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Research Article

# A Method for Surgical Treatment of Complex Forms of Coronary Heart Disease Coronary Arteriovenous Switch as an Alternative to Heart Transplantation

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**Abstract:**

The technical result of the claimed invention is the restoration of blood supply to the myocardium.

The technical result of the claimed invention is achieved due to the fact that the performed complete coronary arteriovenous switch ensures full retrograde blood flow through the coronary veins in the myocardium.

**keywords:** coronary; artery; bypass; grafting

## Introduction

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The invention relates to medicine, namely to cardiovascular surgery.

In ischemic heart disease (IHD), where coronary artery bypass grafting (CABG) is the main basic operation,

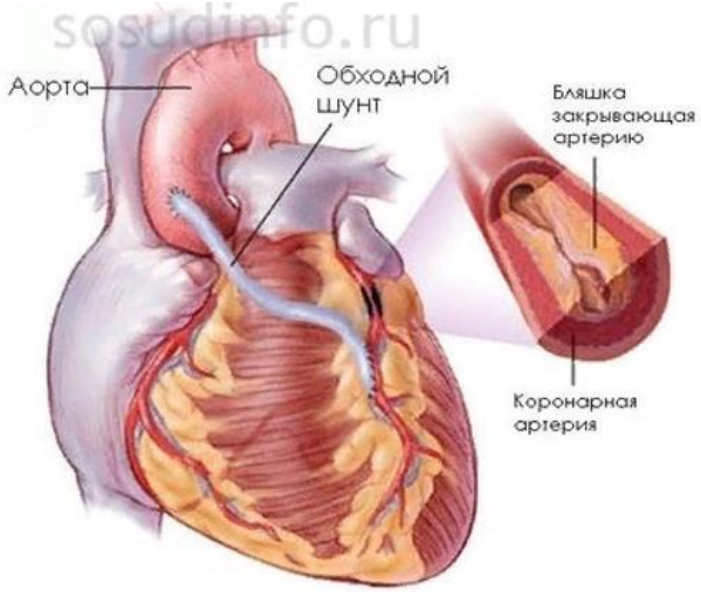


**Figure 1:** Scheme of aortocoronary bypass surgery in the classical version.

There are a number of situations when coronary artery bypass grafting is not feasible:

1 - distal type of coronary artery disease, when the distal part of the artery is impassable and it is impossible to sew a shunt, and therefore the blood will not be able to circulate;

2 - individual variants of coronary bed development are possible;

3 - relapses of the disease, i.e. blockage of shunts and other reasons.

In general statistics, these cases make up 8-12% of the total number of patients with coronary heart disease and present significant challenges for surgeons in their treatment.

4 – In pediatric cardiac surgery, Kawasaki disease causes aneurysmal deformation in the trunks and orifices of the right and left coronary arteries. Coronary artery bypass grafting is unreliable in such cases, as the aneurysmal transformation is progressive.

Heart transplantation and transmyocardial laser tunneling of the left ventricular myocardium are currently used to treat these complex forms of coronary heart disease. In the latter case, laser-created holes through the entire thickness of the left ventricular myocardium partially transform into myocardial vessels with a 1:10 probability, improving blood flow and myocardial contractility. Arterial blood from the left ventricle flows directly into the myocardium through the newly formed vessels, and those that do not become new vessels close and become scar tissue.

A “Method for surgical treatment of ischemic heart disease” is known (Patent RU No. 2192791 C2, IPC A61B 17/00 - 20.11.2002, Bulletin No. 32), which uses the venous bed of the occluded coronary artery basin by applying an aortocoronary bypass graft, the distal anastomosis of which is performed with a vein of the same name as the occluded artery.

The disadvantage of this method is that blood entering the coronary vein through the bypass graft is diverted along the normal blood flow, rather than flowing retrogradely to reach the cardiomyocytes. This circumstance makes this procedure ineffective in clinical practice.

The aim of the claimed invention is to develop a method for surgical treatment of complex forms of coronary heart disease when it is impossible to perform coronary artery bypass grafting or other corrective surgery.

The technical result of the claimed invention is the restoration of blood supply to the myocardium.

The technical result of the claimed invention is achieved due to the fact that the performed complete coronary arteriovenous switch ensures full retrograde blood flow through the coronary veins in the myocardium.

The details, features, and advantages of the present invention follow from the following description of the implementation of the claimed technical solution using drawings showing:

Fig.2 - Scheme of arteriovenous coronary switch, where CS is the coronary sinus; RCA is the right coronary artery; LCA is the left coronary artery; PA is the pulmonary artery; Ao is the aorta; Right atrial appendage; Shunt (vascular prosthesis) 6 - 8 mm synthetic made of polytetrafluoroethylene (PTFE).

Implementation of the invention:

Anatomical and physiological prerequisites:

- coronary veins do not have valves, so retrograde blood flow is possible;

- retrograde cardioplegia, often used in practice, in which the cardioplegic solution is pumped through the coronary sinus, well demonstrates the possibility and effectiveness of retrograde blood supply.

Description of the stages of our version of the CAVP operation – coronary arteriovenous switch.

1. Access -standard median sternotomy
2. Connecting IR– typical bicaval artificial circulation. Full perfusion with compression of the vena cava cannulas and disconnection of artificial ventilation.
3. Normothermia or moderate hypothermia, i.e. body temperature during perfusion within the range of 36.6* - 29*.
4. Cardioplegia- cardiac arrest during major manipulations inside the heart, with Custodiol, since this drug has proven itself most effective in practice when prolonged cardiac arrests are necessary, i.e., during highly complex surgeries.
5. We sew a 6-8 mm Gore-Tex vascular prosthesis (the diameter is selected on site) to the coronary sinus, anastomose end-to-end with a 5/0 Prolene wrap suture, then pass the prosthesis through the apex of the right atrial appendage and apply a soft clamp to the prosthesis.
6. Transverse aortotomy above the coronary sinuses
7. The left coronary artery is cut out on the platform, we turn it around and transplant it into the pulmonary artery. This requires some mobilization of the left coronary artery ostium, 3-5 mm, to safely turn it toward the pulmonary artery.
8. The right coronary artery is cut out on the platform, unfold it, and transplant it into the right atrium. We mobilize it in the same manner to prevent torsion, bending, and excessive tension.
9. We restore the aorta by sewing patches into the coronary sites.from polytetrafluoroethylene and restore the aorta.
10. We perform a proximal anastomosis between the aorta and the graft, which will drain blood from the aorta into the coronary sinus. To seal the area where the graft exits the auricle, we place a purse-string suture externally.
11. We carry out thorough removal of air by slowly filling the heart chambers.
12. We seal the right atrium with a 5/0 prolene wrap suture.
13. We restart the heart by removing the clamp from the aorta and starting blood flow through the aortocoronary venous bypass.
14. Measures to control hemostasis – elimination of possible sources of bleeding.
15. Warming the patient and bringing cardiac activity to the required level, after which we turn off the artificial circulation machine.
16. Sewing electrodes for cardiac pacing.
17. Drainage tube under the sternum for active aspiration.
18. Layer-by-layer suturing of access.

Estimated time of cardiac arrest - aortic clamping is 110-120 minutes.

A contraindication to this procedure is the presence of an accessory left vena cava, which, as an anatomical variant of the normal structure, occurs in 10-12% of cases. In this case, arterial blood flowing from the aorta to the coronary sinus will be diverted into the accessory vein, resulting in

inadequate coronary venous pressure. The procedure will require additional reassignment of the accessory vein to the right atrium.

Coronary arteriovenous switch (CAVS)

SCHEME

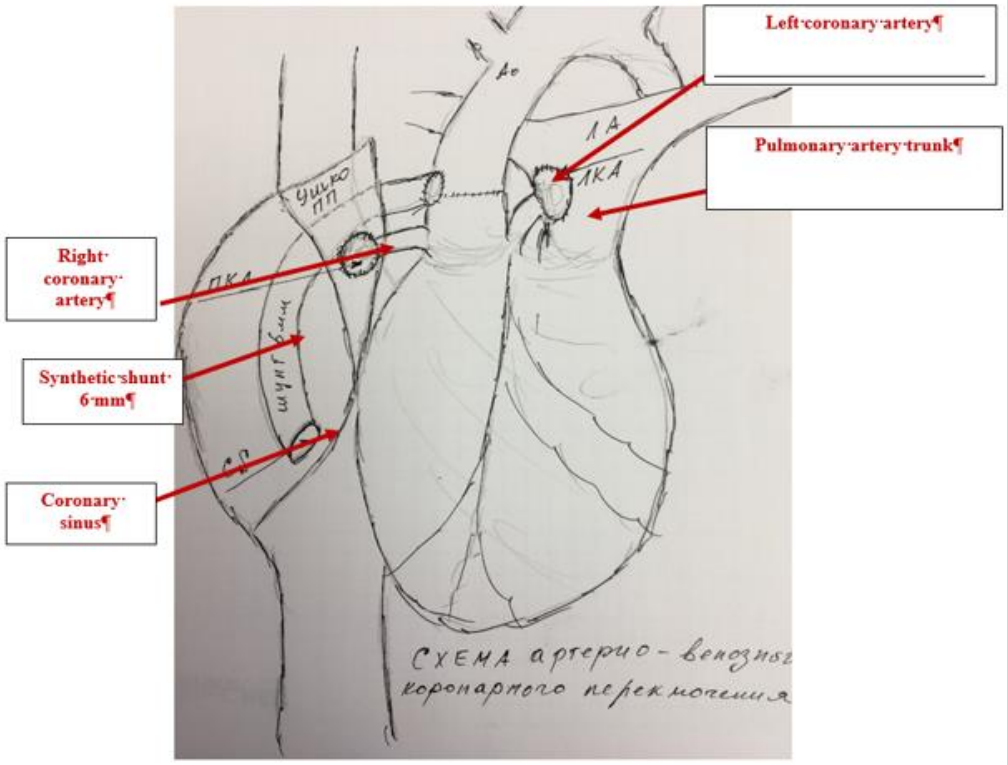


**Figure 2:** Scheme of arteriovenous coronary switching.

CS – coronary sinus; RCA – right coronary artery; LCA – left coronary artery; PA – pulmonary artery; Ao – aorta; Right atrial appendage; Shunt (vascular prosthesis) 6-8 mm synthetic made of polytetrafluoroethylene (PTFE).

Invention formula:An arteriovenous coronary switch operation that includes a sternotomy, connection of a heart-lung machine, and surgical manipulations to improve the blood supply to the myocardium, characterized by the fact that the venous coronary bed with a retrograde flow of arterial blood through it is used as a source of arterial blood supply to the myocardium, and its outflow into the venous bed occurs through the coronary arteries.

The operation was performed as an experiment at the Penza Preclinical Research Center on June 4, 2022, with a positive result. A repeat operation was performed on September 7-8, 2022, at the same Penza Preclinical Research Center. The second operation was much more successful, with a convincing result.

## Conclusions:

1.Coronary arteriovenous switch surgery is an alternative to heart transplantation in complex and recurrent cases of coronary heart disease, as well as in aneurysmal transformations of the coronary arteries in children with Kawasaki syndrome.

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