Closure of an Iatrogenic Ventricular Septal Defect Using a Hybrid Approach and Echocardiographic Guidance

Abstract

Treatment of postsurgical iatrogenic ventricular septal defects (VSDs) remains a challenge. Surgical closure is associated with significant morbidity and mortality. A peripheral accessed percutaneous approach is faced with difficulties of gaining adequate access and complex positioning in a beating heart. We report a case of using a hybrid approach to treat iatrogenic VSD with surgical right atriotomy and delivery of an Amplatzer system under direct visualization and transesophageal echocardiography guidance.

Keywords: *Postoperative complications, septal occluder device, ventricular septal defect*

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Introduction

The presence of hemodynamically significant ventricular septal defect (VSD) after cardiac surgery can result in the right ventricular (RV) volume overload with signs and symptoms of heart failure. Closure of the VSD is needed to prevent sequelae such as ventricular dysfunction, arrhythmias, endocarditis, and pulmonary hypertension.

The treatment of postsurgical iatrogenic VSDs remains a challenge. Surgical closure is associated with significant morbidity and mortality, especially in adults who have undergone prior sternotomy. The occurrence of VSD following septal myectomy is rare with reported incidence between 0% and 2%.[1] In these patients, the ventricular septal tissue quality might be poor due to purposeful prior resection and patch repair could be challenging. Peripheral accessed percutaneous VSD closure is a viable alternative to surgery. However, gaining adequate access and the complex positioning of Amplatzer septal defect closure system (St. Jude Medical Inc., Saint Paul, MN, USA) might prove difficult in a beating heart. We report a case of using a hybrid approach to treat iatrogenic VSD with surgical right atriotomy and delivery of Amplatzer system under direct visualization and transesophageal echocardiography (TEE) guidance.

Case Report

The patient is 50-year-old Caucasian female with a history of hypertrophic cardiomyopathy. She presented with complaints of worsening shortness of breath, dyspnea on exertion, and near syncope. Her other medical history includes hypertension, gastroesophageal reflux disease, and asthma. Preoperative TEE revealed subaortic stenosis with a peak gradient of 42 mmHg and septal hypertrophy. Cardiac catheterization revealed normal coronary arteries with an ejection fraction of 60%.

She was offered alcohol septal ablation but elected to receive extensive transaortic septal myectomy with two bypass runs, and TEE showed no septal defect, peak gradient across the left ventricular outflow tract at 3 mmHg in the operating room. The patient later became progressively hypotensive requiring vasopressor support and remained hypoxic in the intensive care unit (ICU). Bedside TEE showed a new VSD about 14 mm in size with left to right shunt and lay behind the septal leaflet of the tricuspid valve [Figure 1]. The patient was taken back to the operating room emergently. The delayed presentation of VSD was unclear and might be related to damage to the perforator artery of the septum and continued myocardial infarction led to the creation of VSD. Bovine pericardium patch repair was attempted to fix this defect surgically unsuccessfully after multiple

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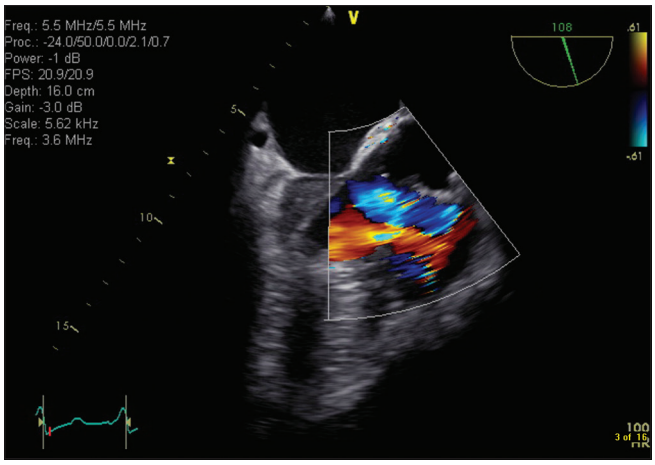

Figure 1: Bedside transesophageal echocardiography showed a 14 mm ventricular septal defect with left to right shunt

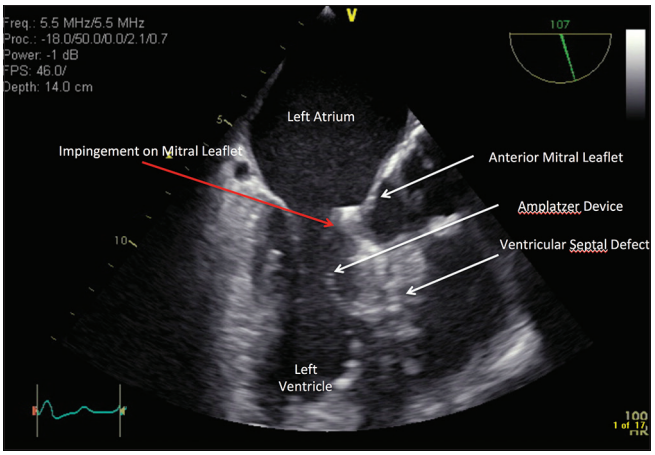

Figure 2: The 24 mm Amplatzer device impinged on the anterior mitral leaflet, causing restriction of motion

cardiopulmonary bypass runs. Extracorporeal membrane oxygenation (ECMO) was initiated, and the patient was transferred to ICU in a critical condition.

Interventional cardiology was consulted for the possible transcatheter closure of the defect, and the patient was taken to the cardiac catheterization laboratory. Amplatzer muscular 14 mm VSD closure system was attempted through the right femoral vein without success utilizing a purely transcatheter technique. The following deployment of the RV disc, tugging on the device resulted in dislodgement of the device, indicating most likely a tear of the pericardial patch. Due to the paucity of surgical options available, it was determined that a hybrid approach with direct visualization of the VSD and transcatheter closure would be tried.

In the operating room, a right atriotomy was created to expose the VSD by the surgeon without removing tricuspid leaflets. Because of the large defect size, the much larger Amplatzer atrial septal defect closure device was attempted. Initially, a 14 F sheath with a 24 mm AMPLATZER® atrial septal occluder was inserted through the right atriotomy across the VSD under TEE guidance. On deployment of the left and RV discs, the delivery cable was left attached to the system while the surgeon closed the right atriotomy. TEE revealed severe mitral regurgitation due to impingement on the anterior leaflet of the mitral valve from the left ventricular disc [Figures 2 and 3]. This device was retrieved and a smaller 18 mm AMPLATZER® atrial septal occluder was deployed. The right atrium was again closed over the cable so that we could visualize the device within the filled heart. TEE revealed good placement of the closure device with neither perturbation of the anterior mitral leaflet and nor the aortic valve in two-dimensional and three-dimensional (3D) [Figures 4, 5 and Supplementary Video 1]. The delivery cable was released from the device and TEE revealed only trace basal inferior communication left [Figure 6]. The ECMO was turned off temporarily during TEE evaluations to detect any shunts or regurgitations by color Doppler. Unfortunately, she still required full ECMO support for a prolonged period of time in the ICU. The family decided to withdraw care, and she died on postoperative day 14.

Discussion

Surgical closure of VSD carries risks of the complete atrioventricular block, residual shunt, and wound infection. Percutaneous closure of congenital or iatrogenic VSDs has been performed since the late 1980s with reasonable success in both pediatric and adult populations.[2] The catheter-based approach has been shown to be a viable alternative to surgical closure.[3] Complications from the percutaneous approach include cardiac arrhythmia, valvular regurgitation as a result of impingement of the occluder on the valve leaflets or chordae tendineae, which may cause acute aortic, mitral or tricuspid regurgitation.

Transcatheter closure of postoperative iatrogenic VSDs has been reported mainly in patients who have had VSD closure surgery. These cases are significantly different from VSDs after myectomy for hypertrophic cardiomyopathy such as in our patient, in which the defect is surrounded by relatively thick and friable myocardium. This could be the reason that our patient had multiple failure with patch repair and torn each time.

Review of literature found six reported cases of iatrogenic VSD after septal myectomy, which were treated with transcatheter techniques.[4-9] In all these cases, the occluder device was delivered antegradely via the femoral vein or internal jugular vein. Our case reported successful closure of an iatrogenic VSD through right atriotomy with a hybrid approach utilizing an atrial septal defect closure device. Initial attempt to percutaneously close the defect proved to be futile as the size of the large defect precluded optimal deployment of Amplatzer VSD closure device. In addition, our patient had a very complex iatrogenic VSD in a severely compromised heart. Precise positioning and

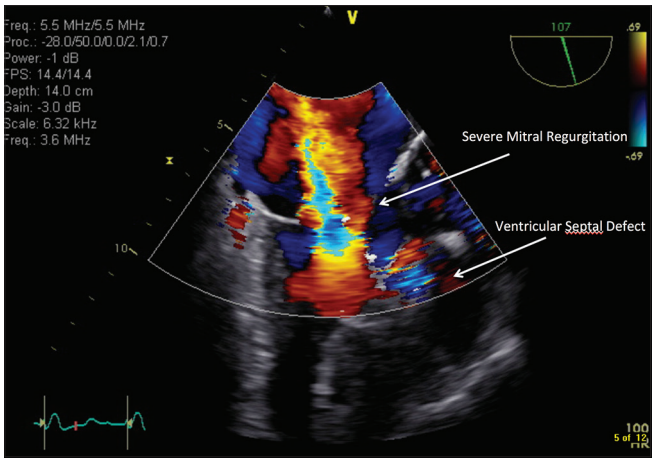

Figure 3: Impingement by the Amplatzer device caused severe mitral regurgitation

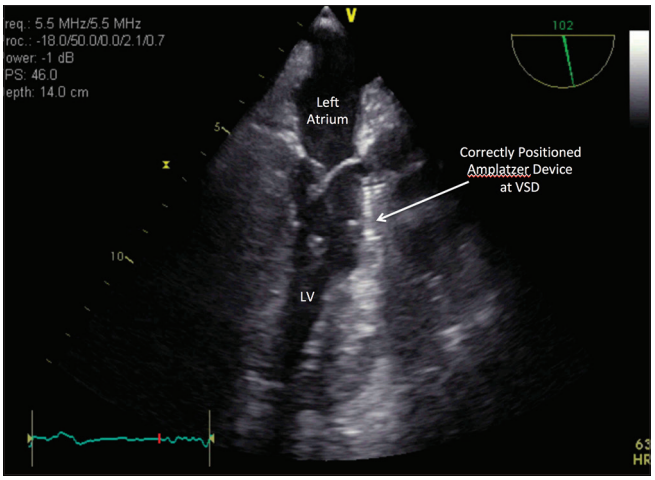

Figure 4: The Amplatzer device is correctly positioned at the ventricular septal defect without mitral leaflet impingement. LV: Left ventricle, VSD: Ventricular septal defect

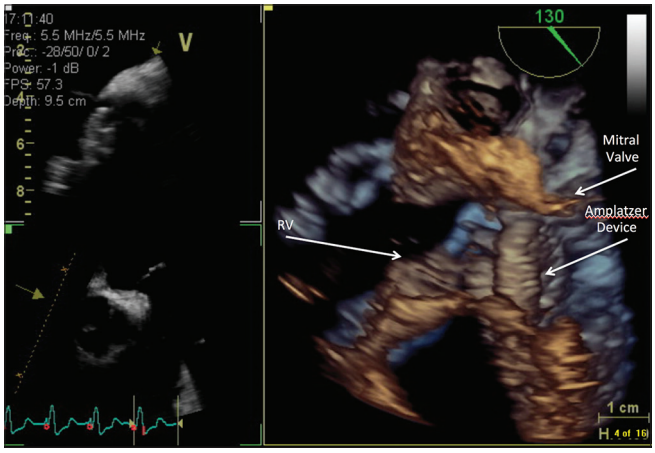

Figure 5: Three dimensional view of correctly positioned Amplatzer device

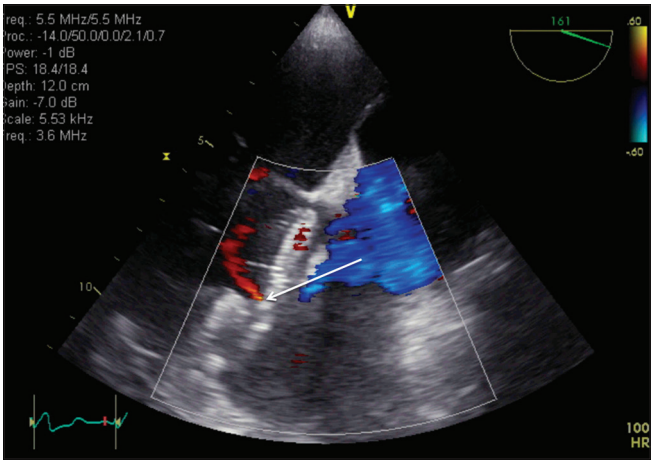

Figure 6: Trace residual interventricular septal defect (arrow) after successful deployment of Amplatzer device

careful deployment are absolutely required. To maintain a still operative field for accuracy and speed, we went on cardiopulmonary bypass and created a right atriotomy for direct visualization and access.

The Amplatzer muscular VSD occluder is the only device available for transcatheter closure of a VSD in the United States. The sizes of the device range from 4 to 18 mm (waist diameter). Due to the large defect, the VSD occluder was too small, and we chose the much larger ASD occluder to close this defect. Eventually, the 18 mm atrial septal defect device was appropriate in this patient.

TEE guidance is critical to guide the hybrid approach closure of VSD. First, TEE can help accurately identify the shape, size, and location of the VSD. This is critical for device sizing and selection. Second, TEE can promptly diagnose Amplatzer caused complications. In our patient, the large size of atrial septal occluder impinged the anterior mitral leaflet and induced severe acute mitral regurgitation. This was only recognized with TEE. TEE-guided our second attempt to avoid mitral valve entanglement and was successful. Third, the complexity of iatrogenic VSD and the relationship with Amplatzer device can be appreciated and easily communicated with 3D echocardiography to the cardiologist. The ability to view from different perspectives is very important for the proceduralist to position the device correctly.

In conclusion, we reported a successful case of hybrid iatrogenic VSD closure with surgical exposure and real-time TEE-guided transcatheter approach to avoid complications.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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