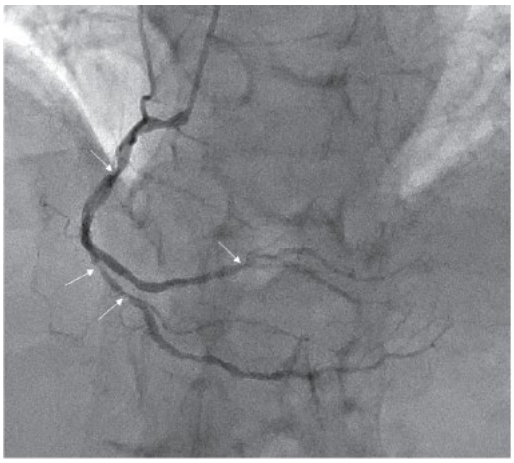

Fig. 11. Clinical observation No. 2. Coronary angiogram of patient M. at the 7th minute of surgery. Arrows indicate RCA stenoses up to 70%

Under conditions of auxiliary peripheral VA ECMO with a total duration of 210 minutes, TLBA and stenting of the LCA trunk with transition to the proximal third of the AIVA were performed; a Xience Alpine 2.75×23 mm stent was implanted (a rated burst pressure of 16 atm). Proximal optimization of the LCA trunk stent section was performed using a 3.0×15 mm high-pressure balloon catheter (a rated burst pressure of 20 atm) (Fig. 12).

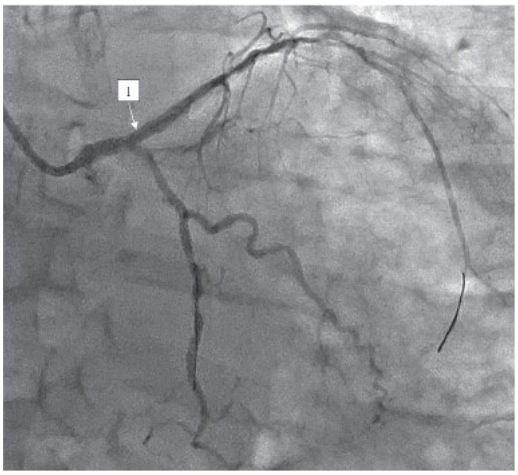

Fig. 12. Clinical observation No. 2. Coronary angiogram of patient M. 1 — implanted stent

Intraoperative monitoring in the volume: ECG, invasive blood pressure, respiratory rate, SpO_2, $EtCO_2$.

During angioplasty and stenting of the LCA trunk, we recorded paroxysms of atrial fibrillation with a heart rate of 140 beats per minute lasting up to 180 seconds, and ventricular fibrillation lasting up to 8 seconds, accompanied by instability of hemodynamic parameters and requiring an increase in ECMO performance to 2500 rpm for 30 minutes with its subsequent decrease to 1500 rpm. We noted spontaneous restoration of sinus rhythm after the cessation of manipulations in the area of the LCA trunk. An intravenous infusion of 600 mg amiodarone was administered to prevent the development of life-threatening rhythm disorders in the future.

The endovascular intervention lasted 80 minutes. Upon completion of the surgery, the ECMO capacity was gradually reduced to 1 liter per minute, and the ECMO session was stopped after 30 minutes. Vasopressor support with norepinephrine was minimized to 0.1 mcg/kg/min. Hemodynamic and gas exchange parameters were maintained within the reference values. Intraoperatively: 3,400 ml of fluid were administered intravenously, diuresis was 600 ml, water balance was +1800 ml. At the end of the intervention, the arterial and venous cannulas were removed, arterial hemostasis was achieved by suturing with a vascular suture, and vein hemostasis was achieved by applying a pressure bandage.

Post-anesthesia monitoring parameters: Consciousness - drug sedation, BP 120/70 mmHg with norepinephrine infusion at a dosage of 0.6 mcg/kg/min, HR 80 beats per minute, SpO2 99%. The patient was transported to the cardiac intensive care unit on extended mechanical ventilation, accompanied by an anesthesiologist-resuscitator under the supervision of medical personnel.

ECG in the early postoperative period: sinus rhythm, heart rate 80 beats per minute; deviation of the electrical axis of the heart sharply to the left; no increase in the height of the r wave V1–5; ST elevation V1–2 (Fig. 13).

Fig. 13. Clinical observation No. 2. Electrocardiogram of patient M. in the early postoperative period

Within 4 hours after surgery, the patient was extubated and transferred to spontaneous breathing, SpO_2 97%. Consciousness was clear, encephalopathy symptoms regressed. Sinus rhythm with heart rate of 80 beats per minute. Blood pressure 110/70–100/60 mm Hg; vasopressor support was stopped 6 hours after the end of surgery. The early postoperative period was complicated by the development of bilateral lower lobe pneumonia with grade 1 respiratory failure; signs of congestion were observed in the pulmonary circulation; moderate congestion according to ultrasound of the lungs.

The patient was under observation in the intensive care unit for 4 days, where triple antiplatelet therapy was administered: acetylsalicylic acid, 100 mg once daily; clopidogrel, 75 mg once daily; sodium enoxaparin, 1 mg/kg twice daily, due to the intraoperatively developed paroxysm of atrial fibrillation. Also, diuretic, antibacterial and mucolytic therapy, monitoring and correction of glycemia, electrolyte imbalance; preventive anti-ulcer therapy; early rehabilitation and breathing exercises using the inspiratory and expiratory components of the Acapella respiratory trainer were carried out.

During the observation period in the intensive care unit, angina pain did not recur, rhythm disorders were not registered, and signs of post-puncture hematomas were not revealed. The patient was transferred to the

cardiology department on the 5th day, discharged from hospital on the 15th day.

ECG before discharge from hospital: sinus rhythm, heart rate of 62 beats/min, sharp leftward deviation of the electrical axis of the heart; first degree AV block; negative T waves in leads I, aVL and V1–V3; insufficient increase in the height of the R wave in the chest leads (Fig. 14).

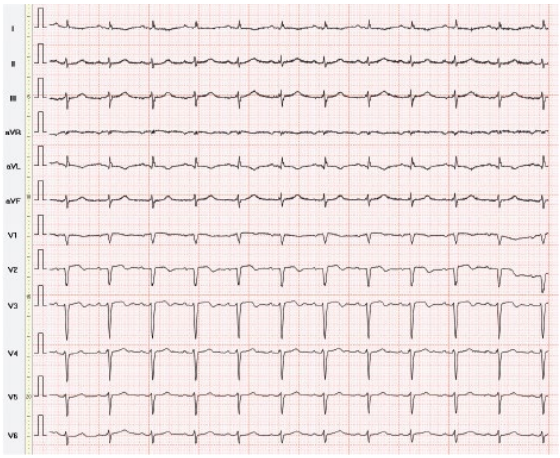

Fig. 14. Clinical observation No. 2. Electrocardiogram of patient M. before discharge from hospital

According to the Unified Medical Information System of the City of Moscow, 1 month after inpatient treatment the patient feels satisfactory, follows the recommended therapy, denies recurrence of angina pain and clinical picture of decompensation of chronic heart failure. Stenting of the RCA is planned.

DISCUSSION

The article presents two cases of patients for whom (in our opinion) emergency PCI under mechanical circulatory support using peripheral VA ECMO was preferable to emergency coronary artery bypass grafting due to the following: impossibility of its performance, as well as the presence of risks (in the first case, prohibitive, and in the second case, high) of its performance because of acute stage of MI, polymorbid background of patients (obesity, diseases of the musculoskeletal system, chronic cardiac and respiratory failure, type 2 diabetes mellitus, Charlson comorbidity index of more than 5 points). The risk of life-threatening intraoperative rhythm disturbances was realized at the stage of manipulations in the area of the LCA trunk in both clinical cases. These complications were successfully resolved. Due to hemodynamic support of blood circulation by VA ECMO, both patients underwent endovascular intervention and were safely discharged to the outpatient stage of treatment.

There are currently no randomized clinical trials devoted to this method of mechanical circulatory support during HiR PCI. A sufficient number of multicenter observational studies and individual reports indicate the high efficiency of the method; however, at the same time, they note a high incidence of complications (an increase in the risk of bleeding by 2.5 times, a 3.5-fold increase in the risk of ischemic stroke, an increase in the duration of mechanical ventilation and stay in the intensive care unit by 2 days) [9–15].

According to D.L. Shukevich et al. [2], the oldest patient who underwent stenting of the LCA trunk under ECMO conditions was 69 years old. Our observations show that in older (92 years, clinical observation No. 1) and comorbid patients with multivessel coronary disease, even in the case of an unprotected trunk, successful stenting is possible under conditions of mechanical circulatory support using the peripheral VA ECMO method.

CONCLUSION

Percutaneous coronary intervention for acute myocardial infarction in patients with severe multivessel coronary disease involving the left main coronary artery trunk, especially in cases of the unprotected trunk, is advisable and safe to carry out under conditions of mechanical circulatory support using venoarterial extracorporeal membrane oxygenation in order to reduce the risk of intra- and postoperative complications, including fatal ones.

REFERENCES

1. Lindstrom SJ, Pellegrino VA, Butt WW. Extracorporeal membrane oxygenation. *Med J Aust*. 2009;191(3):178–182. PMID: 19645652 https://doi.org/10.5694/j.1326-5377.2009.tb02735.x
2. Koutouzis M, Kolsrud O, Albertsson P, Matejka G, Grip L, Kjellman U. Percutaneous coronary intervention facilitated by extracorporeal membrane oxygenation support in a patient with cardiogenic shock. *Hellenic J Cardiol.* 2010;51(3):271–274. PMID: 20515862
3. Rossiyskoe obshchestvo spetsialistov po ekstrakorporal'noy membrannoy oksigenatsii. *Statistika Ro-sEKMO.* (In Russ.). Available at: https://xn--j1aeg1d.xn--p1ai/registr/statistika?ysclid=ly69jz27ap958135749 [Accessed May 28, 2025]
4. Piccolo R, Guistino G, Mehran R, Windecker S. Stable coronary artery disease: revascularization and invasive strategies. *Lancet*. 2015;386(9994):702–713. PMID: 26334162 https://doi.org/10.1016/S0140-6736(15)61220-X
5. Kornelyuk RA, Vereshchagin IE, Shukevich DL, Ganyukov VI. Mechanical circulatory support in high-risk percutaneous coronary intervention. *Kompleksnye problemy serdechno-sosudistykh zabolevaniy*. 2018;7(4S):54–65. (In Russ.). https://doi.org/10.17802/2306-1278-2018-7-4S-54-65
6. Kornelyuk RA. Organ protection and prevention of polyorgan insufficiency during high-risk percutaneous coronary intervention by using extracorporal membrane oxygenation. *Kompleksnye problemy serdechno-sosudistykh zabolevaniy.* 2021;10(2S):27–31. (In Russ.). https://doi.org/10.17802/2306-1278-2021-10-2S-27-31
7. Bazylev VV, Evdokimov ME, Pantiukhina MA, Morozov ZA. Artificial circulation in high-risk percutaneous coronary interventions. *Angiologiya i sosudistaya khirurgiya. Zhurnal im. akad. A.V. Pokrovskogo.* 2016;22(3):112–119. (In Russ.)
8. Ganiukov VI, Popov VA, Shukevich DL, Evtushenko SA, Khaes BL. Transcutaneous coronary intervention accompanied by biventricular circulatory support and combined with extracorporeal membranous oxygenation. *Angiologiya i sosudistaya khirurgiya. Zhurnal im. akad. A.V. Pokrovskogo*. 2013;19(1):137–141. (In Russ.)
9. Koutouzis M, Kolsrud O, Albertsson P, Matejka G, Grip L, Kjellman U. Percutaneous coronary intervention facilitated by extracorporeal membrane oxygenation support in a patient with cardiogenic shock. *Hellenic J Cardiol*. 2010;51(3):271–274. PMID: 20515862
10. Arlt M, Philipp A, Voelkel S, Schopka S, Husser O, Hengstenberg C, et al. Early experiences with miniaturized extracorporeal life-support in the catheterization laboratory. *Eur J Cardiothorac Surg*. 2012;42(5):858–863. PMID: 22555310 https://doi.org/10.1093/ejcts/ezs176
11. Chen JS, Ko WJ, Yu HY, Lai LP, Huang SC, Chi NH, et al. Analysis of the outcome for patients experiencing myocardial infarction and cardiopulmonary resuscitation refractory to conventional therapies necessitating extracorporeal life support rescue. *Crit Care Med*. 2006;34(4):950–957. PMID: 16484889 https://doi.org/10.1097/01.CCM.0000206103.35460.1F
12. Ricciardi MJ, Moscucci M, Knight BP, Zivin A, Bartlett RH, Bates ER. Emergency extracorporeal membrane oxygenation (ECMO)-supported percutaneous coronary interventions in the fibrillating heart. *Catheter Cardiovasc Interv*. 1999;48(4):402–405. PMID: 10559824 https://doi.org/10.1002/(sici)1522-726x(199912)48:4<402::aid-ccd17>3.0.co;2-3
13. Shammas NW, Roberts S, Early G. Extracorporeal membrane oxygenation for unprotected left main stenting in a patient with totally occluded right coronary artery and severe left ventricular dysfunction. *J Invasive Cardiol*. 2002;14(12):756–759. PMID: 12454340
14. Vanzetto G, Akret C, Bach V, Barone G, Durand M, Chavanon O, et al. [Percutaneous extracorporeal life support in acute severe hemodynamic collapses: single centre experience in 100 consecutive patients]. *Can J Cardiol*. 2009;25(6):e179–186. PMID: 19536387 https://doi.org/10.1016/s0828-282x(09)70093-5
15. Yamauchi T, Masai T, Takeda K, Kainuma S, Sawa Y. Percutaneous cardiopulmonary support after acute myocardial infarction at the left main trunk. *Ann Thorac Cardiovasc Surg*. 2009;15(2):93–97. PMID: 19471222
14. Vanzetto G, Akret C, Bach V, Barone G, Durand M, Chavanon O, et al. [Percutaneous extracor-poreal life support in acute severe hemodynamic collapses: single centre experience in 100 consecu-tive patients]. *Can J Cardiol*. 2009;25(6):e179–186. PMID: 19536387 https://doi.org/10.1016/s0828-282x(09)70093-5
15. Yamauchi T, Masai T, Takeda K, Kainuma S, Sawa Y. Percutaneous cardiopulmonary support after acute myocardial infarction at the left main trunk. *Ann Thorac Cardiovasc Surg*. 2009;15(2):93–97. PMID: 19471222

Received on 14/09/2024
Review completed on 19/11/2024
Accepted on 24/03/2025