7세 소아에서 선천성 심방중격결손 수술 직후 나타난 급성 저산소증 - 증례 보고 -

부산대학교 의학전문대학원 마취통증의학교실

김혜진, 이도원, 홍정민

Acute hypoxemia after operation of congenital ASD in 7-yr-old patient -A Case report-

Kim Hyae jin, Lee Dowon, Hong Jeong min

Department of Anesthesia and Pain Medicine, Pusan National University Hospital

Abstract

심방중격결손은 선천성 심장질환 중 흔한 질환이며, 외과적 수술로 안전하게 교정할 수 있다. 결손을 수술로 치료한 후 하대정맥이 좌심방으로 우회되는 것은 드문 합병증으로 수술 직후 급성이나 만성으로 저산소증이 나타날 수 있다. 본 증례는 7세 여아에서 선천성 심방중격결손으로 수술 후 감작스런 저산소증이 나타났으나, 수술장에서 경석도 초음파상에 하대정맥의 이상 소견을 발견하지 못하였고, 수술 후 CT angiography 상에서 하대정맥이 좌심방으로 향해 있는 것을 진단하여 재수술 했던 경험을 보고하고 있다. 두 번 째 수술에서 패치를 이용하여 결손 부위의 폐쇄치료를 성공적으로 마쳤고, 환아는 수술 후 어떠한 부작용 없이 회복하였다.

본 연구는 2013년도 양산부산대학교병원 임상연구비 지원으로 이루어졌음.
Key words: acute hypoxemia, atrial septal defect, congenital heart surgery

Introduction

The postoperative course that follows correction of atrial septal defect (ASD) is generally uneventful, complications after ASD patch closure include postpericardiotomy syndrome (typically 7 to 14 days after the operation) and arrhythmias. Inadvertent closure of inferior vena cava (IVC) opening after ASD patch closure is very rare complication. It causes hypoxemia acutely and cyanosis with clubbing chronically, paradoxical embolism in severe case.

Here in case, we experienced acute hypoxemia after closure of ASD without knowing the cause at that time.

Case description

A 7-yr-old, 23kg female patient was admitted for palpitation for 4 years. Transthoracic echocardiography (TTE) revealed atrial septal defect (ASD) with enlarged right heart, trivial tricuspid regurgitation (TR). Chest CT confirmed partial anomalous pulmonary venous connection (PAPVC) with right superior pulmonary vein draining into right atrium. She was referred to surgery for closure of the ASD, and treatment of PAPVC. She was scheduled for ASD patch closure.

In the operating room, anesthesia was induced uneventfully. In addition to other monitors, a biplane transesophageal echocardiography (TEE) probe was inserted and the preoperative diagnosis was confirmed. Preoperative TEE demonstrated large ASD, trivial TR, good ventricular function. (Figure 1)

She achieved total cardiopulmonary bypass (CPB) by a median thoracotomy approach. The ASD was identified and sutured. There was no PAPVC on surgical field. The right atriotomy was then closed.

During the termination of CPB, unexpectedly the pulse oxygen saturation was about 94% and continued to deteriorate. We applied 100% oxygen with recruit maneuver and hyperventilation. Despite this management, her oxygen saturation was maintained to 90–92%. On arterial blood gas analysis, PO2 was 54mmHg and oxygen saturation was 89%. We examined TEE to identify surgical repair, ASD was corrected with patch and there was no leakage. (Figure 2A)

There was no obstruction or stenosis at right ventricular outflow tract. (Figure 2B) Ventricular contractility was good. Because the pediatric echocardiographic probe allowed only biplane, we could not identify all section of anatomy. We decided to transfer the patient to
intensive care unit (ICU) and observe her at the ICU. At the ICU, she was exhibited low oxygen saturation (89–90%) and hypotension, Dopamine was infused with 4mcg/kg/min. There was no improvement, we checked chest CT again. Chest CT revealed abnormal drainage of inferior vena cava to left atrium. (Figure 3) Surgeons then decided to re-explore the ASD repair. We immediately planed emergency operation, After right atriotomy, the patch was found to be sutured to the IVC entrance. The suture line was then taken down and the ASD was defined and repaired. After repair of ASD, we could not identify IVC drainage with a conventional midesophageal (ME)bicausal view on TEE examination. Instead of that, we advanced the TEE probe deeply and track hepatic vein drain to the IVC. Using that method, we could identify IVC flow draining to right atrium with a color Doppler. We confirmed that there was no other defect or abnormal anatomy. During post CPB period, oxygen saturation maintained 95–96%. There was an event of ventricular tachycardia, we gave 4J of defibrillator and amiodarone infusion. After that, the patient had an uneventful postoperative course.

**Discussion**

In a recently reported surgical series of ASD repair, there were no operative deaths. The common complications were postoperative atrial arrhythmias, SA, and AV blocks necessitating pacemaker implantation, mediastinal bleeding, and transient ischemic attack (TIAs) or strokes.\(^1\) Inadvertent diversion of the IVC into the left atrium (LA) is usually reported as a rare complication following surgical large posteroinferior ASD closure in the era of CPB.

Diversion of the inferior vena cava into the left atrium during operative repair of low lying secundum type atrial septal defects was reported in 1957 by Bedford et al.\(^2\) Multiple case reports have later described iatrogenic diversion of IVC flow to the LA after surgical incorporation of the Eustachian valve of the IVC in the repair of a low-lying ASD.\(^3\-7\) It has also been reported after closure of sinus venosus defect of the inferior vena caval type.\(^5\) These defects are liable to be incompletely closed at the lower end, or when sutured under tension the repair may disrupt postoperatively\(^6\). This complication was more frequent before the routine use of cardiopulmonary bypass because time limitations were imposed by only hypothermia and no inflow occlusion. Most situations accounting for the
inadvertent diversion are large Eustachian valves, which are mistaken for the margin of the ASD. In addition to large Eustachian valves mistaken for the margin of the ASD, there is another form of inadvertent diversion, Foreexample, the lower portion of the defect was too low to be closed by direct suture or by means of a patch, thus creating a direct IVC-to-LA communication failure to recognize an IVC type of sinus venosus. Secundum ASD with inferior extension is often confused with inferior sinus venous defects.

Intraoperative TEE is very helpful tool to find out immediate surgical result for congenital heart surgery. There have been reports that they could identify the inadvertent diversion of IVC after ASD repair operation with intraoperative TEE. Others reported that they did not find residual defect or shunt after ASD closure in the operating room, they could confirm residual shunt or diversion of IVC with contrast CT, cardiac catheterization or contrast echocardiography outside the operating room.

In our case, we could not diagnose abnormal drainage of IVC immediately after CPB. With our equipment, we could use only biplane TEE, which made limitations to examine extensively. It also prevented us to visualize IVC drainage and because of the abnormal anatomy of the patients, we could not find IVC on the conventional ME bicaval view.

At the second emergency re-do operation, we use another portable echocardiography, it permitted us to examine multiplane view. However, we could not identify drainage of IVC to LA. We think it is because of limitations of TEE and anatomical abnormality of this patient. After reposition of ASD patch, IVC was not visualized by TEE on conventional ME bicaval view. We could find IVC flow through tracking hepatic vein draining to IVC.

In the case of delayed diagnosed IVC diversion, they did not find out any residual defect immediately after ASD closure using intraoperative TEE. Like our case report, they could not detect IVC drainage to LA in the operating room. They observed the patient at the intensive care unit outside operating room, the patient showed worsening hypoxia. They performed contrast echocardiography using agitated saline and it demonstrated IVC diversion to LA. In congenital heart patients, they often exhibit anatomical anomaly and that makes it difficult to figure out all structure. This matter prevents us to detect abnormal flow immediately after cardiopulmonary bypass off. Therefore, in the case of acute hypoxia with
unknown cause under the TEE examination, agitated saline injected intravenously from below is a simple and inexpensive procedure and can be a good diagnostic tool in the operating room.

In this case report, we missed the cause of acute hypoxia using TEE. We never have had the experience of iatrogenic diversion of IVC before, we couldn’t consider that possibility. We need a close examination with TEE or contrast TEE to find out the cause of hypoxia in the operating room.

**Conclusion**

Although repair of ASD is a fairly safe and complication is rarely reported, life threatening adverse result is possible. If there is acute hypoxia with unknown cause after ASD closure, we have to consider about abnormal blood flow through incomplete or malpositioned patch closure. In the case of IVC diversion, it can be visualized on TEE or not. If we could not figure abnormal flow out on TEE, we can consider contrast echocardiography prior to closing the chest.

**References**

Kim Heejin, Yido Won, Hongmin


Figure 1 Preoperative transesophageal echocardiography examination. A biplane probe was inserted, and it demonstrated large atrial septal defect (ASD) with left to right shunt. Upper: 2D image, lower: color doppler image
Figure 2 Postoperative transesophageal echocardiography examination immediate after cardiopulmonary bypass off. Figure 2A shows ASD patch closure with no leakage, figure 2B shows good right ventricular outflow tract (RVOT) flow.
Figure 3 Postoperative chest CT after 1st operation. Inferior vena cava is draining into left ventricle.