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Missed Traumatic Conoventricular Septal Defect: A Case Report

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ABSTRACT

Traumatic ventricular septal defects (VSDs) after penetrating trauma to the left chest are rare. Most of the traumatic VSDs are located in the muscular ventricular septum, and a few reports place them in the membranous ventricular septum. There has been no report of traumatic conoventricular VSD by penetrating trauma. We present a case of penetrating cardiac injury (PCI). The rupture of the right ventricular free wall was found and repaired in emergency operation. This is the first report of the use of auricular forceps to control cardiac rupture bleeding. After operation, we found traumatic conoventricular VSD, which was repaired under cardiopulmonary bypass.

INTRODUCTION

Penetrating cardiac injuries (PCIs) are highly lethal, with an estimated pre-hospital mortality rate of 60% to 80%. A recent series from two high-volume trauma centers demonstrated that current mortality for PCIs after admission is approximately 40%; this series reported that the most frequently injured chamber of the heart is the right ventricle (RV) [Morse 2016; Mina 2017]. VSDs caused by PCI are rare, with muscular VSDs being the most frequently reported type in the literature and case reports, and a small part are located in the membranous ventricular septum. This is the first report of traumatic conoventricular VSD by penetrating trauma. In emergency surgery, the right ventricular rupture bleeding was controlled by using the auricular forceps. This is the first report of the use of auricular forceps to control the right ventricular rupture bleeding, and it proved to be an effective method.

CASE REPORT

A 33-year-old female was admitted to the emergency department for penetrating stab wounds to the third intercostal space on the left sternal border. On arrival, her vital signs were stable. A fast-chest computed tomography (CT) showed pericardial effusion and anterior mediastinal hematoma (Figure 1). The patient gradually developed an increase in heart rate and a decrease in blood pressure, considering pericardial tamponade, so she immediately was transferred to the operating room. Median sternotomy was performed, and a large amount of blood gushed out after pericardiotomy. A finger was inserted into the hole on the right ventricular free wall to achieve immediate hemostasis. Hemodynamics were stabilized. All clots and pericardial effusion were removed. The ruptured free wall of the right ventricle was clamped with auricular forceps (Figure 2), closed with U-shaped stitches and reinforced with Teflon felts (Figure 3).

The postoperative period was uneventful. However, on the first postoperative day a grade 4/6 pansystolic murmur over the entire precordium was noted. A thrill in the chest wall was readily palpable. Transthoracic echocardiography (Figure 4) demonstrated a small to moderate size (8.49mm) conoventricular septal defect with a left to right shunt as evaluated by color flow Doppler, the aortic valve and pulmonary valve had good function, and no regurgitation was found (Figure 4). The intensity of the murmur remained constant over the next several days, and the patient showed no signs of cardiac decompensation. Eight days after the first operation, the traumatic conoventricular septal defect was repaired under cardiopulmonary bypass. A median sternotomy incision was created and a right ventriculotomy was performed through the original site. Intraoperative exploration revealed that the

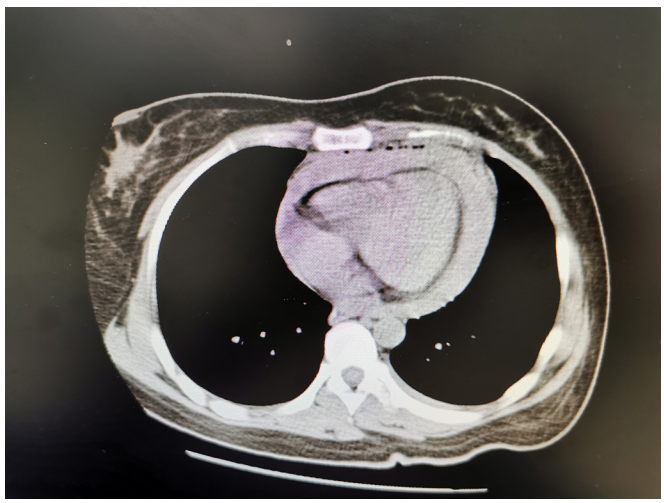

Figure 1. The fast-chest computed tomography (CT) showed pericardial effusion and anterior mediastinal hematoma.

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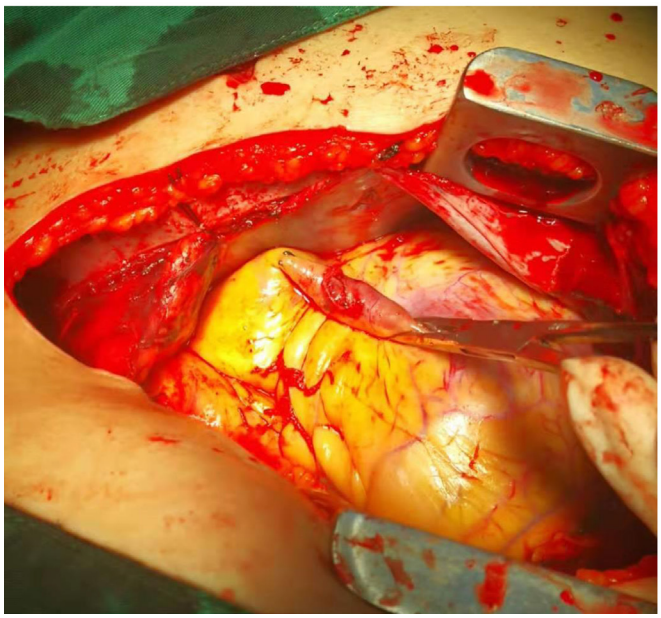

Figure 2. Via emergent median sternotomy, a right ventricular free wall stabbing injury was seen. A finger was inserted to achieve immediate hemostasis. The ruptured free wall of the right ventricle was clamped with auricular forceps, which can reduce bleeding and facilitate suturing.

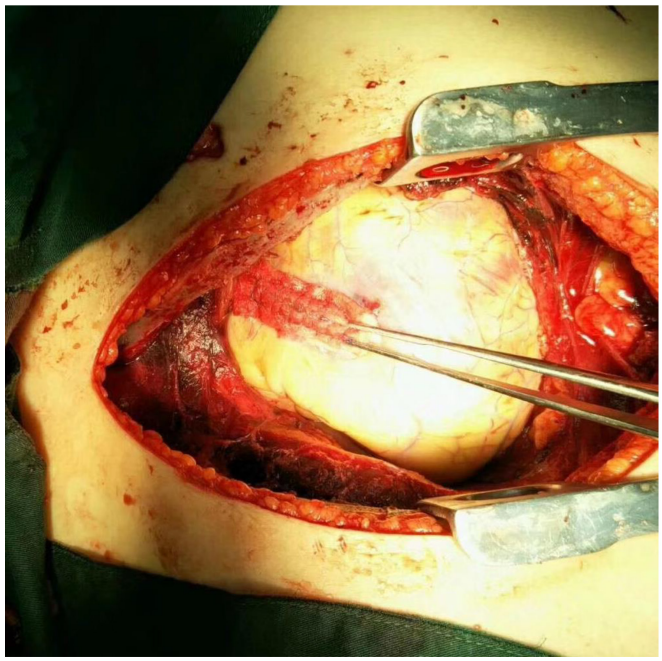

Figure 3. The ruptured free wall of the right ventricle was repaired by U-shaped stitches and reinforced with Teflon felts.

defect was located in the conoventricular septum, under the aortic valve and pulmonary valve, and the aortic valve and pulmonary valve were in good function (Figure 5). The defect was closed by continuous suture with glutaraldehyde treated autologous pericardial patch.

The patient had an uneventful postoperative recovery and was discharged from the hospital on the ninth postoperative day. Reexamination of echocardiography showed good heart function and no residual ventricular septal shunt.

DISCUSSION

In penetrating chest trauma, because the right ventricle forms most of the anterior surface of the heart, it is the site of entry more often than the left (62% for the right ventricle versus 38% for the left), and it is the most common site of entry [Restrepo 2012]. The occurrence of a VSD after PCI has an incidence of 1% to 5% [Olsovsky 1996]. Stab wounds and gunshot wounds are the main causes of PCIs, and the increased frequency of gunshot wounds in the past decade is associated with increased overall mortality, multichamber injuries, and multicavity injuries [Morse 2016].

This paper reports a patient with left anterior chest stab wound. The vital signs were stable when she was admitted to the emergency department, and CT indicated pericardial effusion. Subsequently, hemodynamic deterioration occurred, and median sternotomy was performed in the emergency operation room. The ruptured free wall of the right ventricle was found. It previously had been reported that a finger was inserted into the hole on the left ventricle to achieve immediate hemostasis [Hsu 2015], and another case reported that the ruptured free anterior wall of the right atrium was controlled by vascular clamp [Ayyan 2015]. There was still a small amount of bleeding when the finger was inserted into the cardiac rupture, which affected the operation. The pressure of the free wall of the right ventricle and the free anterior wall of the right atrium are not high and considering that the radian of auricular forceps is better than vascular clamp, the surgeon successfully clamped the right ventricular free wall rupture with auricular forceps without bleeding. The surgeon then sutured the rupture with a U-shaped suture. Considering the small beat amplitude of the free wall of the right ventricle, if the rupture is not large, clamping the rupture with auricular forceps will not cause too much damage.

The majority of patients with penetrating cardiac injuries (PCIs) initially presented with cardiac tamponade physiology and massive left hemothorax. In this case, the patient developed pericardial effusion and tamponade, which may be an important reason for the patient to be admitted to the hospital and receive surgical treatment. In PCI patients, tamponade may provide a physiologic advantage (lower mortality) compared with exsanguination. Mina et al reported 80 cases of PCI patients, 44 cases (55%) developed cardiac tamponade, 30 cases (38%) developed massive left hemothorax, mortality in the tamponade group was 16% (7/44 patients) compared with 72% (26/36 patients) in the exsanguination cohort [Mina 2017].

Unfortunately, due to the limitations of hospital conditions, the patient was not able to undergo emergency transthoracic echocardiography before surgery, the anterior cardiac murmur could not be detected due to pericardial effusion, and there was no intraoperative evaluation of cardiac structure by transesophageal echocardiography. After

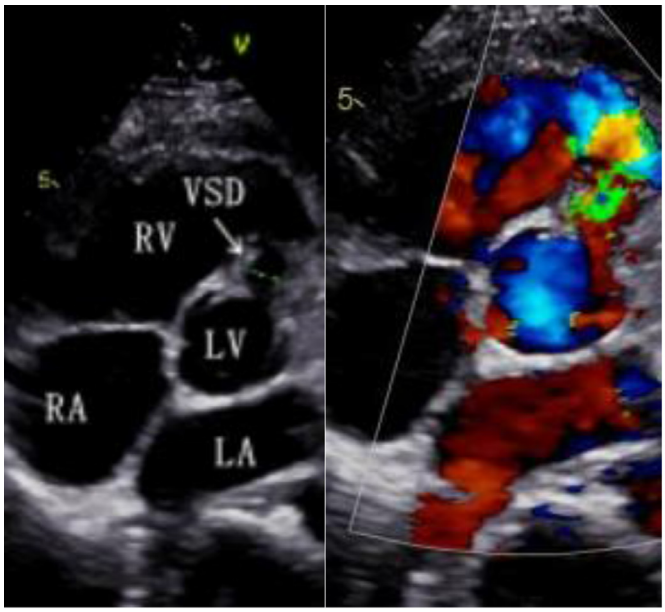

Figure 4. Two-dimensional transthoracic echocardiogram from short axis view of aortic root illustrated a small to moderate size (8.49mm) conoventricular septal defect (arrow) (left) with color Doppler illustrated left-to-right shunt (right). LA, left atrium; RA, right atrium; LV, left ventricle; RV, right ventricle

emergency operation, physical examination revealed a grade 4/6 pansystolic murmur over the entire precordium, and transthoracic echocardiography showed a conoventricular septal defect, located above the ridge, below the aortic and pulmonary valves. The site of traumatic ventricular septal defect mostly is located in the muscular ventricular septum, and the small part is located in the membranous ventricular septum. This is the first report of traumatic conoventricular septal defect by penetrating trauma.

The treatment of traumatic VSD includes conservative management in the hope of spontaneous closure, surgical repair, and transcatheter closure. The first spontaneous closure of traumatic ventricular septal defect was reported in 1965 [Walker 1965], and it is believed the most likely mechanism of closure would seem to be fibrosis of the missile tract in the ventricular septum, possibly assisted by hypertrophy of surrounding septal muscle. There were several similar reports afterward [Glancy 1972; Asfaw 1975; Midell 1975; Bryan 1988; Wu 2019].

Traumatic VSDs with spontaneous closure had been reported either in the muscular septum or in the membranous septum, and long-term conservative management observation was recommended for patients with no symptoms of cardiac decompensation/no pulmonary hypertension/pulmonary-to-systemic shunts less than 2:1/VSD of <10 mm in diameter, in the hope that spontaneous closure may occur.

The traditional treatment for VSD is to repair VSD under cardiopulmonary bypass, but with the development of cardiac interventional technology, the mainstream treatment for VSD is transcatheter closure, which is specifically true for those with a location remote from the tricuspid and aortic

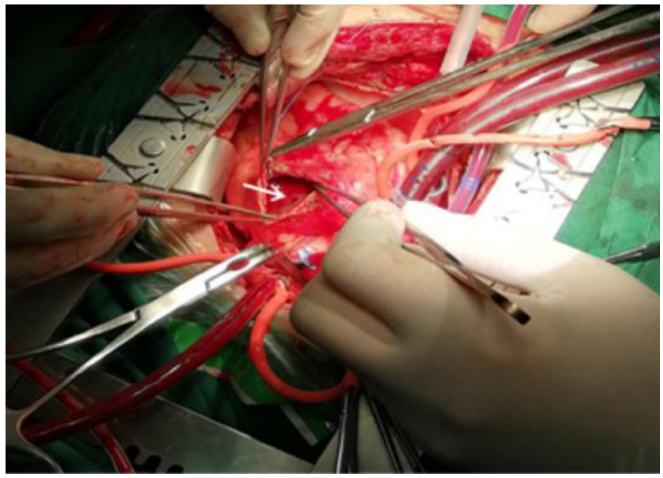

Figure 5. Intraoperative exploration revealed that the defect was located in the conoventricular septum, under the aortic valve and pulmonary valve. The aortic and pulmonary valves were in good function.

valves with an adequate amount of surrounding tissue to avoid interaction with the subvalvular apparatus. Transcatheter closure is less invasive and could be a feasible and effective choice for the treatment of traumatic VSDs, especially in patients who have undergone recent sternotomy for the repair of other cardiac injuries and who may be placed at greater risk by reoperation [Khajali 2020; Karagodin 2020].

The patient reported in this case was not suitable for transcatheter closure because the VSD was located in the conus, close to the aortic and pulmonary valve. To communicate with the patient and her family, since the patient had stable vital signs and no symptoms of cardiac decompensation and the diameter of the VSD was less than 10mm, it was suggested that conservative management could be considered in the hope of spontaneous closure of the VSD. However, because the patient was involved in legal disputes, and the VSD's spontaneous closure would take a long time, the repair of the VSD under CPB was performed at the request of the patient and her family.

It is feasible and effective for patients with penetrating cardiac injury to clamp the right ventricular free wall rupture with auricular forceps. For the treatment of traumatic VSDs, although transcatheter closure is the most popular surgical method in the near future, conservative management should be considered for patients without symptoms or pulmonary hypertension in the hope of spontaneous closure. For traumatic conoventricular VSD, which is close to the aortic valve and pulmonary valve, the use of an occluder will affect the function of the valve, surgical repair is an alternative treatment.

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