Case Report

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The First Experience of Aortic Valve Repeated Replacement Using the "Valve in Valve" Technique in a Patient with Dysfunction of a Biological Prosthesis

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INTRODUCTION Aortic valve replacement in cardiopulmonary bypass with suture fixation of the prosthesis is the "gold standard" in cardiac surgery. Currently, the frequency of use of heart valve bioprostheses is increasing in older patients. Despite all the advantages of using heart valve bioprostheses, this type of prosthesis has a major drawback - it is not durable. In most cases, the reason for the dysfunction of prostheses in the late postoperative period is early calcification of the prosthesis valves or their rupture due to degeneration. With the development of new "gentle" techniques for replacing heart valves, transcatheter aortic valve implantation was introduced into clinical practice. The use of transcatheter aortic valve implantation (TAVI) "valve in valve" for reoperations in older patients is of great interest, since in recent years the procedure has been widely used in clinical practice and shows promising data in patients with high surgical risk.

AIM OF STUDY Show first experience of using a technique «valve in valve» at N.V. Sklifosovsky Research Institute for Emergency Medicine.

MATERIAL AND METHODS The results of surgical treatment of a patient with aortic valve bioprosthesis dysfunction using the TAVI "valve in valve" technique are presented.

RESULTS The use of the TAVI "valve in valve" method made it possible to perform reprosthetics of the aortic valve (AV) from a transfemoral approach, not to increase the volume of intervention during reoperation, to avoid trauma to the structures of the heart and nearby tissues when accessing the AV in a patient with a high surgical risk.

CONCLUSION The use of the TAVI "valve in valve" method in cardiac surgery makes it possible to achieve good immediate and long-term results when it is necessary to replace the AV in patients with a high surgical risk.

Keywords: dysfunction of the bioprosthesis of the heart valve, re-operation on the heart, valve-to-valve surgery, transcatheter implantation of the aortic valve prosthesis, TAVI "valve in valve"

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Ao — aorta
AV — Aortic valve
CPB — cardiopulmonary bypass
CT — computed tomography
EchoCG — echocardiography
LA — left atrium
LV — left ventricle
PA — pulmonary artery
TAVI — Transcatheter aortic valve implantation

The aortic valve (AV) replacement under conditions of cardiopulmonary bypass (CPB) with suture fixation of the prosthesis is the "gold standard" in cardiac surgery. Currently, the frequency of using the heart valve bioprostheses is growing [1, 2]. Biological cardiac valve prostheses have certain advantages over mechanical ones, including biocompatibility, more physiology-friendly hemodynamic characteristics, and avoidance of the need for continuous use of anticoagulants [3, 4]. The era of bioprostheses began after the development of the method of preserving biological tissue with glutaraldehyde, proposed by A. Carpentier. This technique was later improved by W. Hancock [5]. In the 1970s and 1980s, there was a swift advance in the use of biological valves in AV prosthetics [6]. However, in the future, the hype in the use of bioprostheses decreased, due to the frequent development of valve-associated complications that required reprosthetics or led to a fatal outcome [7]. The cause of prosthetic dysfunction in the long-term postoperative period in most cases was the early calcification of the prosthetic valves or their rupture due to degeneration. To date, the major drawback of biological prostheses is the lack of their durability [8]. However, in recent years, new methods of biotissue preservation have been developed for the production of biological prostheses, which increase their service life [9]. Strict compliance with the indications and age limits also contributes to improving the results of using biological prostheses.

In 2016, 270 operations were performed in Russia to replace heart AV bioprostheses [10]. Repeated open-heart operations are associated with a higher risk of perioperative complications and an increase in the number of deaths, which can primarily come about due to the traumatic nature and technical difficulties of re-operation [11]. At the stage of obtaining access, mobilization of heart structures for connecting the CPB pump, aortic clamping, and achieving cardioplegia, the right chambers, major vessels, coronary arteries, and aortocoronary shunts that had been formed during previous operations may be unintentionally injuried,

which can provoke massive bleeding. When manipulating on intracardiac structures under conditions of limited access, there are often difficulties in explanting the prosthesis due to the overgrowth of the pannus, the fixed aortic root, and the fusion of the prosthesis posts with the aortic wall. All of the above leads to difficulties in excising the AV prosthesis and suturing the fibrous ring, the risk of damage to the structures of the aortic root and its tubular part, which increases the time of CPB and aggravates the postoperative period. According to the literature, the hospital mortality rate for repeated operations on AV varies from 2.3% to 17.6 % [12-14].

To reduce the traumatic nature of reoperations, various techniques of heart valve replacement have been developed.

The presence of a biological prosthesis makes it possible to use the "reimplantation" technique of valve replacement with a mechanical prosthesis into the frame of a biological prosthesis. The first clinical cases in the world literature were described by C. Campanella et al., (1990) [15] and H. Raffa et al. (1991) [16]. C. Campanella et al. performed valve-in-valve mitral valve reimplantation in a 58-year-old female patient, H. Raffa et al. reimplanted a prosthesis in prosthesis to a 31-year-old male, and in both clinical cases, both patients were discharged safely on day 10. V. V. Sokolov (1996) was the first in our country to perform the mitral valve reimplantation with a mechanical prosthesis into the bioprosthesis frame [17].

With the development of new "gentle" technologies for replacing heart valves, transcatheter AV implantation (TAVI) was introduced into clinical practice. The world's first TAVI operation was performed by A. Cribier in France in 2002 [18]. In clinical practice, the world's first TAVI "valve in valve" procedure was performed by R. Wenaweser in 2007 in an 80-year-old female patient who suffered AV prosthesis dysfunction [19]. This marked a new stage in the history of cardiac surgery in high-risk patients with a previously implanted prosthesis. The advantages of this technique are: avoiding CPB and myocardial ischemia, a low-traumatized intervention, the procedure performance under local anesthesia, and the constructively provided possibility of safe reimplantation in case of malformation.

Diagnostic tests such as echocardiography (EchoCG) and computed tomography (CT) are of great importance. Currently, the aortic CT with bolus contrast enhancement and electrocardiographic synchronization (ECG synchronization) is the leading method of examination in terms of preoperative preparation of patients before the TAVI procedure using the "valve in valve" technique [20].

The use of the TAVI "valve in valve" method for repeated interventions is of great interest, since in recent years the procedure has been widely used in clinical practice and shows promising data in patients with high surgical risk.

The purpose of this work was to show the first experience of using the "valve in valve" technique at N.V.Sklifosovsky Research Institute for Emergency Medicine.

CLINICAL OBSERVATION

From July 2016 to October 2020, 83 TAVI operations, including one "valve in valve" procedure, were performed in the Department of Emergency Cardiac Surgery, Assisted Circulation and Heart Transplantation of N.V.Sklifosovsky Research Institute of Emergency Medicine.

Clinical Case Report

Patient K., 72 years old, was admitted in November 2019 with complaints of shortness of breath on minimal physical exertion and reduced tolerance to it. On hospital admission, the patient condition was objectively relatively satisfactory. The skin was clean; acrocyanosis, cyanosis of the lips were noted. Asthenic. No congestion in the lungs. The respiratory rate was 17 per minute. Heart sounds are muffled, the regular rhythm at auscultation, with a heart rate of 86 per minute, blood pressure 100/55 mm Hg, auscultation systolic noise in the AV projection. There was no swelling. The diuresis was preserved, adequate. Height 153 cm, weight 40 kg. The body surface area is 1.3 m2. The patient's clinical status was consistent with NYHA functional class III. Chronic heart failure II A.

From medical history: in July 2008, the patient underwent surgery for the critical stenosis of bicuspid AV and the ascending aorta dilatation at N.V.Sklifosovsky Research Institute of Emergency Medicine: the AV replacement with Carpentier-Edwards-21 bioprosthesis and linear exoprosthetics of ascending aorta with the linear vascular prosthesis of Inter-Gard-24 under CBP conditions (Fig. 1).

Long-term postoperative period was uneventful. In June 2019, the patient had the above complaints. The AV bioprosthesis dysfunction with the formed critical stenosis of the bioprosthesis outlet was verified. According to EchoCG data: in the AV position, there was a shadow of the bioprosthesis, the prosthesis leaves are consolidated, considerably limited in movement, the aortic root diameter being 3.4 cm, the peak gradient on the AV was 99 mm Hg, the mean one being 62 mm Hg, left ventricular (LV) regurgitation of the 1st degree, the final LV diastolic volume was 96 ml, the LV ejection fraction was 60%, the interatrial septum was 1.2 cm thick, the LV wall posterior is 1.2 cm thick, systolic pressure in the pulmonary artery (PA) was 40 mm Hg. Coronary angiography revealed no hemodynamically significant pathology.

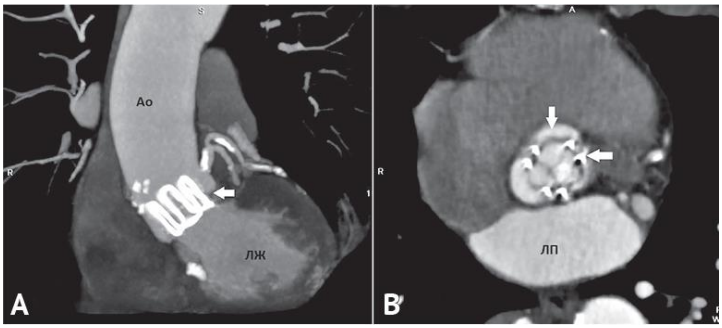

Fig. 1. Multislice computed tomography of the aorta with electrocardiographic synchronization. A — oblique frontal reconstruction (Ao — aorta, ЛЖ — left ventricle); B — cross section (ЛП — left atrium). In the aortic position, the elements of the frame of the Carpentier Edvards 21 aortic bioprosthesis are visualized (arrows)

Among the concomitant pathologies, attention was drawn to arterial hypertension of the 2nd degree, risk 3; impaired glucose tolerance; chronic obstructive pulmonary disease, bronchial asthma of uncontrolled course; obliterating atherosclerosis of the vessels in the lower extremities. The calculated risk on the EuroSCORE II model was 11.63%.

Taking into account the patient's age, her condition severity, marked concomitant pathology, repeated nature of the intervention, high surgical risk of surgery under CPB conditions, the decision was made to perform TAVI for the patient using the "valve in valve" technique.

On the 4th day after hospitalization, the patient underwent transcatheter implantation of the AV prosthesis "valve in valve" with the CoreValve Evolut R-23 bioprosthesis (Fig. 2).

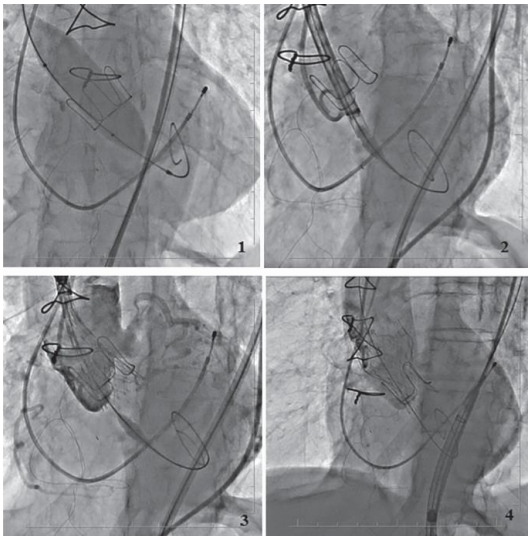

Fig. 2. TAVI “valve in valve” . 1 — predilatation of the aortic valve cusps; 2 — delivery of the Evolut R-23 prosthesis to the implantation site; 3 — opening of the Evolut R-23 prosthesis; 4 — view of the implanted prosthesis Evolut R-23

From the operation log:

The left common femoral artery was mobilized, and the right common femoral artery was punctured. A temporary pacemaker was inserted into the right ventricular cavity through the right jugular vein. Pre-dilation of the previously implanted AV prosthesis was performed with a balloon catheter during electrocardiostimulation up to 180 beats/min. The delivery system delivered the CoreValve Evolut R-23 AV prosthesis and implanted it in the aortic position. On the control aortography, there was no regurgitation in the LV cavity.

At the transesophageal EchoCG, the valve was visualized in the aortic position, and there was no regurgitation into the LV cavity.

The early postoperative period was uneventful. Tracheal extubation was performed 4 hours after surgery, The patient was transferred from the intensive care unit on the 3rd day. The postoperative period was uneventful.

At control echocardiography, the function of the AV prosthesis was satisfactory: a peak gradient of 29 mm Hg, paraprosthetic regurgitation of 0-1 degree. Systolic blood pressure in the PA was 39 mm Hg.

On the 6th day after surgery, a control multislice computed tomography of the aorta with ECG synchronization was performed (Fig. 3).

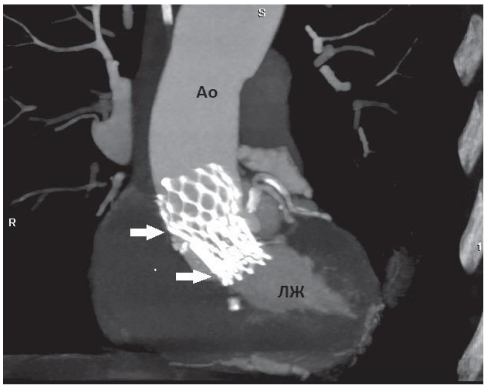

Fig. 3. Multislice computed tomography of the aortic root with electrocardiographic synchronization after transcatheter aortic valve implantation using the valve-to-valve technique. Oblique frontal reconstruction (Ao — aorta, ЛЖ — left ventricle). The frame of the Medtronic CoreValve Evolut R 23 bioprosthesis (arrows) inserted into the bioprosthesis is visualized

On the 7th day after surgery, the patient was discharged from the clinical department.

On the 21st day after surgery, a control examination was performed. According to EchoCG data, the peak gradient on the AV prosthesis was 25 mm Hg, the mean gradient was 14 mm Hg, paraprosthetic regurgitation in LV was 0-1 degree, and the LV ejection fraction was 66%.

At 11 months after surgery, dynamic echocardiography showed that the peak gradient on the AV prosthesis was 30 mm Hg, the mean one was 12.2 mm Hg, paraprosthetic regurgitation in LV was of 0-1 degree, the LV ejection fraction was 63%.

DISCUSSION

Standard AV replacement surgery is a complex procedure and is associated with an increased risk due to the presence of adhesions in the pericardial cavity, and in some patients, due to previously performed coronary artery bypass grafting, difficulties in excising a previously implanted prosthesis, and narrow fibrous rings of the AV and aorta [21]. All these technical difficulties affect the time of myocardial ischemia, the duration of CPB, the volume of blood loss and explain the increased hospital mortality and postoperative complications in this group of patients [22]. Choosing the TAVI "valve in valve" method reduces the impact of the repeated intervention risk factors on the surgery outcome.

To date, we have gained extensive experience in performing TAVI "valve in valve" operations. A number of authors and clinical studies report good immediate and long-term results of this method [23-26]. A 1-year all-cause mortality rate after surgery is 12.4% [27].

In this clinical example, previously performed AV prosthetics was complicated by the development of AV prosthesis dysfunction as a result of degenerative changes in the prosthetic valves, calcification and limited mobility with the formed stenosis of the outlet.

The use of the TAVI "valve in valve" method made it possible to perform AV reprosthetics from transfemoral access, avoiding to increase the volume of intervention during repeated surgery, obviating technical difficulties associated with adhesions in the pericardial cavity, difficulties with accessing AV through the exoprosthetic aorta and with excising the previously implanted prosthesis. This was especially important in an older patient with a complicated medical history, severe concomitant pathology, repeated nature of the intervention, and a high surgical risk of the procedure under CPB conditions. The EchoCG data obtained intraoperatively and in the early postoperative period showed good hemodynamic characteristics of the AV prosthesis, minimal paraprosthetic regurgitation.

Thus, the use of the TAVI "valve in valve" method in cardiac surgery practice makes it possible to achieve good immediate and long-term results when it is necessary to replace the AV in patients with a high surgical risk.

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