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A Dual Atrioventricular Approach to Repair Pseudoaneurysm after Mitral Valve Surgery

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Abstract

Background Left ventricular pseudoaneurysm (LVPA) is an uncommon but potentially fatal complication following atrioventricular groove rupture.

Case Description We present a patient with a massive LVPA involving the lateral commissure and under the mitral P3 segment following coronary artery bypass grafting and mitral valve (MV) repair. MV replacement and arteriovenous pseudoaneurysm were repaired by dual approach via the left atrium with excision of the previously dehisced mitral ring to expose the defect and patch repair the atrioventricular defect through the pseudoaneurysm free wall.

Conclusion This is a rare case of a large subacute postoperative LVPA repaired by dual atrial–ventricular approach to treat a contained atrioventricular groove rupture.

Keywords

- aneurysm
- coronary artery bypass grafting
- CABG
- heart
- mitral valve surgery
- surgery
- complications

Introduction

Left ventricular pseudoaneurysms (LVPA) can develop following a cardiac rupture contained by scar tissue or pericardial adhesions without hemopericardium.[1] LVPAs consist of fibrous tissue, but lack endocardium and myocardium, and are therefore defined as false or pseudoaneurysms.[2] In most cases, myocardial free wall rupture leads to rapid cardiac tamponade and death; however, a LVPA may form and prevent massive hemorrhage.[1] Unfortunately, pseudoaneurysms are unstable and are prone to fatal rupture.[3] LVPA has several known etiologies including transmural acute myocardial infarction (MI) and cardiac surgery (approximately one-third of cases) but most notably happen after mitral valve replacement (MVR).[1] The incidence of LVPA following MVR is ∼0.02 to 2.0%.[3] While cases of LVPA can be asymptomatic and discovered incidentally, symptomatic cases present with congestive heart failure (36%), chest pain (30%), and dyspnea (25%).[1] We describe a patient with a medical history of carotid endarterectomy, MI who underwent two-vessel coronary artery bypass grafting (2× CABG) and mitral valve repair who developed a massive submitral LVPA.

Case Presentation

A 61-year-old man with a 20-year smoking history and peripheral arterial disease presented to his regional hospital with left lower extremity weakness, aphasia, and worsening dyspnea. Magnetic resonance imaging (MRI) confirmed right middle artery cerebral stroke as well as 85% stenosis of the right internal carotid artery (ICA). An uptrending troponin-I to 3.510 ng/mL prompted the diagnosis of non-ST elevation myocardial infarction and immediate cardiac catheterization followed. Cardiac catheterization revealed 70% left main coronary artery stenosis and complete occlusion of the distal right coronary artery. Two days after catheterization, the patient went for right ICA endarterectomy and two-vessel CABG with left internal mammary artery (LIMA) to left

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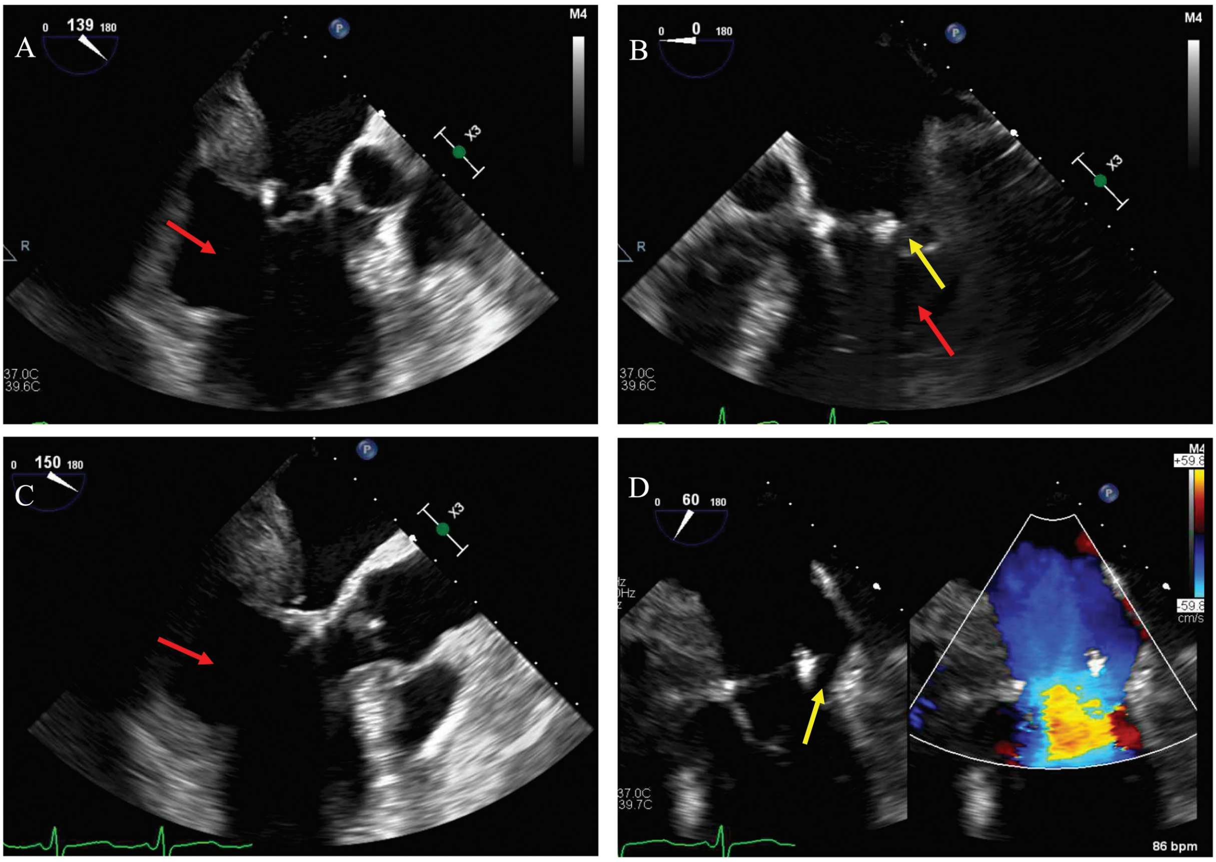

Fig. 1 Preoperative transesophageal echocardiograms. Pseudoaneurysm (red arrow) and dehisced mitral ring (yellow arrow). Panels (A) to (D) Transesophageal echocardiograms 5 days prior to final surgical intervention.

anterior descending artery and saphenous vein graft to obtuse marginal along with mitral valve repair with a 28-mm annuloplasty Physio II Ring (Edwards Lifesciences, Irvine, California, United States). The patient was supported with inotropes, vasopressors, and intra-aortic balloon pump postoperatively.

On postoperative day 6, a chest computed tomography scan performed due to respiratory distress revealed a potential LVPA. Subsequent transesophageal echocardiography (TEE) identified an outpouching of the basal inferolateral left ventricular wall as well as a supra-annular and posterolaterally dehisced mitral annuloplasty ring. The patient was subsequently transferred to our institution, where noncontrast cardiac MRI confirmed the finding and identified a significant amount of layered thrombus. A repeat TEE at our institution further characterized the dehisced mitral ring as well as the LVPA contained by the posterolateral pericardium (►**Fig. 1**). The patient subsequently underwent redo sternotomy for repair of the LVPA repair along with MVR (►**Fig. 2**).

During surgery, the right ventricle was found to be densely adhered to the sternum likely from severe pericarditis due to residual intrapericardial blood. The LIMA was identified and prepared for temporary occlusion during the cardioplegic arrest. After standard bicaval cardiopulmonary bypass was established and cardioplegic arrest, the left atrium was opened, and the mitral valve was inspected. The dehisced annuloplasty ring was removed, and the whole posterior leaflet was detached from the annulus. The LVPA neck measuring 8×6 cm was identified under the P3 area of the annulus and extending toward the lateral commissure. The anterior leaflet was detached from the annulus, and while preserving all chords, the A2 segment was divided in the middle separating it into medial and lateral portions in preparation for total chordal-sparing MVR. Given that the pseudoaneurysm defect was much larger than the orifice of the mitral valve, it was apparent that bovine patch repair via intracardiac approach would not be feasible even if all mitral leaflets were detached. We therefore decided it was necessary to patch the pseudoaneurysm via an external approach. The $12 \times 10 \times 9$ cm pseudoaneurysm was first exposed and incised. Subsequently, a large amount of thrombus was removed with great care to avoid any fragmentation. The pseudoaneurysm wall was then carefully cleaned of all thrombi with high power suction with an open-ended tip (►**Fig. 3A**). The neck of the pseudoaneurysm was patched on the posterior aspect of the heart using a bovine pericardium patch and sewn to the underside of the mitral annulus extending to the anterior and medial aspects of the ventricle (►**Fig. 3C**). The remaining flaps of the pseudoaneurysm were excised and closed by suture.

In repairing the mitral annulus, chordae tendineae were spared to support the posterior annulus with parts of the anterior and posterior leaflets and to maintain left ventricular structure. Pledgeted sutures in a noneverting manner

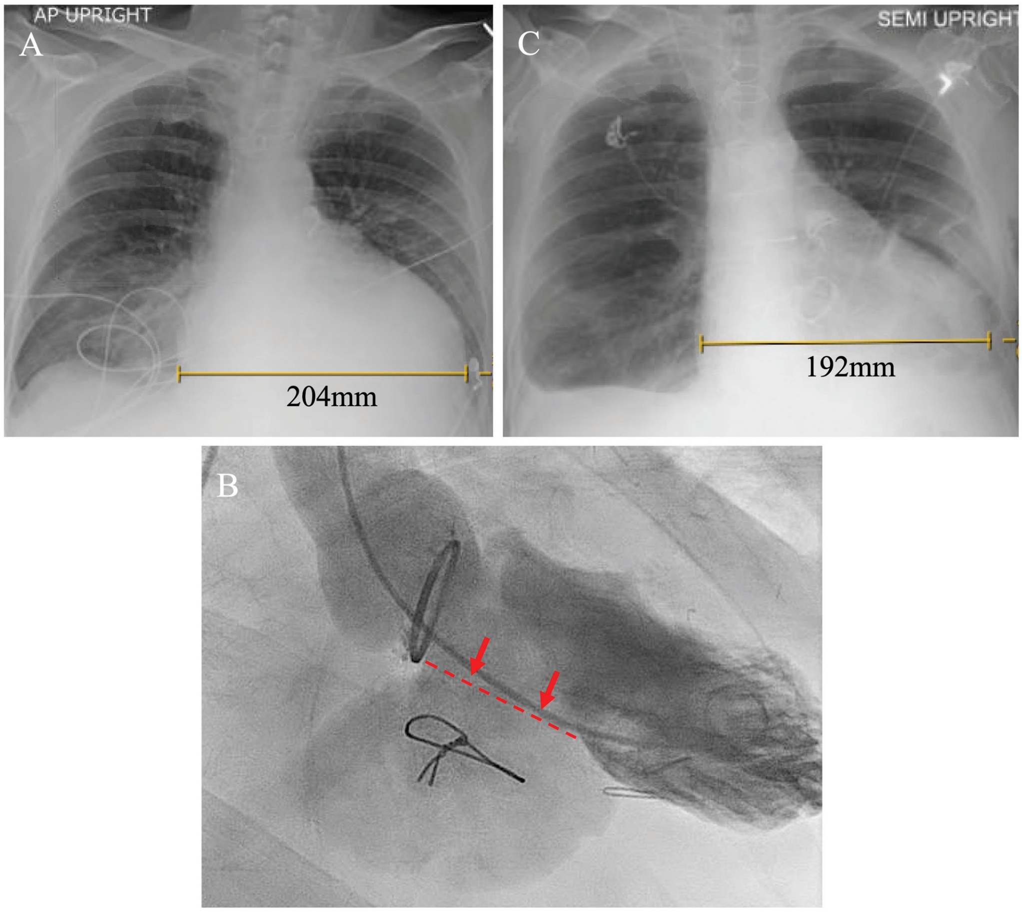

Fig. 2 Preoperative chest X-ray, preoperative coronary angiogram, and postoperative chest X-ray. Pseudoaneurysm (red arrow). Panels (A) and (C) Improvement in cardiac maximal dimensions between preoperative day 12 (A) and postoperative day 23 (C) with a reduction in cardiomegaly. Panel (B) Left heart coronary angiogram with dashed line delineating pseudoaneurysm neck.

were placed from the ventricular side to the atrial side at the level of the A3–P3 commissure (►**Fig. 3D**). Sutures were placed through the patch and the annulus was sized to accommodate a new 29-mm pericardial Magna Valve (Edwards Lifesciences). The sutures were secured, and the atrium was closed. The cross-clamp time was 180 minutes, and total cardiopulmonary bypass time was 267 minutes. Final postoperative TEEs confirmed successful closure of the LVPA, normally functioning mitral valve prosthesis, and an ejection fraction of 50%.

Discussion

LVPAs are classified into either acute or chronic dependent on formation from an inciting event, such as surgery or MI. An acute LVPA develops within 2 weeks, while a chronic LVPA develops at least 3 months after the inciting event.[3] Acute cases, due to the high likelihood of fatal rupture, are typically managed by urgent surgical repair, whereas the management of chronic pseudoaneurysm is driven by symptomatology and anatomic characteristics. Elective surgical repair is indicated for symptomatic cases. For asymptomatic cases, expanding LVPAs with a diameter more than 3 cm should undergo elective surgical repair given the increased risk of expansion and rupture. Stable LVPAs less than 3 cm in diameter should undergo surveillance. Aside from these guidelines, studies have indicated that narrow neck LVPAs may spontaneously resolve and be treated medically with dual antiplatelet therapy, statins, β-blockers, and diuretics.[4–6] Therefore, medical management may be a viable option for patients with chronic small stable LVPAs or patients for which surgical intervention is too high risk. Surgical repair has a 23% mortality rate; however, the risk of rupture from untreated LVPAs is 30 to 45% and may be as high as 50% at 2 years, which often drives the decision to pursue surgical intervention.[1,7] Ultimately, surgery is the optimal decision for large LVPAs, such as in our patient's case of a LVPA developing after MVR.

Along with the substantial risk of rupture, pseudoaneurysms produce a highly thrombogenic environment with a stroke risk from thromboembolism.[8] Moreno et al found the risk of stroke in untreated LVPA to be 10% at 1 year and 32% at 4 years.[9] In large LVPAs with preexisting thrombi masses, the risk of acute thromboembolism is even greater. As in our patient, a significant amount of time was taken to adequately remove the thrombogenic clot from the walls of the aneurysm prior to patching the LVPA. Aortic cross-clamping was critical to prevent mobilization of thrombi prior to dissection of the pericardial-pseudoaneurysm adhesions, debridement, and vacuum suction of thrombi located within the internal

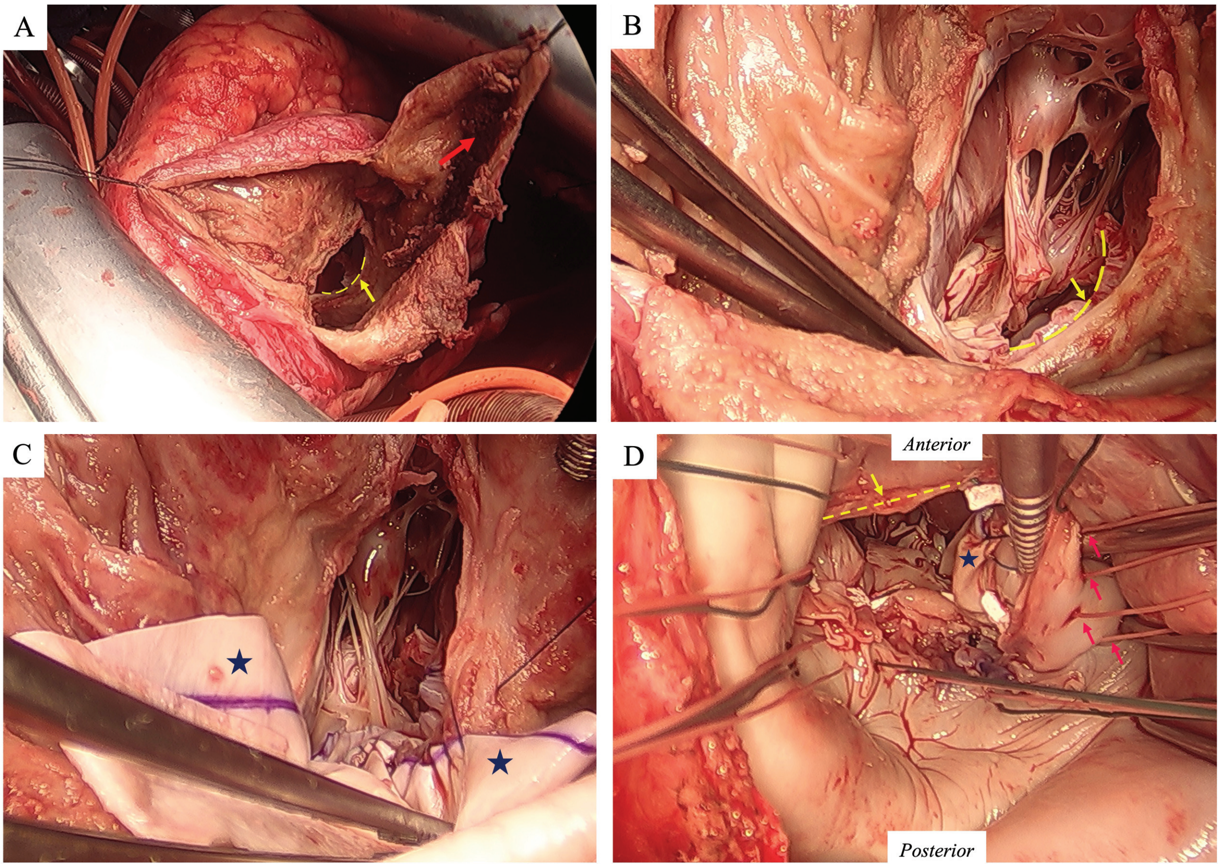

Fig. 3 Intraoperative repair of the pseudoaneurysm. Panel (A) Pseudoaneurysm neck (yellow arrow) and pseudoaneurysm sack (red arrow). Panel (B) Cut anterior leaflet of mitral valve (dashed yellow line). Panel (C) Bovine pericardial patch (blue stars). Panel (D) Surgeon's view: anterior annulus (dashed yellow line), patch (blue star), and noneverting pledgeted annular sutures (red arrows).

aspect of the pseudoaneurysm. Once embolization risk has been reduced by the aforementioned techniques, surgical resection, and patching of the pseudoaneurysm follows.

The main approaches for cardiac pseudoaneurysm repair include internal transmitral endocavitary resection and external resection. The chosen surgical approach is driven by the position of the pseudoaneurysm and the underlying pathology. Pseudoaneurysms developing after MVR tend to occur in the posterior subannular region of the mitral valve in the left ventricle.[2] The transmitral approach is advantageous in instances in which MVR is necessary and has been utilized in numerous chronic LVPA cases attributed to MVR or MI.[10–13] Furthermore, the approach may be ideal in higher risk patients, as hemorrhage following external pseudoaneurysmal adhesion removal and pseudoaneurysm partial resection is mitigated. In the transmitral approach, the neck of the aneurysm is closed with a prosthetic patch and the ventricular patch can be used in the reconstruction of the mitral annulus during MVR, thus providing further stability to the new mitral valve.[13] We first attempted to pursue the transmitral approach with cardiopulmonary bypass (due to the large aneurysm size); however, the mitral annulus measured less than 3 cm, which was too small to pass the patch through to complete an endocavitary repair. Therefore, we preceded with a hybrid external–internal resection approach. External repair of the LVPA, located at the A3–P3 mitral valve area, was challenging because the edges of the pseudoaneurysm extended up to the mitral valve annulus and atrioventricular junction; however, we were able to sew the bovine pericardial patch under the mitral annulus.

In contrast, the external approach is beneficial if the existing prosthetic mitral valve does not require explantation when functioning properly with minimal regurgitation.[14] The first prosthetic mitral valve in our case was identified to have mild mitral regurgitation on cardiac MRI but demonstrated posterolateral dehiscence necessitating its removal. The dehiscence likely triggered LVPA development. The external approach is further required in the presence of a small mitral annulus, such as in our case. A variation on the external approach through the coronary sinus was documented by Guo et al, in which a LVPA developed near the coronary sinus, moderately compressing the coronary sinus, and could not be located on the epicardial surface.[15] To prevent explantation of a functioning mitral valve prothesis, a coronary sinus incision was performed to access the LVPA under the posterior annulus at the posterior commissure near the coronary sinus. The authors note that this approach is not suited for large LVPAs located further from the coronary sinus, as in our patient.

Our patient is alive at the time this case report was written and was referred for outpatient cardiac rehabilitation. Despite the high-risk nature of the patient's condition, we were able to successfully repair the patient's LVPA and replace the mitral valve without any further complications. Early identification of the LVPA using TEE proved essential in the rapid evaluation of the patient's pseudoaneurysm. While cardiac MRI was particularly useful in identifying thrombogenic clots within the LVPA, mitral valve dehiscence, and additional pseudoaneurysm features, TEE is ideal for primary evaluation and screening for LVPA. With the high mortality associated with pseudoaneurysms and low cost and ease of TEE use, screening for pseudoaneurysms prior to discharge and at follow-up for cardiac surgery and MI may be warranted.

Conclusion

Acute atrioventricular ruptures are known to be fatal, especially in the case of a reoperative event. We present a patient with a history of carotid endarterectomy, 2x CABG, mitral valve endocarditis, MI, and MVR who developed a delayed atrioventricular rupture that formed as a LVPA extending from the posterior mitral annulus to the atrioventricular junction. The LVPA was repaired through a unique dual approach: the pseudoaneurysm was externally incised, debrided, and suctioned before a bovine patch was internally sewn under the posterior mitral annulus with the existing mitral leaflets and chordae for additional annular reinforcement prior to MVR. Given that LVPA mortality is acutely high, we propose immediate medical management followed by surgical intervention in the subacute period, when possible, to improve patient survival.

Conflict of Interest
None declared.

References

1. Frances C, Romero A, Grady D. Left ventricular pseudoaneurysm. J Am Coll Cardiol 1998;32(03):557–561
2. Yeo TC, Malouf JF, Oh JK, Seward JB. Clinical profile and outcome in 52 patients with cardiac pseudoaneurysm. Ann Intern Med 1998; 128(04):299–305
3. Prêtre R, Linka A, Jenni R, Turina MI. Surgical treatment of acquired left ventricular pseudoaneurysms. Ann Thorac Surg 2000;70(02):553–557
4. Inoue T, Hashimoto K, Sakamoto Y, et al. Spontaneous closure of a large left ventricular pseudoaneurysm after mitral valve replacement. Gen Thorac Cardiovasc Surg 2016;64(06):337–339
5. Li X, Wang Y, Wang D, Lai C, Wang C. The evolution of left ventricular pseudoaneurysm from the rupture of left ventricular free wall following acute myocardial infarction: a case report. BMC Cardiovasc Disord 2020;20(01):5
6. Mathur M, Gupta S. Cardiac pseudoaneurysm- a death defying entity. J Clin Diagn Res 2016;10(06):TD06–TD07
7. Csapo K, Voith L, Szuk T, Edes I, Kereiakes DJ. Postinfarction left ventricular pseudoaneurysm. Clin Cardiol 1997;20(10):898–903
8. Nassenstein K, Bruder O, Breuckmann F, Erbel R, Barkhausen J, Schlosser T. Prevalence, pattern, and functional impact of late gadolinium enhancement in left ventricular hypertrophy due to aortic valve stenosis. Röfo Fortschr Geb Röntgenstr Neuen Bildgeb Verfahr 2009;181(05):472–476
9. Moreno R, Gordillo E, Zamorano J, et al. Long term outcome of patients with postinfarction left ventricular pseudoaneurysm. Heart 2003;89(10):1144–1146
10. Hiraoka A, Kuinose M, Chikazawa G, Yoshitaka H. Endoscopic repair for left ventricular pseudoaneurysm with right minithoracotomy. Interact Cardiovasc Thorac Surg 2013;16(01):85–87
11. Honda K, Okamura Y, Nishimura Y, Hayashi H. Patch repair of a giant left ventricular pseudoaneurysm after mitral valve replacement. Ann Thorac Surg 2011;91(05):1596–1597
12. Min SK, Sir JJ, Nah JC, Kim YI. Successful resection of a giant left ventricular pseudoaneurysm developed later after mitral valve replacement. J Korean Med Sci 2010;25(07):1080–1082
13. Ricci M, Greene T, Salerno TA. Transmitral endoventricular repair of left ventricular pseudoaneurysm following mitral valve replacement. J Card Surg 2002;17(01):75–78
14. Hirasawa Y, Miyauchi T, Sawamura T, Takiya H. Giant left ventricular pseudoaneurysm after mitral valve replacement and myocardial infarction. Ann Thorac Surg 2004;78(05):1823–1825
15. Guo HW, Xu JP, Chang Y, Xiong H. Coronary sinus approach to repair an intracardiac ventricular pseudoaneurysm. J Card Surg 2012;27(06):692–695

