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Surgical Ventricular Reconstruction and Aortic-Coronary Bypass Grafting in a Patient with Left Ventricular Aneurysm: Case Report and Literature Review

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ABSTRACT

Heart failure (HF) is a chronic disorder in which the heart muscle is unable to pump blood effectively, resulting in an inadequate supply of oxygen and nutrients to tissues (including the heart muscle itself). With time, HF leads to ischemic heart disease (IHD), which is associated with narrowing of the coronary arteries, impaired myocardial perfusion, oxygen deficit, and damage. The article shows the case of a 69-year-old man with ischemic heart disease and left ventricular aneurysm, and multiple comorbidities such as myocardial infarction, atrial fibrillation, and previous cardiac procedures. The patient underwent surgical ventricular reconstruction (SVR) combined with coronary artery bypass grafting (CABG). The course of the operation was successful. A review of the available literature indicates that performing SVR combined with CABG can significantly improve heart function in people with ischemic cardiomyopathy. Nevertheless, these interventions carry a significant risk of complications – such as infections, bleeding, myocardial infarction recurrence, and neurological events – which limit their usefulness for many patients. New therapeutic options that include shockwave therapy (SWT), used in combination with CABG, and early use of sacubitril/valsartan treatment after CABG, have demonstrated promising results in improving the function of the heart muscle and decreased risk of re-hospitalizations.

Keywords: CABG, SVR, ischemic heart disease, cardiac failure, cardiac surgery

1. INTRODUCTION

Heart failure (HF) is a progressive clinical condition of a serious nature. Its essential feature is the progressive loss of the heart's ability to pump blood effectively, which results in inadequate tissue perfusion. Patients suffering from HF manifest symptoms such as shortness of breath, fatigue, and lower-limb edema. The disease shows a progressive tendency, with periods of symptomatic stability, interspersed

with episodes of clinical deterioration despite continued therapy (Groenewegen et al., 2020). In 2021, HF was defined as a condition caused by structural and/or functional cardiac anomalies by major scientific bodies all over the world. It is reflected in elevated levels of natriuretic peptide and/or objective evidence of pulmonary congestion, and systemic symptoms (Savarese et al., 2023). The New York Heart Association (NYHA) heart failure classification system remains widely used to assess circulatory function in patients with HF. Ischemic heart disease (IHD) is one of the main etiological factors of HF, and accounts for about 60% cases in many regions of the world (Bhattacharyya et al., 2011). Coronary artery bypass grafting (CABG) surgery remains a class I indication for patients suffering from ischemic heart failure (Ferrel et al., 2022).

HF treatment includes a variety of methods, which can be divided into several main categories. Pharmacotherapy that consists of the use of renin-angiotensin-aldosterone system inhibitors (RAASIs), including ACEIs, angiotensin receptor blockers (ARBs), and angiotensin-neprilysin receptor inhibitors (ARNIs), beta-blockers, mineralocorticoid receptor antagonists (MRAs), and Sodium-Glucose Cotransporter 2 Inhibitor (SGLT2i). CABG and percutaneous coronary intervention (PCI) come under methods used in cardiac surgery for revascularization. Methods such as left ventricular assist devices (LVADs) and mechanical circulatory support (MCS) provide mechanical support for circulation. Surgical treatment methods also include ventricular reconstruction (SVR) and aortic valve replacement. Patients in the most severe condition sometimes require a heart transplant (Greene et al., 2023).

Surgical ventricular reconstruction (SVR) is a procedure that aims to control unfavorable left ventricular remodeling by eliminating the dyskinetic and scarred portion of the ventricle, preventing further dilation, and restoring normal ventricular geometry. The goal of SVR is to reduce left ventricular volume and restore its physiological, elliptical shape, thereby improving EF. This procedure, along with its modifications, was pioneered by Cooley, Dora, and Jatene, with the most used technique being the Dora procedure, also known as endoventricular valvular patch plasty (EVCPP). SVR is commonly performed in conjunction with CABG in patients suffering from severe left ventricular dysfunction, secondary to coronary artery disease (Fujii et al., 2004).

2. CASE REPORT

A 69-year-old man with IHD, hypertension, systemic atherosclerosis, dyslipidemia, and overweight was admitted to the Cardiac Surgery Clinic for surgery, including SVR and CABG of the right coronary artery (RCA). The patient had a history of CCS II (Canadian Cardiovascular Society II), NYHA II (New York Heart Association II), and atrial fibrillation. He had a history of myocardial infarction (2016) and percutaneous coronary angioplasty of the anterior interventricular branch (PCI LAD - Percutaneous Coronary Intervention Left Anterior Descending + stent) in November 2023.

Echocardiography and computed tomography revealed a large aneurysm of the inferior wall of the left ventricle (LV). LV EF was 60%. Coronary angiography revealed a significant change in the RCA. The preoperative risk according to the EuroSCORE II scale was approximately 10%. A CT angiogram of the thoracic aorta revealed extensive atherosclerotic disease involving the descending aorta, the visceral arteries, and the wall of the iliac arteries. The heart was enlarged, with a tricuspid aortic valve. A massive pseudoaneurysm measuring approximately 100x107 mm, partially thrombosed, with a 44x63 mm portal was visualized in the posterior-inferior portion of the left ventricular wall, below the mitral valve annulus. The main vascular trunks branching from the aortic arch were patent, with small calcified atherosclerotic plaques. Calcified atherosclerotic plaques with stenoses of up to 50% were found in the bulbs of both internal carotid arteries. The left common iliac artery had a short (2.5 mm) dissection, likely due to atherosclerotic ulceration. A small amount of fluid was found in the pericardial sac. The image from the CT angiography with a visible atherosclerotic process is shown in Figure 1.

During surgery, the patient underwent a median sternotomy, and the saphenous vein was harvested from the lower limb. Extracorporeal circulation was established by cannulating the superior and inferior vena cavae and the ascending aorta. The aorta was clamped, and Del Nido cardioplegia was administered. The LV aneurysm was opened, leaving the distal portion attached to the pericardial sac after removal of the organized thrombus. A Double Stretch patch was used to reduce the ventricle, and the LV was then sutured over the patch. A bypass was created to the right ventricular branch (RVB) from the RCA. The aorta was unclamped, and the saphenous vein was anastomosed to the aorta with Prolene 6.0 sutures. The patient was removed from extracorporeal circulation without complications. Protamine was administered and decannulated. Following the achievement of hemostasis and the placement of two mediastinal drains, the chest was closed in layers. Temporary cardiac pacing electrodes were retained. Transesophageal echocardiography (TEE) showed mild mitral regurgitation. The operation lasted 215 minutes and was completed successfully. A Foley catheter was inserted because of urinary retention. In next step, the patient started taking VKA (Vitamin K Antagonist) therapy for

three months, with the option of switching to a NOAC (Non-Vitamin K Antagonist Oral Anticoagulant), or discontinuing anticoagulation if there are no longer clinical indications.

Fig. 1. Angio-CT with visualized atherosclerotic process

On the fifth day after surgery, echocardiography results were as follows: IVS (Interventricular Septum) 10/14 mm, LV 64/56 mm, PW (Posterior Wall) 10/14 mm, Ao root (Aortic Root) 39 mm, LA (Left Atrium) 47 mm, EF 34%. Mitral valve: V max 11 m/s, A 0.87 m/s. Aortic valve: V max 1.43 m/s, P max 8 mmHg. The patient was in good general condition, with good respiratory and circulatory function, and was discharged home on the eighth day after the procedure with the following recommendations: acetylsalicylic acid (enteric-coated tablets) 75 mg 1x1, amlodipine (tablets) 5 mg 2x1, enoxaparin (solution for injection in a pre-filled syringe) 60 mg/0.6 ml (6000 IU) 2x1, torasemide (tablets) 5 mg 1x1, ezetimibe + rosuvastatin (tablets) 20 mg + 10 mg 1x1, clonidine (tablets) 70 mcg 3x2, nebivolol (tablets) 5 mg 1x1, tamsulosin (prolonged-release capsules) 400 mcg 1x1, valsartan (tablets coated) 160 mg 2x1, warfarin (tablets) 5 mg. The patient was referred to the cardiac rehabilitation department.

3. DISCUSSION

In the presented case of a 69-year-old man who suffered from coronary artery disease and a left ventricular aneurysm, the use of surgical SVR and CABG yielded significant clinical benefits. The patient, who has experienced a myocardial infarction, atrial fibrillation, and prior cardiac interventions, underwent a successful procedure without any complications. The results of this procedure are consistent with previous studies that demonstrated the benefits of SVR in enhancing myocardial function and improving overall patient outcomes in individuals with coronary artery disease. A meta-analysis including 7,685 patients showed that combining SVR with CABG leads to a significant increase in left ventricular EF and reduced symptoms of heart failure (Ferrell et al., 2022).

In the presented case, although the preoperative EF was 60%, it declined to 34% postoperatively– most likely due to early cardiac remodeling after the surgery. Cardiac surgical procedures such as SVR and CABG are associated with the risk of serious complications like bleeding, infection, myocardial infarction, and neurological events. Intraoperative aneurysm rupture remains the most critical risk factor for patients with LV aneurysms and may result in severe clinical exacerbation (Rivinius et al., 2023). Results from the STICH study have raised concerns about the long-term effectiveness of SVR combined with CABG, as no statistical advantage regarding survival or cardiac-related rehospitalization rates over CABG alone was found. This has contributed to a decline in the use of SVR (Buckberg et al., 2009). Nevertheless, many contemporary studies — including those by Yang and colleagues — continue to highlight the value of SVR in carefully selected patient groups (Yang et al., 2023). Evaluating international revascularization guidelines, Lawton and colleagues highlight the importance and necessity of individualizing therapy based on individual patients' profiles and current clinical evidence. Consequently, the decision to perform the SVR must involve a careful balancing of anticipated surgical advantages

versus the inherent procedural risks (Lawton et al., 2022). Furthermore, data from the CAST-HF trial demonstrated that SWT further enhances myocardial function, which may lead to better clinical outcomes (Holfeld et al., 2024). Additionally, early initiation of sacubitril/valsartan after CABG has the potential to support myocardial recovery and reduce the risk of rehospitalization (Nurzhanova et al., 2024). According to the 2021 ACC/AHA/SCAI guidelines, CABG remains the gold standard for the treatment of ischemic heart disease, complicated by HF.

4. CONCLUSION

Based on our patient report and a review of the available literature, we can confirm that SVR combined with CABG is an effective treatment for HF caused by IHD and left ventricular aneurysm, providing significant benefits in terms of optimizing hemodynamic function and alleviating heart failure symptoms. However, these procedures relate to risks of complications that should be considered before deciding on a potential surgical procedure. Alternative methods, such as SVR and early use of sacubitril/valsartan after CABG, may be valuable adjunctions to standard procedures. Further research is necessary to better understand the long-term benefits and risks of SVR combined with CABG and to fully evaluate the long-term efficacy and safety of alternative methods.

Abbreviations:
HF – heart failure
IHD – ischemic heart disease
CABG – Coronary Artery Bypass Grafting
SVR – Surgical Ventricular Reconstruction
EF – Ejection Fraction
IVS - Intraventricular Septum
RAASi – Renin Angiotensin Aldosterone System inhibitor
ACEI – Angiotensin Converting Enzyme Inhibitor
ARNI – Angiotensin-Neprilysin Receptor Inhibitors
ARB – Angiotensin Receptor Blocker
MRA – Mineralocorticoid Receptor Antagonists
SGLT2i – Sodium Glucose Cotransporter 2 Inhibitor
PCI – Percutaneous Coronary Intervention
LVAD – Left Ventricular Assist Devices
EVCPP – Endoventricular Patch Plasty
RCA – Right Coronary Artery
CCS – Canadian Cardiovasculary Society
NYHA – New York Heart Association
LV – Left Ventricle
Angio-CT – Computed Tomography Angiography
RVB – Right Ventricular Branch
TEE – Transesophageal Echocardiography
VKA – Vitamin K Antagonist
NOAC – Non-Vitamin K Antagonist Oral Anticoagulation
Ao root – Aortic root

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Conflict of interest
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Data and materials availability
All data associated with this study will be available based on the reasonable request to corresponding author.

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