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Case Report

Minimally Invasive Device Closure of Traumatic VSR Using PDA Occluder: A Case Report and Review of the Literature

Shoubo Xiang[1], Xian Luo[2], Qianhua Dong[3], Bo Xiang[4], Tao Yu[4], Shengkun Peng[5], Mingliang Zuo[3], Mao Chen[1,*]

[1]Department of Cardiology, West China Hospital of Sichuan University, 610041 Chengdu, Sichuan, China
[2]College of Medicine and Life Sciences, Chengdu University of Traditional Chinese Medicine, 610075 Chengdu, Sichuan, China
[3]Ultrasound in Cardiac Electrophysiology and Biomechanics Key Laboratory of Sichuan Province, Sichuan Provincial People's Hospital, Affiliated Hospital of University of Electronic Science and Technology, 610072 Chengdu, Sichuan, China
[4]Department of Cardiac Surgery, Sichuan Provincial People's Hospital, Affiliated Hospital of University of Electronic Science and Technology, 610072 Chengdu, Sichuan, China
[5]Radiology Department, Sichuan Provincial People's Hospital, Affiliated Hospital of University of Electronic Science and Technology, 610072 Chengdu, Sichuan, China
*Correspondence: chenmao@scu.edu.cn (Mao Chen)

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Abstract

Background: Acute ventricular septal rupture (VSR) following blunt chest trauma is a rare but life-threatening complication. Early surgical repair is challenging due to fragile myocardial tissue, and delayed surgery improves survival. **Case Presentation**: A 15-year-old male in cardiogenic shock after chest trauma was managed with off-label closure of traumatic VSR using a patent ductus arteriosus (PDA) occluder, the procedure stabilized hemodynamics and allowed delayed surgical repair. **Conclusions**: Minimally invasive VSR closure using a PDA occluder may serve as a temporary, life-saving measure in emergency-cases. Further research is required to evaluate the safety, efficacy, and long-term outcomes of this approach.

Keywords

traumatic ventricular septal rupture; transesophageal echocardiography; patent ductus arteriosus occluder; case report

Introduction

Acute ventricular septal rupture (VSR) is a rare but life-threatening complication of blunt chest trauma [1,2]. The rupture leads to a left-to-right shunt and cardiogenic shock [3]. Early surgical repair is technically demanding and carries high risks [4–6], while delayed surgery may improve outcomes due to myocardial healing [7–9].

In this case report, a patient diagnosed with a large traumatic VSR who was treated at our institution is presented.

Case Presentation

Clinical Presentation and Initial Assessment

A 15-year-old male presented with cardiogenic shock after a motor vehicle accident causing blunt chest trauma. Initial findings included acute hypoxic respiratory failure, pulmonary edema, and multi-organ dysfunction. Transthoracic echocardiography (TTE) revealed a 28 mm irregular VSR near the apex (Fig. 1) with significant left-to-right shunting (Qp:Qs 3.9) and biventricular dilation.

Device Selection and Approach

Although the patient required a large-sized occluder to cover this extensive defect, a specifically designed ventricular septal defect (VSD) occluder of sufficient size was not available at the time. To make an informed decision, the team considered various options, including an atrial septal defect (ASD) occluder. However, the wider disc profile of the ASD occluder posed a greater risk of additional myocardial tissue damage. After careful deliberation, it was determined that the patent ductus arteriosus (PDA) occluder, despite not being specifically designed for traumatic VSR, offered the most feasible and immediate solution for temporary stabilization under the challenging clinical circumstances. The procedure was performed under general anesthesia with transesophageal echocardiography (TEE) guidance.

After systemic heparinization, a purse-string suture was placed, and the right ventricle was accessed. A guidewire was passed through the VSR into the left ventricle, and a 14 French (14F) delivery sheath was implanted. A 32/34 mm PDA occluder was delivered to the left ventricle (LV) through the sheath (Fig. 2), with adjustments made under TEE guidance to optimal placement with mild residual shunting (Fig. 3A).

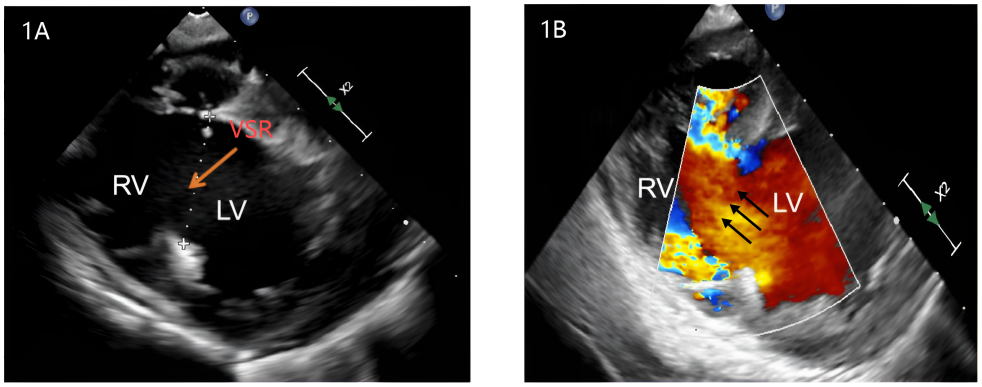

Fig. 1. Transthoracic Echocardiography (TTE) of VSR. Parasternal short-axis view at the level of the apex obtained during initial assessment. (A) A large, irregular VSR is visible near the apex of the heart, indicated by the yellow arrow. (B) Color Doppler demonstrates a significant left-to-right shunt across the VSR, shown by the black arrow. VSR, ventricular septal rupture; LV, left ventricle; RV, right ventricle.

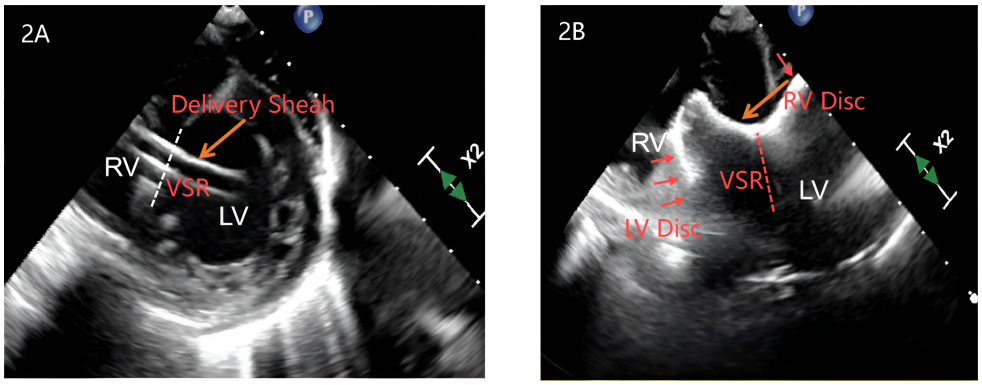

Fig. 2. Transesophageal Echocardiography (TEE) Guidance during Device Closure. Short-axis TEE images depicting the stages of device deployment. (A) A 14 French (14F) delivery sheath (indicated by the yellow arrow) is advanced over a guidewire from the right ventricle (RV), traversing VSR into the left ventricle (LV). (B) Following sheath placement, a 32/34 mm PDA occluder (indicated by the yellow arrow) is deployed between the LV and RV, spanning the VSR. The two discs of the occluder are visualized, one on each side of the septum (indicated by the red arrow). PDA, patent ductus arteriosus.

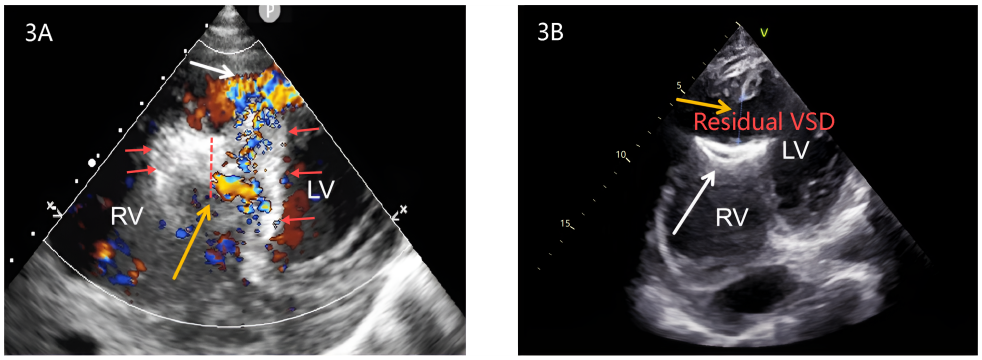

Fig. 3. Echocardiographic Assessment: Post-Deployment and Six-Month Follow-up. (A) Transesophageal echocardiography (TEE) image immediately post-device deployment: A mild to moderate residual left-to-right shunt is observed at the inferior edge of the defect, denoted by the white arrow. The yellow arrow indicated the successful placement of the PDA occluder across the VSR. The red arrow points to the disc of the occluder. (B) TTE apical four-chamber view at the six-month follow-up. Significant dislodgement of the PDA occluder (white arrow) with the device migrated into the right ventricular (RV) cavity. The yellow arrow marked the location of the residual VSD. VSD, ventricular septal defect.

Post-Procedural Care and Recovery

Following the minimally invasive device closure, the patient was closely monitored in the surgical intensive care unit (SICU). Continuous hemodynamic monitoring was instituted, and serial echocardiograms were conducted to ensure the PDA occluder remained in place and to monitor for any complications. Antiplatelet therapy was administered to prevent thrombus formation. venoarterial extracorporeal membrane oxygenation (VA-ECMO) support was gradually weaned as the patient's cardiac function improved, allowing for the discontinuation of ECMO by day 15 post-procedure.

Follow-up and Complications

Scheduled follow-up visits with echocardiograms were used to monitor the device position, residual shunt, valvular function, and overall cardiac function over time. At six months, the patient developed progressive right ventricular failure. TTE revealed partial device dislodgement into the RV cavity (Fig. 3B), resulting in a bidirectional shunt and new-onset severe tricuspid regurgitation secondary to anterior tricuspid leaflet prolapse.

Definitive surgical repair was subsequently performed with a Teflon felt patch and interrupted sutures.

Fig. 4 illustrates the flowchart of management of the patient, outlining the pathway with key decision points for device selection, weaning from VA-ECMO, and the transition from temporary closure to definitive surgical repair.

Discussion and Conclusion

Clinical Challenges

Traumatic VSR management is challenging due to the fragile and inflamed nature of the injured myocardium. While surgical closure remains the gold standard [1–3], delayed surgery often yields better outcomes by allowing myocardial healing [7–9]. However, hemodynamic instability frequently necessitates urgent intervention.

Temporary Device Closure Strategy

In this case, minimally invasive closure using a PDA occluder provided immediate hemodynamic stabilization, though this off-label approach carries risks of device migration and valvular interference. The anatomical location of traumatic VSR, typically near the apex with thin tissue [2,9], requires precise TEE guidance for optimal device placement and complication prevention [10].

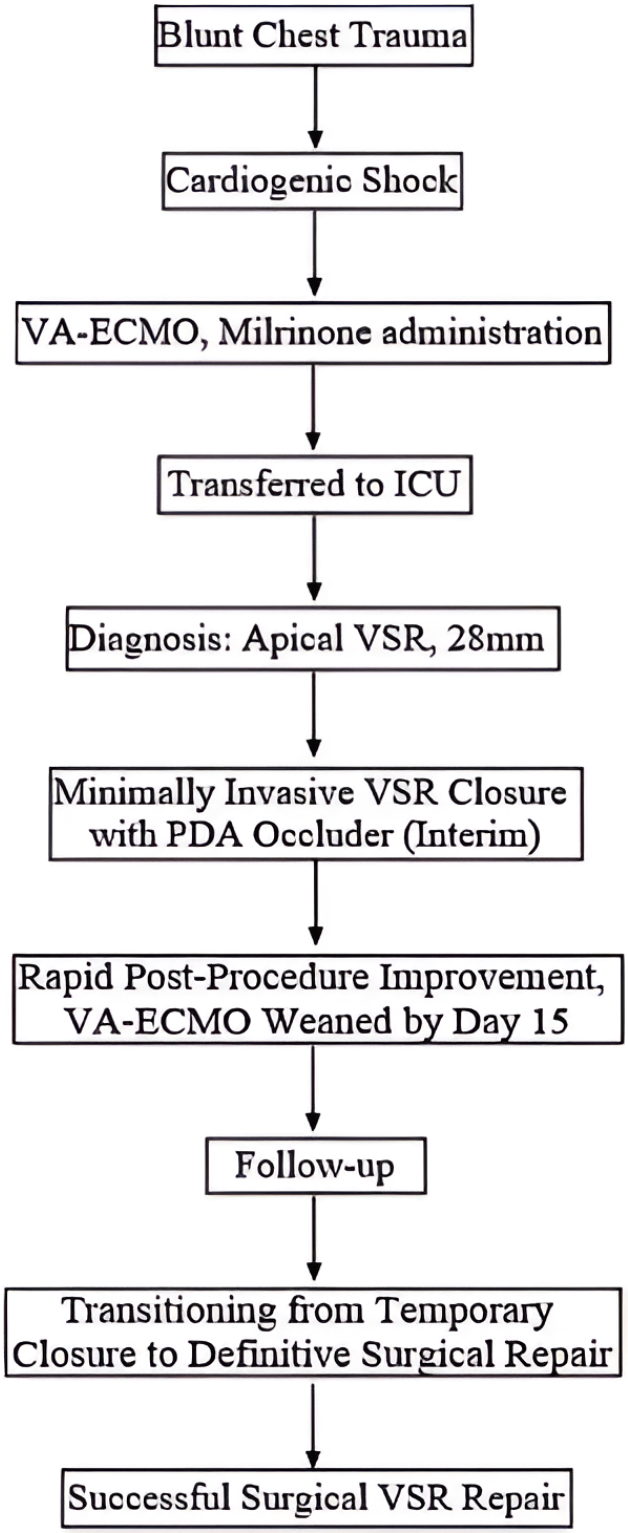

Fig. 4. Flowchart of Management of the Patient. ICU, Intensive Care Unit; VA-ECMO, venoarterial extracorporeal membrane oxygenation.

Role of Mechanical Support

VA-ECMO serves as a critical bridge to definitive treatment in hemodynamically unstable patients [3]. How-

ever, its prolonged use increases the risk of bleeding, thrombosis, and systemic complications [7,11], necessitating a timely transition to definitive treatment.

Future Perspectives

This case demonstrates the potential of minimally invasive device closure as a bridge therapy in high-risk patients [12,13] by reducing surgical risks [14]. Future research needs to focus on the long-term effects of PDA occluders as a bridge therapy for traumatic VSR, optimal patient selection, comparisons with other treatment options, and the integration of technological advancements, all aimed at improving patient outcomes.

Conclusions

Successful management of traumatic VSR requires a multidisciplinary approach combining temporary stabilization strategies with definitive surgical repair. The PDA occluder shows promise as a bridge therapy, though careful patient selection and close monitoring are essential.

Abbreviations

VSR, ventricular septal rupture; PDA, patent ductus arteriosus; TEE, transesophageal echocardiography; VA-ECMO, venoarterial extracorporeal membrane oxygenation; VSD, ventricular septal defect; TTE, transthoracic echocardiography; LV, left ventricle; RV, right ventricle.

Availability of Data and Materials

Data used to support the findings of this study are available from the corresponding author upon request.

Author Contributions

SBX and XL collected the clinical data and drafted the manuscript. QHD, BX, TY, SKP and MLZ collaboratively analyzed and interpreted the data. MC designed the study and contributed to writing and reviewing the manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Ethics Approval and Consent to Participate

The study was carried out in accordance with the guidelines of the Declaration of Helsinki and approved by the Ethics Committee of Sichuan Provincial People's Hospital (Protocol No. 2024-508). Informed consent was obtained from the patients for this study.

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Conflict of Interest

The authors declare no conflict of interest.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.59958/hsf.8185.

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