

Transcatheter Closure of a Residual Shunt after Surgical Repair of Traumatic Ventricular Septal Defect

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The traumatic ventricular septal defect (VSD) is a rare but potentially life threatening complication of chest wall injury. The traumatic VSD occurs in up to 4.5% of penetrating cardiac trauma. Most of the patients are usually operated on because of heart failure and/or significant left-to-right shunt. The feasibility of surgical repair under cardiopulmonary bypass may be affected by coexisting pulmonary, cerebral or other vascular injuries. Transcatheter closure of VSD is being considered as an alternative therapeutic modality to surgery in order to avoid the potential risk of cardiopulmonary bypass. We report a patient who underwent a successful transcatheter closure of VSD with an Amplatzer[®] VSD occluder. The patient had a residual VSD with significant left-to-right shunt after surgical repair of post-traumatic VSD using cardiopulmonary bypass. (**Korean J Pediatr 2005;48: 1143-1147**)

Key Words : Traumatic ventricular septal defect, Transcatheter closure

Introduction

About 4.5% of the patients with penetrating injuries carry the ventricular septal defect(VSD) and most of the patients receive cardiopulmonary resuscitation or emergency thoracotomy because the vital signs are unstable when they come to hospital. Since detailed examination for the extent of cardiac and thoracic damage are not carried out at emergent situation, undiscovered or remained abnormal findings can be found after an operation. In addition, the hypoxia in several organs makes this disease even more serious due to unstable vital signs.

The closure of the VSD by an interventional cardiac catheterization is regarded as a therapeutic alternative to avoid the risk of an operation since being reported for the first time by Lock, et al.¹⁾ in 1988. At the beginning, the device, which was designed for the closure of atrial septal

defect or patent ductus arteriosus (PDA), was used but it had several limitations as follows: large delivery sheath, inability to recapture and reposition, embolism, and high rate of residual shunt²⁻⁴⁾. However, after Amplatzer[®] VSD occluder for muscular VSD was introduced successfully in animal experimentation in 1998⁵⁾, several authors⁶⁻⁸⁾ reported the successful attempts in children and adults.

Nowadays, transcatheter closure is not only being preferred for postoperative residual shunt, but being utilized as an adjunct to surgery in complex cyanotic heart disease^{9, 10)}.

We report a case that treated residual VSD by interventional cardiac catheterization after surgical repair of VSD and left ventricular laceration arising from multiple stabs.

Case Report

Patient : Choi ○ Dae, 13 years old, male

Chief complaint : multiple stab wound and hemorrhage

Family history : His younger brother was diagnosed of schizophrenia.

Present illness : Massive bleeding was noted in chest wall after being stabbed all over the body with scissors by his younger brother during bedtime, and he was brought to the hospital with lethargic consciousness. Cardiopulmonary

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resuscitation was done for the suspected hemothorax and the cardiac tamponade since he had symptoms of respiratory distress, bradycardia, and hypotension.

Physical examination : He looked pale with lethargic consciousness with 60 mmHg of systolic pressure, 125 beats per minute of heart rate, and 25 breaths per minute of respiratory rate. Hemorrhage was noted from about 3 cm of stab wound site, 5 cm distant from left nipple toward lateral upper part. We suspected the hemothorax due to the finding of overall uniformly increased density in the left part of the chest X-Ray. Chest tube was inserted, and blood was continuously drained from it.

Emergency operation : The cardiac tamponade and the hemothorax were noted. About 2 cm of a laceration at cardiac apex of left ventricle was stitched. The transesophageal echocardiography to evaluate the damage of the coronary artery and the function of the left ventricle after emergency operation showed a muscular VSD (Fig. 1). So we performed a reoperation. At the reoperation the post-traumatic VSD was closed by using a Dacron patch through the left ventriculotomy. However, the transesophageal echocardiography performed right after the reoperation showed residual left-to-right shunt around Dacron patch and an enlargement of left atrium and left ventricle (Fig. 2).

Cardiac catheterization : Six months later, cardiac catheterization was performed for the closure of the persistent VSD. The VSD was found in the form of tortuous long tunnel through entire muscular septum. Qp/Qs was 1.6 and pulmonary artery pressure and end-diastolic pres-

sure of left ventricle were normal (Fig. 3). Amplatzer® VSD occluder(AGA Medical Corporation, Golden Valley, USA) with 10 mm of diameter and 7 mm of length was tried because minimum diameter of VSD was 8 mm. The VSD was crossed from the left ventricular side with a 0.018 inch wire using a Judkin’s right coronary catheter. After establishing an arterio-venous guide-wire circuit, the wire was snared and pulled out to the femoral vein. Subsequently, a long sheath was advanced from venous side over this wire across the VSD into the ascending aorta. Then, the device was advanced to the tip of the sheath. The distal disk was then opened and positioned on the left ventricular side of the VSD. The proximal disk was then



Fig. 2. Postoperative transesophageal echocardiography shows residual shunt.



Fig. 1. Transesophageal echocardiography shows ventricular septal defect and left-to-right shunt, after surgical repair of LV laceration in mild-muscular septum.

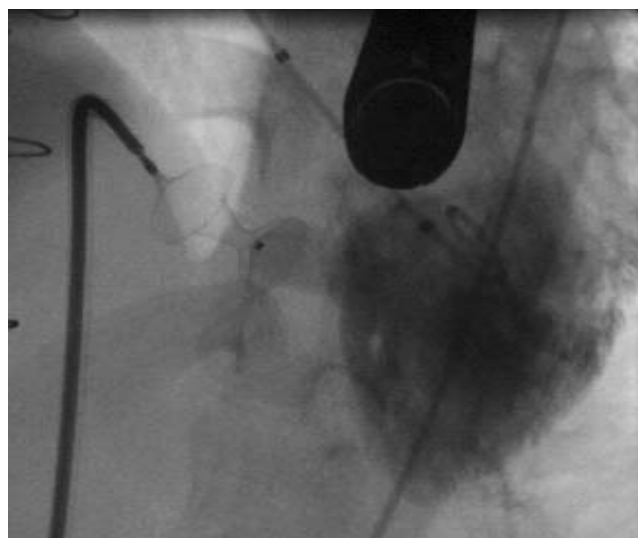


Fig. 3. Left ventriculogram in four chamber view before occluder deployment of long tract of VSD.

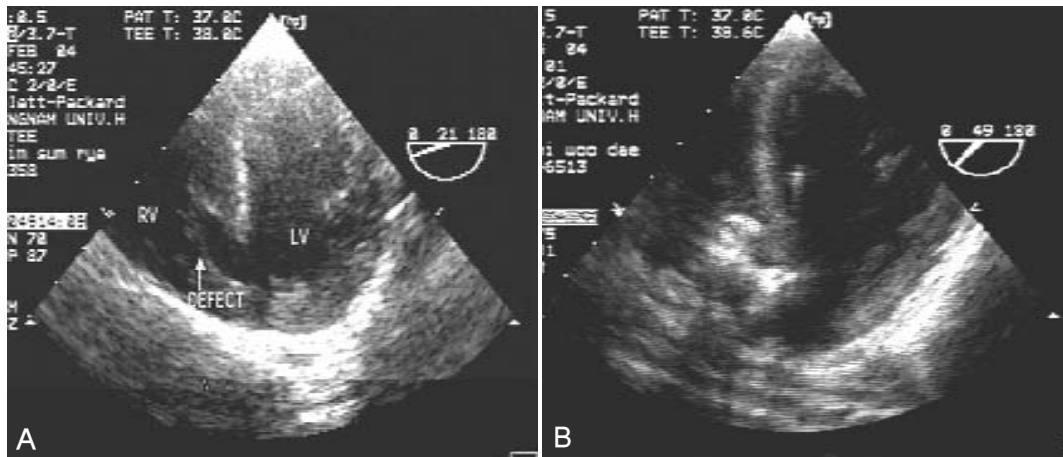


Fig. 4. Transesophageal echocardiography before (A) and after (B) occluder implantation. VSD occluder is visible in midmuscular septum along long tract of VSD.

deployed on the right ventricular side of the defect, keeping a steady traction on the delivery rod (Fig. 4). Simultaneous transesophageal echocardiography was performed to evaluate proper positioning of the device. After the closure, the left ventricular angiogram showed mild residual leakage.

On the echocardiography performed in the second day after the transcatheter occlusion, VSD occluder was observed in the middle of inter-ventricular septum, and residual leakage was not found. Moderate degree of tricuspid regurgitation was observed. No abnormal finding was noted on the 24 hours ECG monitoring and the vital signs. The patient was discharged on the third day after cardiac catheterization. Six months later, echocardiography showed no residual VSD shunt, normal size and function of the ventricle but the moderate tricuspid regurgitation was observed. Now he is stable with enjoying normal school activities.

Discussion

The VSD by trauma such as chest penetrating injuries or blunt injuries is not common. In this case, the VSD was found by the transesophageal echocardiography, which was performed during the emergency operation for the cardiac tamponade and the hemothorax. The VSD was closed with the Dacron patch using cardiopulmonary bypass, but left-to-right shunt remained.

The decision to perform surgical repair of VSD is determined by Qp/Qs and the presence of heart failure. The transcatheter closure of VSD can be used as an alternative of an operation to patients whose Qp/Qs of the residual shunt is above 1.5 after trauma or surgical repair. Espe-

cially, patients who have trauma with serious hemorrhage can avoid the risk of cardiopulmonary bypass to repair residual VSD by using the transcatheter closure.

In the past, an operation was regarded as the only way for the closure of the post-traumatic VSD. However, residual shunt are often found even if the operative closure was performed successfully. Recently Pesenti-Rossi et al.¹¹⁾ reported the case of successful closure of the residual shunt with Amplatzer[®] septal occluder after initial attempt to close the traumatic VSD with an operation. Due to the risk of reoperation and difficult surgical access for post-surgical residual VSD, the transcatheter closure of VSD can be appropriate and effective.

For the past 10 years, the closure of the intracardiac septal defect by cardiac catheterization has been improved with the development of various equipments and the technology of the echocardiography, and it is considered as a treatment of choice and palliation or complementation to operative procedure. Transcatheter closure of VSD can avoid the risk related to the thoracotomy or the cardiopulmonary bypass, and also can reduce the length of hospital stay compared with an operation. After the introduction of transcatheter closure of VSD with Rashikind umbrella by Lock, et al.¹⁾ in 1988, meticulous attempts have been made to close this defect by Clamshell occluder⁹⁾, Sideris buttoned device²⁾, and Gianturco coil⁴⁾. However, as Rashikind umbrella was devised for the closure of the patent ductus arteriosus (PDA) and Clamshell/Buttoned device was devised for the closure of the atrial septal defect, those were not appropriate for the closure of the VSD. The main limitations of these devices were the large delivery system,

the inability of repositioning and redeployment, embolization of the device, and high incidence of residual shunt. With further advancements, Amplatzer® muscular VSD closure underwent human clinical trials, after reporting 100% success rate in animal model in 1998⁵⁾.

Since Amplatzer® muscular VSD closure employs small delivery system (6-8F) that can be used for infants as well, it is easy to reposition and redeploy several times. In addition, as a long connected waist, which is between defects, is filled with thrombogenic polyester material, there is an advantage of more effective closure by thrombosis induction. In our case, there was no residual shunt six months after transcatheter residual VSD closure.

As for reported complications, there are transient bundle branch block or bleeding due to unexpected longer procedure time. In our case, there were no complications like transient bundle branch block, bleeding, infectious endocarditis, or hemolysis.

According to recent report, no residual shunt was found after the closure through Amplatzer muscular VSD occluder for 48 congenital muscular VSD, and there were no complications during follow up period¹²⁾. In addition, there is a report about the successful closure of perimembranous VSD by using new Amplatzer® asymmetric VSD occluder^{13, 14)}.

In the case of residual VSD after surgical repair, the transcatheter closure of VSD can be an alternative therapeutic modality considering the risk of reoperation. Moreover, the morbidity and the mortality of an operation can be reduced by this method even in the cases of congenital ventricular septal defects.

한 글 요 약

**외상성 심실중격결손 수술 후 잔존하는
심실중격결손에 대한
중재적 심도자술을 이용한 폐쇄**

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흉부 관통상에 의해 심실중격결손이 동반된 대부분의 환자들은 내원 시 활력징후가 불안정하여 심폐소생술 및 응급 개흉술을 시행받게 되는데, 이러한 경우 심장과 흉부 손상의 위치 및 정도에 대한 자세한 검사가 이루어지지 않은 상태이므로 발견되지 않았거나 잔존하는 이상 소견들이 수술 후 검사에서 발견될

수 있고 이에 대한 재수술을 필요로 하는 경우도 있다. 심실중격결손의 심도자술을 통한 폐쇄는 수술을 대처할 수 있는 방법으로서, 특히 수술 후 잔존하는 단락의 경우 이차 수술의 위험을 피할 수 있다. 저자들은 흉부 자상에 의한 심실벽의 열창 및 심실중격결손을 수술적 방법으로 봉합한 후 잔존하는 심실중격결손을 기구(Amplazter® VSD occluder)를 이용한 중재적 심도자술로 치료한 증례를 문헌 고찰과 함께 보고한다. 심도자술 6개월 후 시행한 심초음파검사에서 잔존하는 심실 좌우 단락은 없었고, 심실 크기와 기능도 정상이었으며, 현재 상태는 양호하여 정상적으로 학교생활을 하고 있다.

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