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Case Report

# *Felt Sandwich Exclusion for Apical Multiple Muscular Ventricular Septal Defects*

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***Abstract***

***Background and Objective:*** Apical multiple muscular ventricular septal defects (VSDs) are difficult to visualize, and closing these VSDs is technically troublesome. For these reasons, the surgical outcome of the lesion is unsatisfactory. Some surgical techniques have been reported to improve the outcome, but they are not definitive.

***Case presentation:*** We present a 5-month-old infant diagnosed with atrial septal defect (ASD) and multiple muscular and perimembranous VSDs. Pulmonary hypertension (PH) due to high pulmonary blood flow was also observed. Symptoms of this patient were dyspnea and poor weight gain. The surgical treatment was needed for the patient. In the first operation during the infantile period, the patient received closure of the perimembranous and muscular VSDs through the right atrium. ASD closure was also performed. However, postoperative pulmonary blood flow was not decreased compared with that before the operation, and PH was not improved. In addition to these lesions, tricuspid valve insufficiency was also observed after the operation. Postoperative computed tomography (CT) showed channels of apical muscular VSDs in the apex of the right ventricle. Surgical re-intervention was planned to reduce pulmonary blood flow. In the second operation, the exclusion of apex muscular VSDs using the felt sandwich exclusion technique and tricuspid valve repair was performed. After closing multiple muscular VSDs during the operation, pulmonary blood flow was significantly decreased, and PH was improved as well. After the second operation, postoperative echocardiography and catheter examination showed decreased VSD shunt and reduced pulmonary blood flow, resulting in improved PH.

***Conclusion:*** Felt sandwich exclusion for apical multiple muscular ventricular septal defects may be one of the surgical options for apical muscular ventricular sepal defects.

***Keywords:*** Congenital heart disease, Acyanotic heart disease, Multiple ventricular septal defects

## Introduction

Surgical treatment for apical muscular ventricular septal defects (VSDs) remains challenging because there are many variations in the location of the VSDs. It is also hard to visualize these VSDs, and the optimal procedure for closing VSD should be adopted. Closing muscular VSD using the transatrial approach through the tricuspid valve may be difficult, especially in small-body patients. Some surgical closing techniques for the VSDs, including the felt septal sandwich technique and direct closure through the right ventriculotomy, have been reported, but the outcomes of these techniques for the lesion are also not definitive.[1-3] In this report, we present the clinical case of a patient who received effective surgical treatment for apical muscular VSDs.

## Case Presentation

A 5-month-old girl with symptoms of tachypnea and poor weight gain who weighed 4.98 kg had been diagnosed with perimembranous and small muscular

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VSDs, atrial septal defect (ASD), and pulmonary hypertension (PH) due to high pulmonary blood flow. Prior to the surgery, there was a small muscular VSD, and shunt flow through the muscular VSD was estimated little in the preoperative echocardiographic image. This patient received transarterial VSDs closure, both perimembranous and muscular, as well as ASD closure. However, residual muscular VSDs were revealed, and catheter examination showed Qp/Qs of 2.4 and sustained PH after the first operation. By closing perimembranous VSD, ventricular blood shunt flow through the muscular VSDs increased, which was not distinct before the first operation, and PH was persistent. The second surgical procedure to control pulmonary blood flow was mandatory. Apical muscular VSDs exclusion closure was planned as a second operation almost 2 months after the first operation. Before the surgery, we estimated the location of the VSDs channels in the cardiac apex using CT (Figure 1) and localized the part of the exclusion area during the surgery. In the second operation, we established cardiopulmonary bypass (CPB). On the beating heart, the location of apical muscular VSDs was estimated depending on the esophageal echocardiographic image. The cardiac apex was squeezed with forceps, and the disappearance of the VSDs shunt was confirmed in the esophageal echocardiographic image. After a cardiac arrest was obtained in the routine method. Through the right atriotomy, VSD closure was tried. The apical muscular VSDs were not visualized via a tricuspid valve, and closing the VSDs through the right atrium was technically impossible. To exclude the muscular VSDs, we performed the felt sandwich exclusion technique on the cardiac apex where channels of VSDs were located (Figure 2).

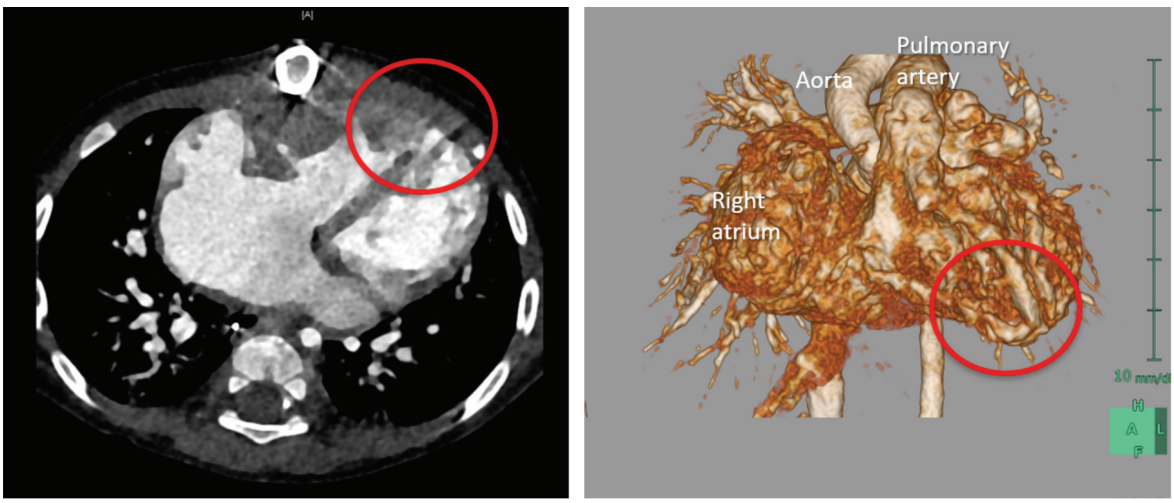


**Figure 1** Computed tomography image showing the channels of the muscular ventricular septal defects in the apex of the right ventricle (red circle)

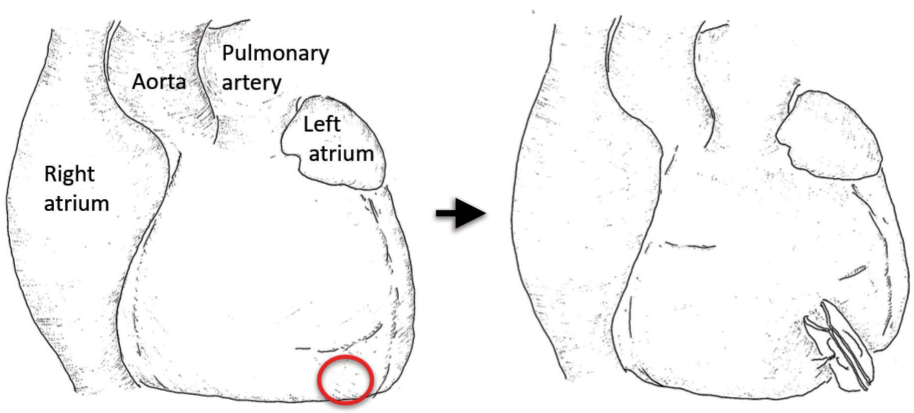


**Figure 2** Cardiac apex (red circle) was excluded using the felt sandwich technique to close the VSD channels near the apex

Two felts (10 mm × 10 mm in size) were sutured with 3-0 polypropylene suture (needle size 31 mm) to exclude the place that was estimated before cardiac arrest by esophageal echocardiography. The stitch was placed 15 mm in depth on the cardiac apex. The tricuspid valve was repaired, and then. After aortic de-clamping, normal heart rhythm was obtained, and weaning from CPB was uneventful. Transesophageal echocardiography after weaning from CPB showed a reduced trans-apical muscular VSDs shunt as compared with that presented before the closure of VSDs and reduced tricuspid regurgitation. After the patient was weaned from CPB, Qp/Qs was less than 1.2, and pulmonary banding was not necessary. The postoperative course was uneventful, and the patient was discharged from the hospital without any complications. Postoperative echocardiography showed a tiny muscular VSD shunt (Figure 3), mild pulmonary hypertension estimated by echocardiography, and good ventricular function, and postoperative catheter examination 1 year after the second surgery showed a Qp/Qs of 1.02 and mild PH, in which the ratio of pulmonary arterial pressure to systemic pressure was 0.4. The patient was placed on anti-pulmonary hypertensive medication.

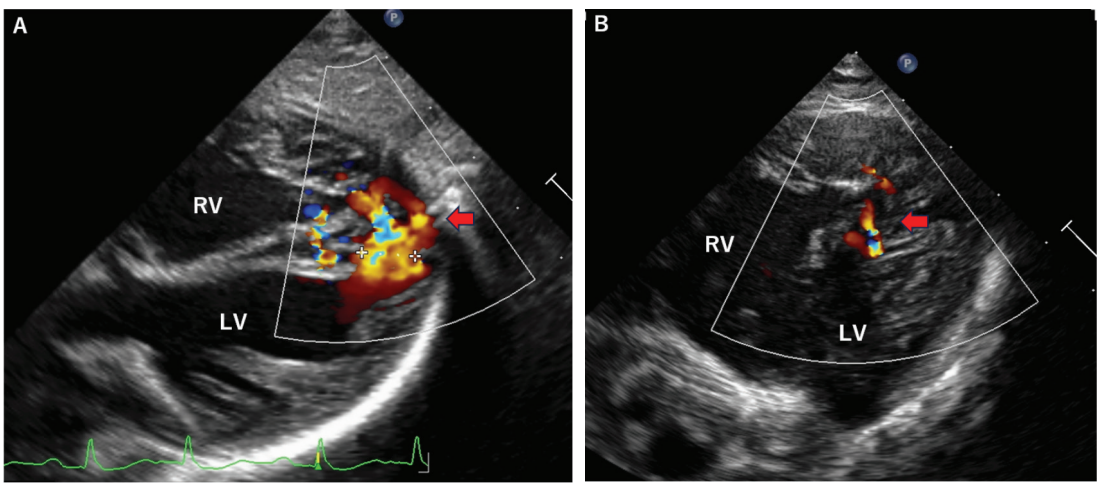


**Figure 3** Pre (A) and post (B) operative echocardiographic image. The width of apical VSDs shunt flow (red arrow) was decreased postoperatively

## Discussion

The optimal diagnosis and treatment of muscular VSDs remains indeterminate. Muscular VSDs exist on various parts of the ventricular septum, and it is hard to visualize the VSD channel in the coarse trabeculations of the right ventricle, not only on preoperative images but also via direct vision during the operation. Furthermore, shunt flow through apical muscular VSDs could not be clearly visualized in patients with multiple VSDs, as was the case in our case. However, CT images obtained before the operation are useful as a reference. In our case, a surgical strategy of apical VSDs sandwich exclusion could be planned while referring to the preoperative image.

Although some surgical approaches, including intraoperative device closure,[4] the ventricle sepal sandwich technique, and direct closure through right ventriculotomy, have been reported, optimal outcomes have not yet been obtained. Device-related complications such as device embolization, tricuspid or aortic valve damage, and recurrent defects may occur, and in our country, device closure of VSD is not comfortable. The ventricle septal sandwich technique is effective; however, the use of numerous felt patches on the ventricular septum disturbs its movement of the ventricular septum, resulting in impairing ventricular function.[2] In addition to surgical techniques, visualization of muscular VSDs is an important factor for the treatment during the surgery. Apical right or left ventriculotomy has been used to visualize the apical muscular VSDs for closure,[5] but ventriculotomy might lead to late ventricular dysfunction, aneurysmal formation, and ventricular arrhythmias in the future due to surgical scar of the ventricle.

Because muscular VSDs can be located anywhere on the ventricular septum, a definitive surgical closure

method cannot be established. The choice of surgical technique should be based on the place where the VSDs are located. For the patient with Swiss-cheese VSDs felt sandwich technique could be useful,[2] and for the patient with VSDs, which could not be closed surgically, pulmonary artery banding should be chosen, expecting natural closure of VSDs or future single ventricle circulation. In determining the best surgical technique, it is important to determine preoperatively where the VSD channels are. In our presented case, preoperative CT image was useful for locating the VSDs and which channels were near the ventricular apex, and these VSDs were to be excluded by using the felt sandwich technique exteriorly.

## Conclusions

Although our felt sandwich exclusion technique is not suitable for VSDs in the base side of the ventricular septum and is not a standard option, this technique may be one of the choices for surgical closure of apical muscular VSDs.

The Institutional Review Board in our institute has reviewed this case report and approved publication, and informed consent has been obtained from the patient's family.

## List of Abbreviation

PH : Pulmonary hypertension
VSD : Ventricular sepal defect
ASD : Atrial sepal defect
CT : Computed tomography
CPB : Cardiopulmonary bypass

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