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The first experience of two-stage transcatheter implantation of bioprostheses in mitral and tricuspid valve (Valve-in-Valve) prostheses in a high-risk surgical patient

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Abstract

Introduction. *Structural degeneration of biological prosthetic heart valves is an inevitable complication in the long term, requiring repeated surgery. Repeated open surgery is associated with a high risk in comorbid patients. Valve-in-Valve (ViV) transcatheter technology has become a minimally invasive alternative.*

Objective. *To demonstrate the effectiveness and safety of a two-stage ViV strategy on tricuspid and mitral valves.*

Material and methods. *A clinical case of a patient born in 1947 with mitral valve (MC) and tricuspid valve (TC) bioprostheses 7 years after the initial open prosthetics is presented. The calculated risk of EuroSCORE II was 21.8%. A two-stage strategy was applied: on 09.29.2025, transcatheter implantation of the MyVal 30.5 mm bioprosthesis was performed in the tricuspid valve position, and on 10.10.2025, MyVal 27.5 mm was performed in the mitral valve position.*

Results. *The postoperative period was uneventful. Control echocardiography showed a significant improvement in hemodynamic parameters: the average gradient on TC decreased from 6.0-7.2 to 3.1 mmHg, regurgitation decreased from 2 to 0-1 art. On MC, the average gradient decreased from 9.0-10.5 mmHg to 6.7 mmHg, regurgitation was minimal. The patient's condition was satisfactory upon discharge, FC regressed from III-IV to II.*

Conclusion. *Two-stage transcatheter valve implantation using valve-to-valve technology is a highly effective and safe method of treating bioprosthesis dysfunction in high-risk surgical patients, which avoids repeated sternotomy and reduces rehabilitation time.*

Keywords: transcatheter prosthetics of the mitral valve, transcatheter prosthetics of the tricuspid valve, implantation of the valve into the valve

Conflict of interest The authors declare no conflict of interest

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EchoCG, echocardiography

EDV, end-diastolic volume

EF, ejection fraction

EOA, effective orifice area

ESV, end-systolic volume

FC, functional class

LA, left atrium

LV, left ventricle

MG, mean diastolic gradient

MV, mitral valve

MVP, mitral valve prosthesis

PASP, pulmonary artery systolic pressure

RA, right atrium

RV, right ventricle

TE EchoCG, transesophageal echocardiography

TV, tricuspid valve

TVP, tricuspid valve prosthesis

Introduction

The widespread use of biological prostheses for the correction of acquired heart defects, especially in elderly patients and those with contraindications to lifelong anticoagulant therapy, has encountered the problem of limited durability of these devices [1, 2]. Structural degeneration of the prosthesis, manifested by the calcification of the leaflets, their rupture, fibrosis and, as a consequence, the development of stenosis and/or regurgitation constitutes a main limiting factor of their use [3, 4]. The frequency of reoperations due to the prosthesis structural degeneration at 10–15 years after implantation can reach 20–50% [5, 6].

Traditionally, the treatment of choice for the prosthesis structural degeneration has been the repeat open cardiac surgery with prosthesis replacement. However, such interventions are technically complex and

associated with a significantly higher risk of intra- and postoperative complications and mortality compared to primary surgeries, especially in patients with multiple comorbidities [7, 8].

The advent of transcatheter technologies, particularly the Valve-in-Valve (ViV) technique, has radically changed the approach to treating this category of patients. First successfully applied to the aortic valve in 2007, this technology was adapted for the mitral and tricuspid positions in 2009 and 2011, respectively [9, 10]. Endovascular technology allows for the implantation of a new valve into a stenotic or regurgitant bioprosthesis through a minimally invasive approach under X-ray and echocardiography guidance, avoiding the need for sternotomy and cardiopulmonary bypass. This significantly reduces surgical trauma and shortens recovery time [11, 12].

Currently, we have not been able to find any reports in the Russian literature on the simultaneous use of prostheses in the mitral and tricuspid positions in the same patient [13]. The presented clinical case report describes a unique experience for our country of a two-stage application of the "valve-in-valve" technology for the correction of a combined dysfunction of tricuspid valve (TV) and mitral (MV) bioprostheses in a patient with an extremely high surgical risk [14].

Clinical Case Report

Medical history

Patient T., born in 1947, has suffered from persistent atrial fibrillation since 2012. In 2018, she underwent mitral valve replacement surgery with a 29 mm SJM Biocor biological prosthesis (St. Jude Medical, USA), and a prosthetic replacement of the TV with a biological prosthesis SJM Biocor, 31 mm, using the cardiopulmonary bypass technique.

The patient was admitted to our clinic with complaints of decreased exercise tolerance, shortness of breath on minimal physical exertion, and peripheral edema. The examination revealed the dysfunction of the MV and TV prostheses, stage III hypertension of grade 3, risk 4 (very high), persistent atrial fibrillation since 2012 (CHA2DS2-VASc=5, HAS-BLED=2), and coronary artery disease: post-infarction cardiosclerosis (previous history of acute myocardial infarction in 2018).

Instrumental examination data during current hospitalization (09.2025)

Transthoracic echocardiography (EchoCG):

TV prosthesis (TVP): the prosthesis leaflets were compacted, thickened, abruptly limited in mobility, the effective orifice area (EOA) was 0.6 cm^2, the mean diastolic pressure gradient (MG) was 6.0–7.2 mmHg, transprosthetic 2nd degree regurgitation.

MV prosthesis (MVP): the prosthesis leaflets were compacted, the motion of the leaflets was limited, EOA was 1.0 cm^2, MG was 9.0–10.5 mmHg, transprosthetic regurgitation, stage 1.

Left ventricular (LV) cavity: EDV 85 mL, ESV 47 mL. Diffuse LV hypokinesis: LVEF was 45%. Left atrium (LA) volume was 120 mL, right atrium (RA) volume was 170 mL. Right ventricle (RV): basal size was 40 mm, TAPSE 10 mm. Pulmonary artery systolic pressure (PASP) was 35 mmHg.

Thus, echocardiography revealed signs of MVP and TVP dysfunctions with moderate to the MVP severe stenosis and the TVP severe stenosis and grade 2 regurgitation. Severe dilation of both atria, moderate dilation of the RV cavity, stage 1 pulmonary hypertension, and moderate diffuse decrease of the LV and RV contractility were noted.

Chest X-ray showed cardiomegaly, hydrothorax on both sides (more on the right), venous congestion in the lungs (Fig. 1).

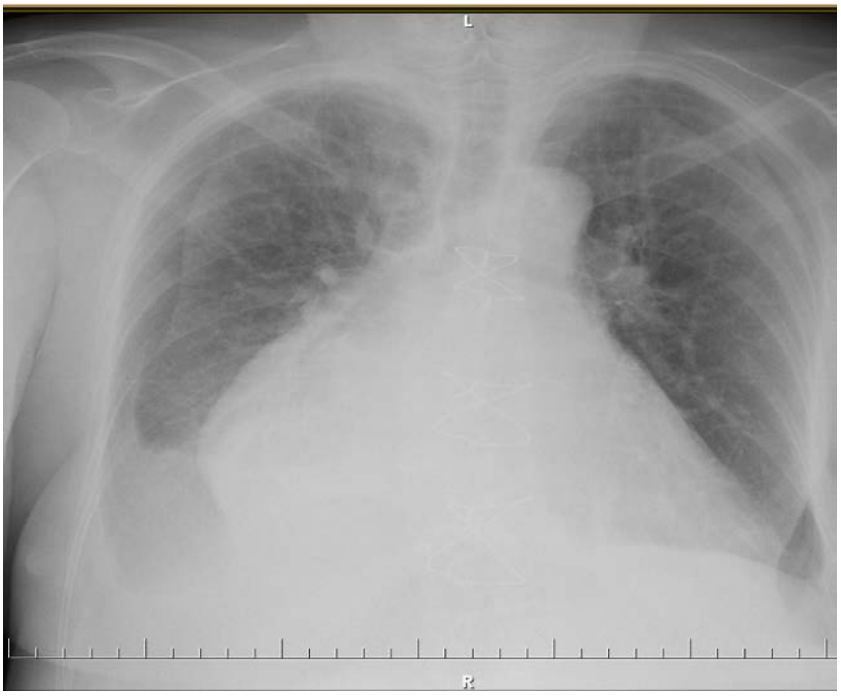


Fig. 1. Chest X-ray before surgery

Comorbidity background

Diffuse atrophic abnormalities in the brain. Chronic cerebral ischemia, stage 2. Dyscirculatory encephalopathy. Sensorineural right-sided hearing loss. Subclinical hypothyroidism. Cholelithiasis, cholecystectomy was performed in 2012. Urolithiasis: calculus in the right kidney. Infarction of the lower third of the left kidney from 2016, the left kidney cyst. Hyperuricemia. Venous varices of the lower extremities. Chronic lymphovenous insufficiency. Mild chronic iron deficiency anemia. Left-sided gonarthrosis stage 2. Height: 164 cm, body weight 63 kg, body mass index 23.4 kg/m^2.

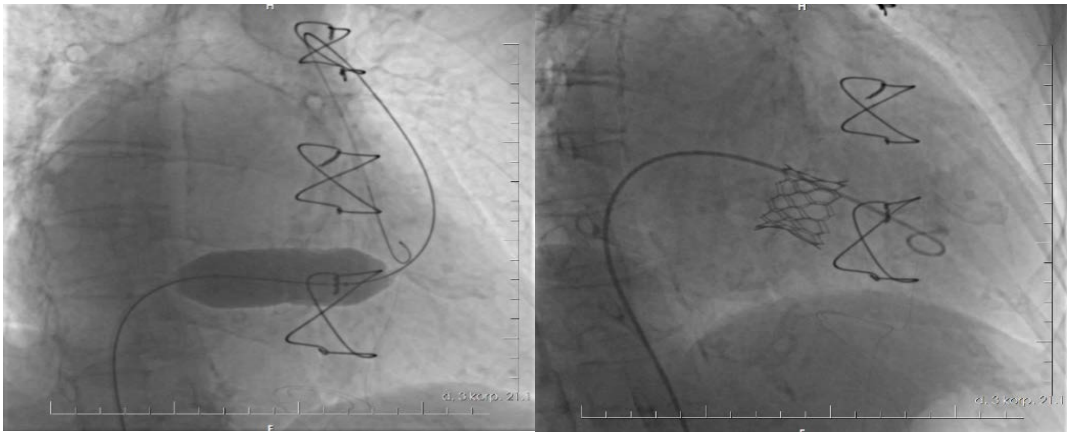
Thus, the EuroSCORE II calculated risk in combination with the history of comorbidities was 21.8% (high risk), which placed the patient

in the category of extremely high surgical risk, making repeated open surgery practically unacceptable [15].

The treatment provided and strategy

A two-stage transcatheter intervention strategy was adopted by Decision No. 10-22 issued on October 11, 2022, by the Medical Council of the N.V. Sklifosovsky Research Institute for Emergency Medicine in conjunctions with the Biomedical Ethics Committee of the Institution. The rationale for this staged approach was a more severe and clinically significant dysfunction of the pulmonary artery, which correction would relieve the pulmonary circulation and stabilize the patient's condition before a more complex procedure on the MV.

The first stage (September 29, 2025) involved a transcatheter implantation of the TV bioprosthesis. For this, a puncture of the right common femoral vein was performed under general anesthesia, and a 6F introducer sheath was inserted. A rigid modified 0.035" guidewire was inserted through the diagnostic catheter into the RV cavity through the TVP. The 6F introducer sheath was replaced with a Python 14 F introducer (Meril Life Sciences Pvt. Ltd., India). Using the Valver Balloon catheter of 25×40 mm (Balton Sp. z oo., Poland), the TVP valvuloplasty was performed. Prosthetic valve MyVal 30.5 mm (Meril Life Sciences Pvt. Ltd., India), under the control of fluoroscopy and transthoracic EchoCG on the Navigator 30.5×35 mm delivery system (Boston Scientific (USA), was implanted into a failed SJM Biocor-31 TV bioprosthesis. The delivery system was removed. Control angiograms showed grade 0–1 regurgitation into the RA cavity. The introducer sheath was removed, and manual hemostasis was achieved. The surgery lasted 95 minutes (Fig. 2).



A **B**

Fig. 2. Implantation of the MyVal 30.5 prosthesis in the tricuspid position. 2A, valvuloplasty of the tricuspid valve bioprosthesis with a balloon catheter; 2B, the crown structure of the new implanted MyVal 30.5 bioprosthesis in the tricuspid position

The postoperative period (after the first stage) was uneventful. A control echocardiogram on the third day after surgery (October 1, 2025) demonstrated excellent hemodynamic results, such as a mean gradient on the newly implanted TVP equal to 3.5–3.8 mmHg (a decrease of more than 30%) and transprosthetic regurgitation of 0–1st degree (decreased from 2nd degree). An increase in LVEF to 54% was also noted compared to preoperative data of LVEF being 45% (Fig. 3).

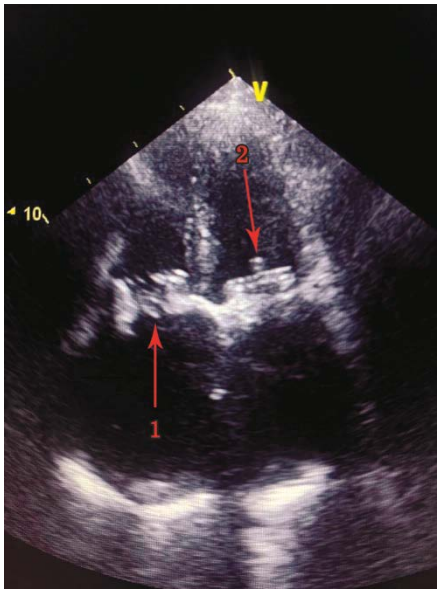
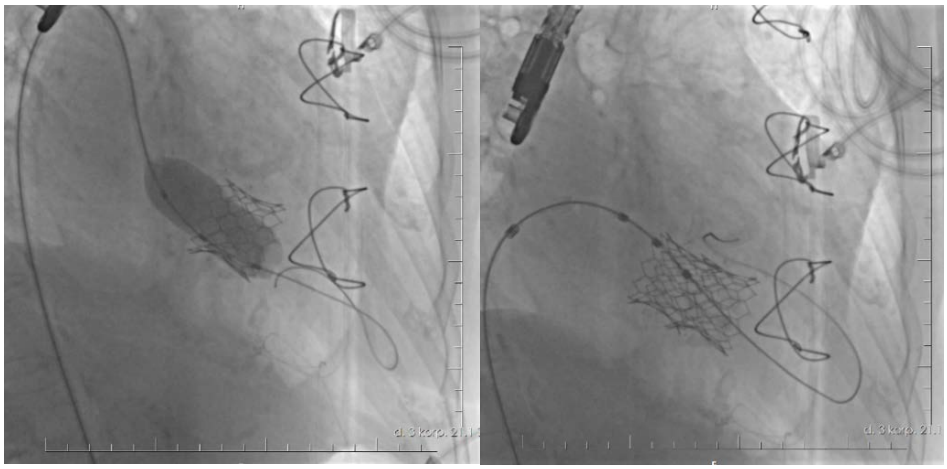


Fig. 3. Transthoracic echocardiography. Apical 4-chamber position. Arrow 1 indicates endovascular MyVal 30.5 prosthesis in the tricuspid valve position; Arrow 2 indicates dysfunctional mitral valve bioprosthesis

After hemodynamic stabilization and the right ventricular failure resolution of on the 12th day after the first surgery, a second procedure involving transcatheter implantation of a mitral valve bioprosthesis was performed on October 10, 2025. For this, a puncture of the right common femoral vein was performed, and a 6 F introducer sheath was inserted. Using a 71 cm Brockenbrough needle (Medtronic Inc., USA) a puncture of the interatrial septum was performed under the control of transesophageal echocardiography and (EP EchoCG). A rigid 0.035″ guidewire was inserted into the left atrium. Using an Advance 35LP 8×100 mm balloon catheter (Cook Medical, USA) a dilation of the puncture hole in the interatrial septum was performed. A guidewire was advanced through the atrial mitral valve into the LV cavity and then into the aorta. A Python 14F introducer sheath was placed. Using the Mammoth balloon catheter of 20×40 mm (Meril Life Sciences Pvt. Ltd., India), the valvuloplasty dysfunctional MVP was performed. A MyVal

27.5 prosthesis on a Navigator 27.5×30 mm delivery system was inserted and implanted into a failing SJM Biocor-29 mitral valve bioprosthesis with pacing through a rigid guidewire at up to 180 bpm. The delivery system and sheath with a Python insertion device were removed, and manual hemostasis was achieved. At the control stage, the emergency room TTEchoCG, a paraprosthetic regurgitation of grade 1 into the left atrium cavity was identified; the gradient on the MV prosthesis being 3.5 mmHg, the pericardial cavity being without abnormalities. The surgery duration was 100 minutes (Fig. 4).



A **B**

Fig. 4. Implantation of the MyVal 27.5 prosthesis in the mitral position. 4A, valvuloplasty of the mitral valve bioprosthesis with a balloon catheter; 4B, the crown structure of the new implanted MyVal 27.5 bioprosthesis in the mitral position

The postoperative period after the 2nd stage of the treatment was also uneventful, without any peculiarities. At discharge, the patient's condition was assessed as satisfactory. Heart failure significantly regressed, to functional class (FC) II. Hemodynamics was stable without inotropic support. According to echocardiography results, the LV cavity

decreased: EDV was 8.2 mL, ESV 36 mL, EF 5.6%. Local contractility of LV myocardium was without impairments. The mean gradient on MVP decreased to 6.7 mmHg. Paired prosthetic regurgitation was of grade 0-1. The mean gradient on the TVP was 3.1 mmHg. Transprosthetic regurgitation was of grade 1. The patient was discharged for outpatient follow-up.

The results of a control X-ray examination of the chest organs in the early postoperative period revealed a decrease in hydrothorax on both sides against the persistent hypoventilation (Fig. 5).

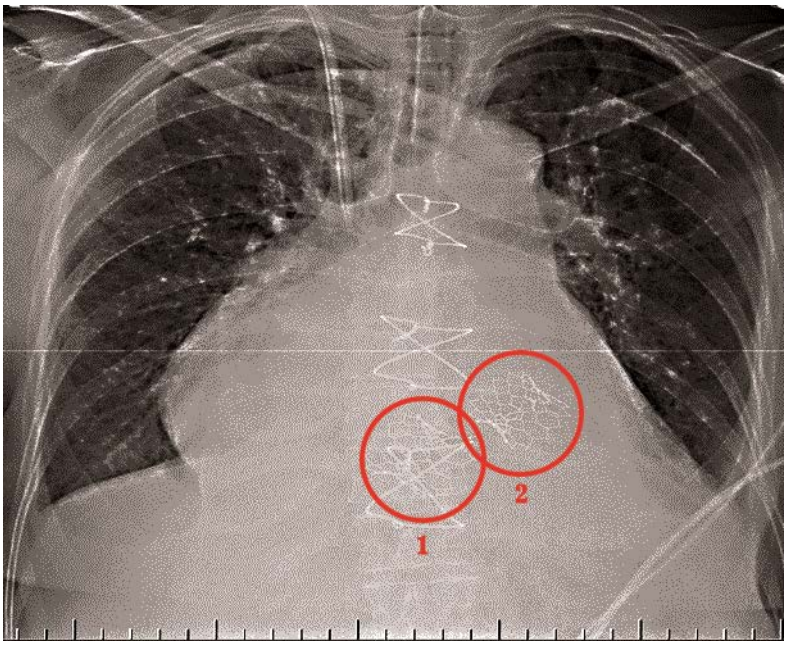


Fig. 5. Chest X-ray before discharge from hospital. Circle 1 indicates MyVal 30.5 endovascular prosthesis in the tricuspid valve position; Circle 2 indicates MyVal 27.5 endovascular prosthesis in the mitral valve position

After 2.5 months, the planned echocardiography revealed MG of 6.5 mmHg on the MVP, regurgitation of grade 0-1, MG of 3.1 mmHg on the TVP, regurgitation of grade 0-1, PASP 28 mmHg. LA volume was 110

mL, RA volume 148 mL. LV cavity: EDV of 80 mL, ESV 34 mL, EF being 58%. RV (basal size) was 40 mm, TAPSE 13 mm (Fig. 6).

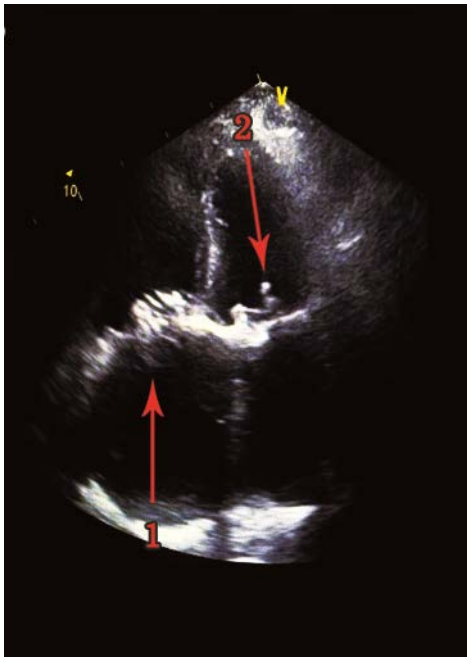


Fig. 6. Transthoracic echocardiography. Apical 4-chamber position. Arrow 1 indicates MyVal 30.5 endovascular prosthesis in the tricuspid valve position; Arrow 2 indicates MyVal 27.5 endovascular prosthesis in the mitral valve position.

Thus, the follow-up echocardiography results at 2.5 months after surgery revealed a satisfactory function of the MVP and TVP, decreased volumes of both atria, and an improvement in the contractile function of both ventricles compared to baseline data. Increased exercise tolerance and decreased dyspnea were also noted (NYHA functional class decreased from III-IV to II).

Discussion

This clinical case report clearly illustrates the potential of up-to-date interventional cardiac surgery in the treatment of such severely ill

patients. A EuroSCORE II risk of 21.8% predicted a high mortality rate with open surgery in our patient. The valve-in-valve technique eliminated the risks associated with sternotomy, adhesion dissection, prolonged cardiopulmonary bypass, and cardioplegia.

The successful outcome has been confirmed by the data from international publications and registries on the endovascular valve-to-valve implantation as a method of choice in high-risk patients [7, 9, 11, 16]. Data described by J. Jdaidani et al. (2023) confirmed that a transcatheter valve-to-valve implantation in the tricuspid position was technically feasible and safe even in complicated anatomical conditions, demonstrating a significant clinical improvement and a low rate of perioperative complications in high-risk patients [17]. This is consistent with our experience, where the initial step was a successful valve-to-valve implantation in the tricuspid position, which stabilized the patient's condition.

Simultaneously performing two complex transcatheter interventions could have placed excessive strain on the patient, particularly on the right heart. The priority correction of severe tricuspid stenosis and concomitant complex drug therapy eliminated blood congestion in the systemic circulation, reduced pressure in the right atrium and systemic venous system, and improved filling of the pulmonary circulation and left ventricle. This is explained by the fact that a reduced blood volume passed through the stenotic tricuspid bioprosthesis into the right ventricle, creating conditions for insufficient filling and, consequently, reduced RV contractility force. This, in turn, led to a decrease in the linear blood flow velocity in the pulmonary circulation, resulting in venous congestion. Tricuspid replacement resolved the main issue, that is the filling of the right ventricle and pulmonary circulation. This improved the contractile function of the right ventricle, reduced blood congestion in the pulmonary

circulation, relieved the systemic circulation, and increased the partial pressure of oxygen in blood, which created more favorable conditions for performing the second procedure on the MV.

The obtained echocardiographic data indicated a good function of the new endoprostheses.

It is important to note that after valve-to-valve implantation, the pressure gradients on the valves, although somewhat higher than on native ones, remain within acceptable values and do not have a hemodynamically significant effect [18, 19]. Data from G. Ventosa-Fernandez et al. (2019) show that even with successful repeat open MV surgeries, there is significant in-hospital mortality (8.1%) and postoperative complications such as the need for repeated interventions, a respiratory failure and acute kidney injury [18].

Our two-stage valve-in-valve approach completely avoided the risks associated with repeat open surgery, providing a clinical improvement without the complications associated with repeat surgeries.

Transcatheter interventions on the tricuspid valve present significant technical challenges due to anatomical features such as the large valve size, complex geometry of valve annulus, and proximity to the conduction system [18]. However, the presence of a rigid frame of the old prosthesis makes the valve-in-valve endoprosthesis procedure more predictable and safer compared to interventions on the native tricuspid valve, as confirmed by data from a multicenter study [10].

In our observations during the first stage, the main problem we encountered was the significantly enlarged RA and LA cavities, which created difficulties in positioning a rigid guidewire in the RV cavity, valvuloplasty of the biological TVP, and implantation of a new bioprosthesis. At the second stage, this challenge involved passing catheters and guidewires from the LA into the dysfunctional mitral valve

prosthesis. One solution to this problem in the case of mitral valve bioprosthesis replacement was the use of a technique for passing a rigid guidewire from the LA through the TVP and the LV cavity into the aorta. This allowed for the reliable placement of a new MVP into the previously failed SJM Biocor-29 prosthesis.

The presented case clearly demonstrates the natural history of degeneration of biological prostheses, which peaks between seven and ten years after implantation [3, 6]. This emphasizes the critical importance of lifelong follow-up of such patients with regular echocardiography for the timely detection of dysfunction. However, in our case, it should be noted that similar long-term regular monitoring the condition of the new TVP and MVP in our patient would also be necessary in the future.

Conclusion

The presented clinical example serves as convincing evidence that transcatheter valve-in-valve technology is not just an alternative, but often the method of choice in patients with a dysfunction of biological prostheses and a high risk of repeated open surgery.

The successful two-stage valve-in-valve implantation of the tricuspid and mitral valves has demonstrated the feasibility of complex, staged hybrid strategies for treating patients with severe comorbidities. This approach not only avoids high-risk interventions but also achieves significant clinical improvement, enhanced quality of life, and, likely, an improved long-term prognosis.

Further gaining the experience and a long-term follow-up of such patients will contribute to the optimization of selection, the improvement of heart valve replacement techniques and achieving better long-term results.

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