Case Report

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Clinical Case of Correction of an Acquired Gerbode Defect After Mitral Valve Replacement in a Patient With New Coronavirus Infection

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BACKGROUND Clinical case. A patient after mitral valve replacement surgery for infective endocarditis was hospitalized with a new coronavirus infection. The examination revealed a left ventricular-right atrial communication. The complex treatment with a good clinical effect was performed at the N.V. Sklifosovsky Research Institute for Emergency Medicine.

Conclusions In the context of a pandemic of a new coronavirus infection, patients with a new coronavirus infection who have undergone a history of heart surgery are subject to greater clinical vigilance regarding the development of postoperative complications, including rare ones.

Keywords: Gerbode Defect, left ventricular-right atrial communication, left ventricular-right atrial shunt, ventricular septal defect, infective endocarditis, new coronavirus infection, prosthetic heart valves, clinical alertness

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CT - computed tomography
LV - left ventricle
IVS - interventricular septum
PAVH - perimembranous portion of the interventricular septum
RP - right atrium
TEE - transesophageal echocardiography
Echo CG - echocardiography

INTRODUCTION

Intracardiac complications after heart valve replacement are infrequent, but the most severe complications in cardiac surgery. One of the rarest complications of operations performed near the membranous part of the interventricular septum (IVS) is the formation of a left ventricular-right atrial communication, described in the literature as an acquired form of Gerbode defect. A similar complication was observed by the cardiosurgical service of the N.V. Sklifosovsky Research Institute for Emergency Medicine in a patient with a new coronavirus infection who had previously undergone mitral valve replacement for infective endocarditis.

Clinical observation

A 27-year-old male patient was hospitalized for the first time in the Department of Emergency Cardiac Surgery, Circulatory Assist and Heart Transplantation of the N.V. Sklifosovsky Research Institute for Emergency Medicine with infective endocarditis with damage to the mitral valve and the formation of its severe regurgitation (type I according to *Carpantier*). Clinically, the disease was manifested by progressive congestive heart failure: increasing shortness of breath, weakness.

The patient has a history of drug addiction, chronic viral hepatitis C.

Laboratory parameters: leukocytosis (up to 12.9×10 ^{9}/l, neutrophilia), hypoalbuminemia (up to 20.8 g/l). According to transthoracic and transesophageal echocardiography (EchoCG and TEE), thickened cusps of the mitral valve were visualized, with a floating vegetation of 19 × 8 mm on the atrial side of the posterior cusp, a drained abscess at the base of the posterior cusp, and severe mitral regurgitation on Dopplerography .

Taking into account the progressive heart failure and the high risk of embologenic complications, mitral valve replacement was performed with a mechanical prosthesis *On-X*-25/33 under cardiopulmonary bypass.

Intraoperatively: upper transseptal approach, in the projection of the *P*3 segment of the mitral valve with the transition to the posteromedial commissure vegetation 10×6×6 mm, in the area of the fibrous ring in the projection of the *P*3 segment, a drained abscess. The fibrous ring of the mitral valve was sutured with U-shaped sutures from the side of the left ventricle (LV) and the *On-X*-25/33 mechanical prosthesis was implanted.

The early postoperative period was uneventful: the patient was extubated 6 hours after the operation, transferred to the clinical department on the 2nd day, according to EchoCG, the mitral valve prosthesis had a good function, the average diastolic transprosthetic gradient was 4.2 mm Hg, 1 degree transprosthetic regurgitation, LV ejection fraction

61%. On the 5th day after the operation, the patient was discharged for the outpatient stage of treatment with recommendations to continue a long course of antibiotic therapy and adhere to the anti-epidemic regimen.

Taking into account the tension of the epidemiological situation, upon admission, before surgical treatment and before discharge, a study of smears from the patient's throat and nasopharynx was performed by nucleic acid amplification to detect ribonucleic acid (RNA) of a new coronavirus infection (PCR test) and the result is negative.

Three days after discharge, the patient complained of intermittent fever up to 38°C, increased dyspnea, and a decrease in blood saturation to 86%. The patient has been diagnosed with a new coronavirus infection (confirmed by the results of PCR testing); according to chest computed tomography (CT) there was mild lesion (lung damage up to 25% on both sides).

Taking into account the history, the patient was hospitalized in the Covid Center of the N.V. Sklifosovsky Research Institute for Emergency Medicine, standard therapy for a new coronavirus infection was started in accordance with the methodological recommendations of the Russian Ministry of Health: antiviral, anticoagulant therapy, oxygen therapy (if indicated). For the purpose of passive immunization, transfusion of pathogen-inactivated fresh frozen plasma of a convalescent donor was performed. Despite the ongoing treatment, the patient's condition remained severe, with negative dynamics in the form of the appearance and increase of heart failure.

EchoCG and TEE revealed high pulmonary hypertension (systolic pressure in the pulmonary artery 80 mm Hg), dilatation of the right heart, severe tricuspid insufficiency, expansion of the inferior vena cava (without its collapse) against the background of good function of the mitral prosthesis and intact systolic LV functions. Moreover, an additional, atypically directed blood flow in the right atrium, merging with the flow of tricuspid regurgitation, was verified. A detailed examination visualized a direct communication between the cavities of the left ventricle and the right atrium (RA), about 20 mm in size (Fig. 1).

The left ventricular-right atrial communication was verified by the data of left ventriculography: a defect was found in the membranous part of the IVS with a diameter of 22.1 mm with a massive shunt from the LV cavity to the RA (Fig. 2).

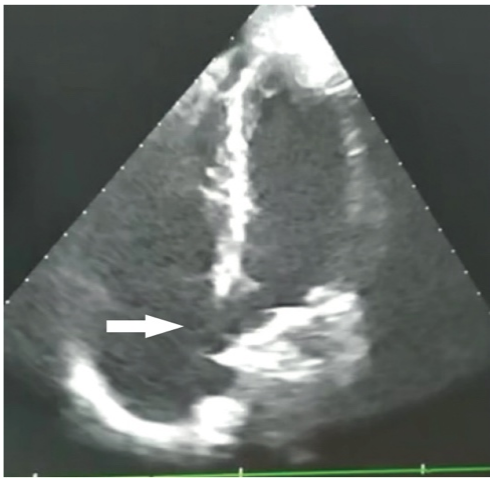

Fig. 1. Transesophageal echocardiography, four-chamber position. The white arrow indicates the left ventricular-right atrial communication

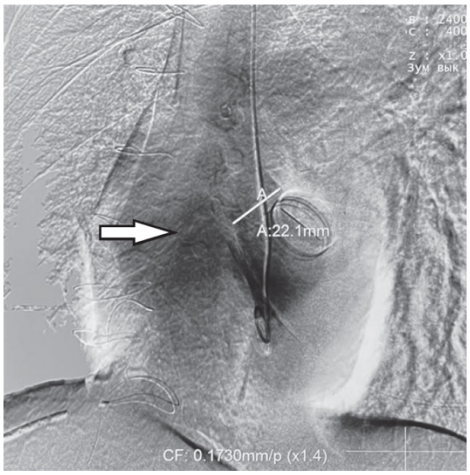

Fig. 2. Left ventriculography. The white arrow indicates the defect

Thus, according to the results of the examination, acquired form of Gerbode defect was diagnosed, associated with mitral replacement after infective endocarditis in the course of existing new coronavirus infection.

An artificial defect in the membranous part of the IVS with a significant left ventricular-right atrial shunt, an increase in pulmonary hypertension, accompanied by a vivid clinical picture of heart failure, became an indication for urgent surgical treatment: the patient underwent plasty of the defect with a patch under cardiopulmonary bypass.

Intraoperatively: perimembranous defect of the IVS, dissection of the posterior walls of both ventricles and the posterior wall of the RA, up to the area of the coronary sinus with a rupture of the latter and the formation of an oblique canal 30 mm in diameter and 30 mm long. The plasty of the defect was performed using a 3×4 cm *ePTFE* (*Cardiovascular Patch*) patch with a continuous twist suture and additional fixation with four U-shaped sutures in the area of contact

with the fibrous annulus of the mitral valve. The rupture of the wall of the coronary sinus is sutured with the formation of a new ostium.

The postoperative period was uneventful: the patient was extubated 6 hours after the operation, transferred to the clinical department on the 2nd day, according to echocardiography, the mitral valve prosthesis had a good function, there were no pathological intracardiac flows, regression of the size of the right heart, normalization of pressure in the pulmonary artery, minimization tricuspid insufficiency. On the 5th day after the operation, having completed the course of inpatient treatment for a new coronavirus infection, the patient was discharged for outpatient follow-up.

DISCUSSION

DESCRIPTION

Gerbode's defect is a type of congenital defect of the perimembranous part of the IVS, which leads to a shunt between the LV and RA due to the anatomical configuration of the atrioventricular valves [1]. The frequency of the defect is 0.08% of all congenital defects diagnosed in vivo, and 0.12% based on autopsy materials [2].

In the last decade, the world literature has increasingly reported an increase in the number of acquired forms of Gerbode's defect [3, 4]. Acquired Gerbode defects are considered a rare complication of cardiac surgery performed near the membranous part of the IVS and are divided into acquired iatrogenic and acquired non-iatrogenic [5].

The two main causes of acquired iatrogenic Gerbode defect are interventions on the valvular apparatus of the heart (prosthetic aortic [6–8], mitral [3, 9, 10]) and interventional procedures (atrioventricular node ablation and endomyocardial biopsy) [11]. The main causes of the noniatrogenic form include infective endocarditis [4, 12–14] and myocardial infarction in the area of the right coronary artery [15–17].

CLASSIFICATION

The classification of the Gerbode defect corresponds to different anatomical relationships of the cardiac structures. *Riemenschneider* and *Moss* [18] initially classified defects as two types: direct and indirect. Direct defects go beyond the membranous part of the IVS, indirect ones include a high IVS defect with concomitant tricuspid regurgitation (a third of the defects are supravalvular, two thirds are subvalvular). *Sakakibara* and *Konn* further expanded the classification to include a third type with supravalvular and subvalvular components, called them intermediate defects [19] (Fig. 3). According to *Yuan*, the occurrence of the three types is 76, 16 and 8 of the total, respectively [13].

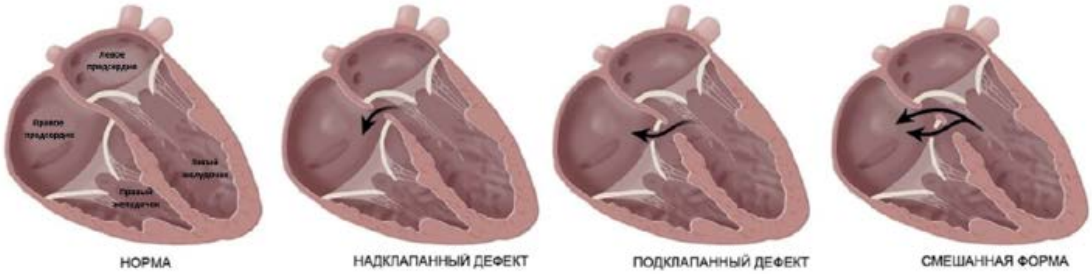

Fig. 3. Types of Gerbode defects according to Riemenschneider-Moss-Sakakibara-Konn

Subvalvular defects of the membranous part of the IVS are located in one of three positions: directly below the septal cusp of the tricuspid valve, in front and medially of the perimembranous part of the interventricular septum, centrally, involving both the membranous and adjacent muscular parts, or as an isolated defect of the IVS by type open common atrioventricular canal [20]. On the LV side, the anterior and central defects are located directly under the right coronary and non-coronary cusps of the aortic valve, the common atrioventricular canal defect extends posteriorly to the septal leaflet of the tricuspid valve. On the left, this defect is separated from the aortic valve with perimembranous part of IVS. Defects such as the common atrioventricular canal are usually large and associated with perforation of the tricuspid valve leaflet or an enlarged commissural space. These defects differ from the more common forms of anomalies in that the atrial part of the perimembranous part of IVS and the mitral valve are usually intact (Fig. 4) [18].

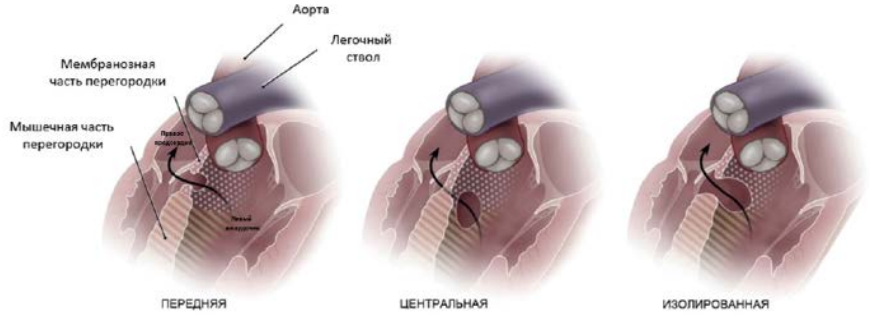

Fig. 4. The scheme of the topography of Gerbode defects

CLINICAL PICTURE

Clinical manifestations of Gerbode defect range from asymptomatic to severe heart failure. The shunt, directed from the high pressure chamber (LV) to the low pressure chamber (LP), easily overloads the pulmonary circulation, causing congestion in the lungs, up to edema. Fever, dyspnea, and peripheral edema may be associated with comorbidities, such as sepsis in endocarditis or a new coronavirus infection, which can objectively make it difficult to diagnose complications [6, 21].

It is known that the *SARS-CoV*-2 virus also damages the muscle tissue of the heart, and after infection with a new coronavirus infection, cases of severe myocarditis with a pronounced decrease in systolic function of the heart were reported, which was clinically manifested by heart failure [22, 23]. The mechanisms of myocardial involvement in the pathological process in a new coronavirus infection have not yet been verified, however, they are most likely associated with direct viral invasion, hypoxia-induced apoptosis, and cell damage in the body associated with a cytokine storm [24].

DIAGNOSTICS

Gerbode's defect is often a diagnostic problem, which is explained by its rare occurrence and visualization features [25]. Understanding the predisposing factors, anatomical and hemodynamic features, and the main echocardiographic characteristics can help in the timely diagnosis and treatment of such a complication.

Echocardiography is the primary link in the detection of an acquired Gerbode defect. Despite the high sensitivity of transthoracic echocardiography in detecting shunts, it is often difficult to distinguish left ventricular-right atrial shunt from tricuspid regurgitation flow in the presence of pulmonary hypertension. Artifacts in the area of interest from prosthetic valves further complicate the visualization of the pathological flow. Additionally, there are difficulties in identifying a direct communication between the LV and the RA. TEE helps to get reliable answers to diagnostic questions.

On the other hand, having an idea of the acquired Gerbode defect and a high level of alertness in patients with a history of cardiac surgery, diagnosis does not seem to be a very difficult task. In patients with no clinical improvement or progression of heart failure after surgery for repair of mitral and / or aortic valve disease, ablation of the atrioventricular node, endomyocardial biopsy, among other things, the described complication should be excluded.

Thus, echocardiography should pay attention to:

- atypical direction of the pathological flow in the right atrium;
- systolic-diastolic nature of the shunting blood flow;
- increased systolic pressure with normal diastolic pressure in the pulmonary artery;
— no signs of pressure overload of the right ventricle (flattening of the IVS) [20].

Other imaging modalities, such as magnetic resonance imaging, may be used in addition to echocardiography. By providing additional detailed anatomical and physiological information, it allows assessment of shunt anatomy, measurement of left and right heart volumes, and quantification of shunt blood flow [26–29].

TREATMENT

Asymptomatic, chronic, or small defects are usually an incidental finding during clinical examination and respond well to conservative therapy [30–32].

If surgical treatment is necessary, in most cases it will be sufficient to suture the defect with a continuous suture or use a xenopericardial patch or synthetic tissue. The closure of a large Gerbode defect associated with partial or complete destruction of the tricuspid valve may require reconstruction or replacement of the tricuspid valve [33]. A number of authors reported on the possibility of closing the defect with a dacron patch with reimplantation of the septal leaflet of the tricuspid valve on the patch and subsequent implantation of the annuloplastic ring [34]. *Matt* [35] suggests the use of a double-folded patch to close the defect and reconstruct the annulus and septal cusp of the tricuspid valve.

In the near future, due to the development and improvement of interventional techniques, it is likely that minimally invasive endovascular closure of the defect will become possible in patients of high surgical risk, elderly and senile, with many concomitant diseases with a small defect [36].

CONCLUSION

The acquired form of Gerbode's defect is a rare complication of cardiac surgery that usually develops in the presence of additional risk factors. In the described clinical example, the cause of the complication was active infective endocarditis with destruction of the fibrous ring in the area of the posteromedial commissure of the mitral valve in a patient with drug addiction and chronic viral hepatitis *C*. The manifestation of the disease was masked by the course of a new coronavirus infection, which complicated and slowed down the diagnostic search.

A certain clinical vigilance is required in the appearance and / or progression of signs of heart failure in patients after cardiac surgery. A new coronavirus infection can mask the cardiac manifestations of serious complications, as well as complicate their differential diagnosis.

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