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Original research

SANDWICH TECHNIQUE FOR VENTRICULAR SEPTAL RUPTURE FOLLOWING MYOCARDIAL INFARCTION: TWO CASE REPORTS

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ABSTRACT

Background: *Ventricular septal rupture (VSR) is a rare but catastrophic mechanical complication of acute myocardial infarction (AMI), occurring in approximately 0.3% of cases. Despite advances in reperfusion therapy, VSR remains associated with high morbidity and mortality, particularly in patients with cardiogenic shock. The optimal timing for surgical intervention is debated, and the choice of surgical technique is crucial to improving outcomes. The "sandwich technique," which involves placing patches on both the left and right ventricular sides, has shown superior durability compared to traditional single-patch closure.*

Case Report: *We present two cases of post-myocardial infarction VSR successfully treated with the sandwich technique. The first case involved a 58-year-old woman with anterior STEMI complicated by VSR, which progressed despite percutaneous coronary intervention (PCI). Surgical closure using the sandwich technique led to a successful outcome. The second case was a 41-year-old man with inferior-posterior STEMI and VSR, requiring intra-aortic balloon pump (IABP) support before surgical repair. Both patients recovered well postoperatively and were discharged in stable condition.*

Conclusions: *These cases underscore the need for individualized strategies in VSR management. The Sandwich technique offers durable repair in infarcted myocardium, while IABP support and a multidisciplinary Heart Team are vital for optimal outcomes.*

Key words: *Ventricular septal rupture, myocardial infarction, sandwich technique.*

I. BACKGROUND

Ventricular septal rupture (VSR) is a rare but catastrophic mechanical complication of acute myocardial infarction (AMI), occurring in approximately 0.3% of cases [1]. Despite advances in reperfusion therapy, including primary percutaneous coronary intervention (PCI), VSR remains associated with high morbidity and mortality, particularly in patients who develop cardiogenic shock [2]. The mortality rate without surgical intervention approaches 90%, emphasizing the critical need for prompt diagnosis and definitive treatment [3].

Acute ST-elevation myocardial infarction (STEMI) is the most common precipitating event leading to VSR, typically occurring within the first week post-infarction. The pathophysiology involves transmural infarction with myocardial necrosis and subsequent mechanical wall disruption, resulting in a left-to-right shunt that exacerbates hemodynamic instability. The excessive left-to-right shunting increases pulmonary congestion, decreases systemic perfusion, and contributes to worsening heart failure [2].

Clinically, patients with VSR often present with acute decompensated heart failure, cardiogenic shock, hypotension, and a new harsh systolic murmur best heard at the left lower sternal border. Given its life-threatening nature, early recognition and confirmation via echocardiography, particularly with color Doppler imaging, are essential. Cardiac catheterization can further delineate the extent of the rupture and assess for concomitant coronary artery disease [2].

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The management of post-AMI VSR remains challenging, primarily due to the high operative risk associated with surgical repair in acutely infarcted myocardium. The optimal timing for surgical intervention is debated, with early repair linked to increased perioperative mortality due to myocardial friability, while delayed repair risks worsening cardiogenic shock and multiorgan failure [2, 4].

In hemodynamically unstable patients, mechanical circulatory support (MCS) is often required to stabilize the patient before definitive intervention. Common MCS modalities include: Intra-aortic balloon pump (IABP): Reduces left ventricular afterload and improves coronary perfusion but has limited impact on overall hemodynamics; Extracorporeal membrane oxygenation (ECMO): Provides full cardiac and respiratory support, often used in patients with profound cardiogenic shock; Impella or TandemHeart devices: Augment left ventricular unloading and systemic perfusion while awaiting definitive repair [5].

Surgical repair remains the definitive treatment for VSR, with the "sandwich technique" gaining prominence due to its improved structural integrity compared to conventional single-patch closure. This technique involves the placement of two patches-one on the left and one on the right ventricular side-providing reinforced closure and reducing the risk of residual shunting. By incorporating infarct exclusion principles, the sandwich technique minimizes suture line dehiscence and enhances long-term outcomes [6].

There have been few reports of this condition in Vietnam, which is why we would like to present two clinical cases of VSR in STEMI patients successfully treated using the "sandwich technique."

II. CASE PRESENTATION

Case 1: A 58-year-old female patient with a history of diabetes mellitus was admitted for acute ST-elevation myocardial infarction (STEMI) at the 12th hour, complicated by cardiogenic shock with an ejection fraction (EF) of 35%, demonstrating hypokinesia in the apical, anterior, and anteroseptal regions of the left ventricle. A ventricular septal rupture (VSR) was detected near the apex, measuring approximately 5 mm in diameter, resulting in a left-to-right shunt.

Emergency coronary angiography revealed subtotal occlusion of the proximal and mid-left anterior descending artery (LAD), while the left circumflex and right coronary arteries showed mild atherosclerosis (Figure 1). The patient underwent emergency percutaneous coronary intervention (PCI) of the LAD and received optimal medical therapy, including heart failure and vasopressor management.

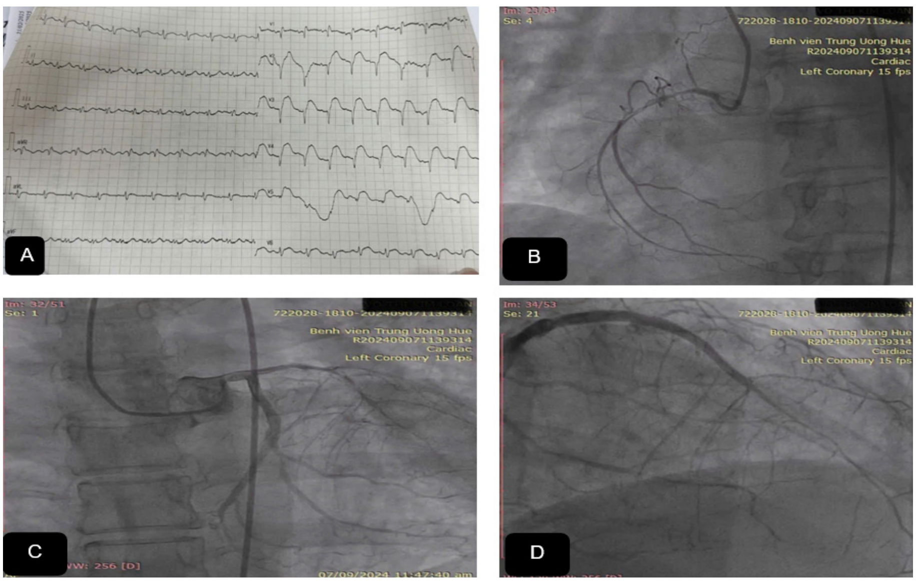

Figure 1: ECG at admission with ST elevation in V1-V6 (A). Coronary angiography showed stenosis in right coronary artery with small diameter (not culprit lesion) (A), almost occluded in left descending artery (LAD) and normal left circumflex (LCx) (B and C). Post-stent percutaneous coronary intervention in LAD (D).

Despite intervention, the patient's clinical condition did not improve after two days, and the septal rupture increased in size from 5 mm to 8 mm. Surgical closure of the ventricular septal defect (VSD) was indicated after five days. The patient subsequently showed improvement and was discharged in stable condition on day 23.

Case 2: A 41-year-old male patient with no known prior medical history was admitted to a local hospital with a diagnosis of acute inferior-posterior STEMI and underwent emergency PCI of the posterior descending artery (PDA). However, post-intervention, the patient remained dyspneic, and further evaluation revealed a ventricular septal rupture measuring approximately 10 mm near the apex. He was subsequently transferred to Hue Central Hospital for further management with the diagnosis of acute heart failure (EF 40%) secondary to acute myocardial infarction due to PDA occlusion, status post-PDA stenting, complicated by ventricular septal rupture.

On initial assessment, the patient was alert, with blood pressure ranging from 90-100/60-70 mmHg under noradrenaline support. A continuous murmur was audible at the left third to fourth intercostal spaces. Laboratory tests included elevated hs-Troponin T (0.596 ng/mL), elevated NT-proBNP (12448 pg/mL). Following a multidisciplinary Heart Team discussion, the patient underwent intra-aortic balloon pump (IABP) insertion and surgical repair of the ventricular septal defect (VSD) using the Sandwich technique on day 12 after the myocardial infarction (Figure 2). Postoperatively, the patient demonstrated progressive clinical improvement and was discharged in stable condition 14 days after surgery.

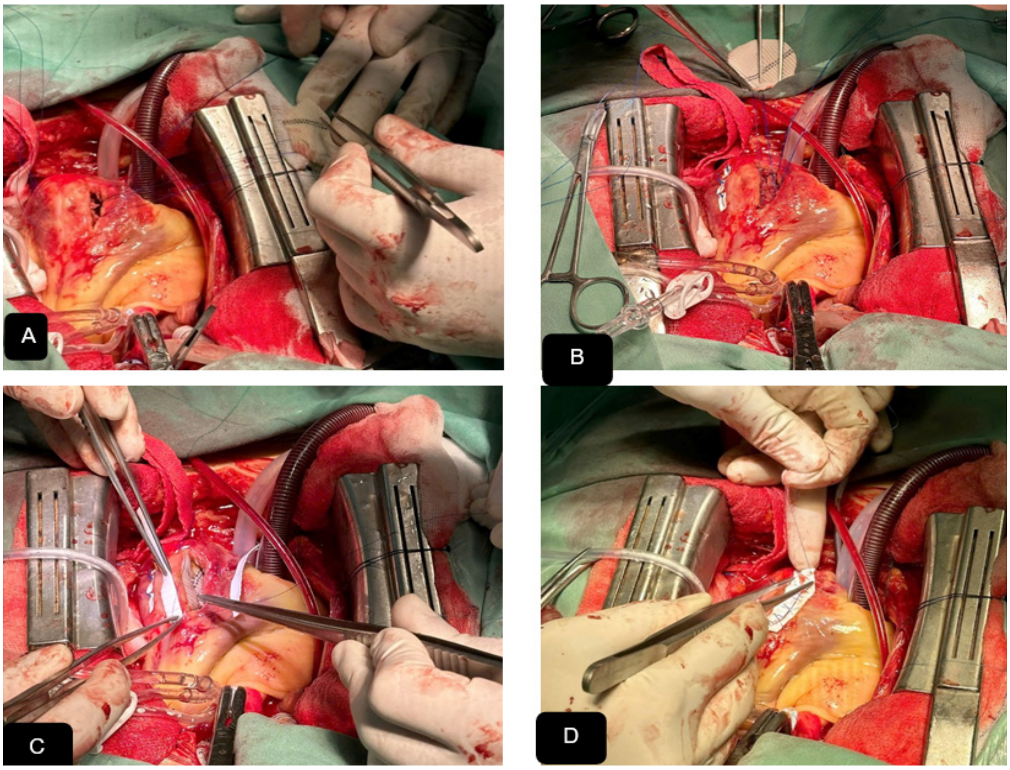

Figure 2: Ventricular septal rupture in operation (A).
Sandwich technique procedures explained in discussion section (B, C, and D).

III. DISCUSSION

3.1. Timing of ventricular septal rupture repair

The ideal timing for definitive surgical repair of VSR remains uncertain. While the 2013 ACC/AHA guidelines advocate for emergent surgical intervention regardless of hemodynamic status, the optimal approach remains debated and should be tailored to each patient [7].

In hemodynamically stable patients with preserved end-organ function and favorable anatomy, early surgery should be considered due to the risk of sudden hemodynamic deterioration. However, when the surgical anatomy is complex or concerns exist regarding tissue fragility, delaying surgery may be reasonable. The rationale for delayed intervention, despite potential biases, has a mechanistic basis. After infarction, metalloproteinase activity and tissue degradation peak around day 7, while new collagen deposition begins by days 2-4, with complete collagen replacement of necrotic myocytes by day 28. This suggests that postponing surgery could enhance repair by allowing the tissue to stabilize, strengthen, and differentiate from surrounding healthy myocardium. In such cases, intensive care monitoring may facilitate tissue healing and improve the chances of a successful repair. Watchful waiting may also be appropriate in patients on potent dual antiplatelet therapy due to significant platelet inhibition [2] (Figure 3). Recognizing the potential benefits of delayed repair, the 2017 ESC guidelines support elective surgery in patients who initially stabilize with aggressive conservative management [8].

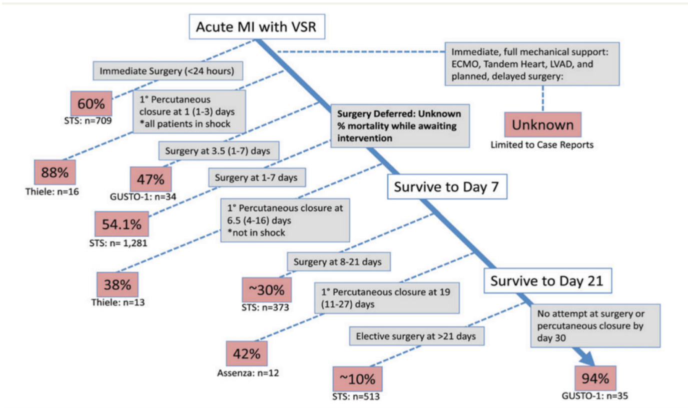

Figure 3: Published studies indicate a progressive decrease in mortality with longer delays in VSR repair [2].

In Case 1, despite initial percutaneous coronary intervention (PCI) and medical management, the VSR progressed in size, necessitating surgical closure. In Case 2, early surgical intervention was required due to persistent instability despite PCI and optimal medical therapy. These cases highlight the importance of individualizing timing based on clinical presentation, hemodynamic status, and feasibility of temporary circulatory support.

3.2. Why choosing surgery over percutaneous intervention?

While percutaneous closure has emerged as a potential alternative for post-myocardial infarction VSR, surgery remains the gold standard in most cases. Percutaneous device closure is limited by anatomical constraints, particularly in large or irregularly shaped defects, as well as in cases where there is significant myocardial necrosis. Additionally, device embolization and high residual shunting rates are major concerns with percutaneous approaches. In contrast, surgical repair allows for direct visualization of the defect, debridement of necrotic tissue, and reinforcement with the sandwich technique, ensuring a more durable closure [2, 6]. In both cases presented, the location and size of the defect, along with the need for definitive closure, favored surgical intervention over a percutaneous approach.

3.3. Rationale for using the sandwich technique

The sandwich technique is a modification of conventional VSR closure, designed to address the inherent structural weakness of infarcted myocardial tissue. Traditional single-patch repair carries a high risk of residual shunting and recurrence due to the friability of infarcted myocardium. The sandwich technique, which involves placing patches on both the left and right ventricular sides, reinforces the defect from both directions, minimizing tension on the suture lines and providing a more durable closure. Additionally, surgical adhesives such as BioGlue can be used to further stabilize the repair site [6].

The sandwich technique involves several key steps to ensure a secure and durable repair. First, the infarcted myocardial tissue surrounding the defect is carefully debrided to remove necrotic and friable tissue. This step is crucial to provide a stable anchoring site for sutures and patches. Next, a biocompatible patch, typically made from bovine pericardium or synthetic material, is placed on the left ventricular side and secured using interrupted or continuous sutures. Another patch of similar material is positioned on the right ventricular side, effectively "sandwiching" the defect between the two layers. The patches are then sutured together to reinforce the closure, and a biological adhesive is applied to minimize residual leakage and enhance healing (Figure 4, 5).

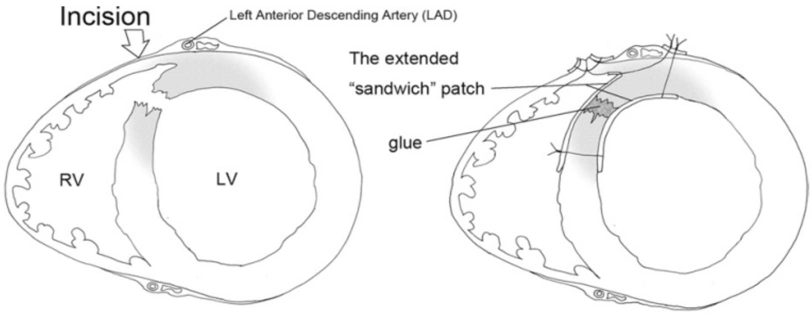

Figure 4: Cross-sectional view of anterior VSD repair using the extended sandwich patch technique via the RV approach

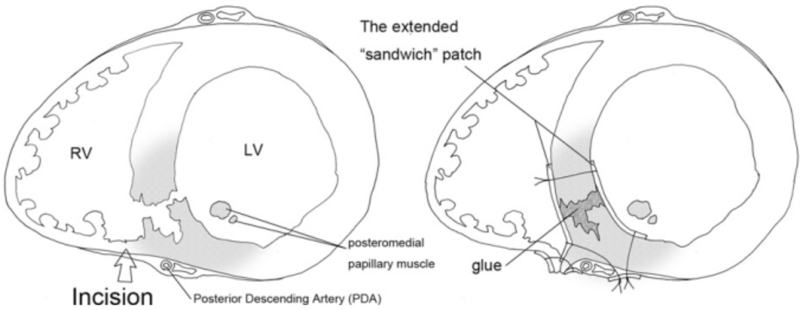

Figure 5: Cross-sectional view of posterior VSD repair using the extended sandwich patch technique via the RV approach [6].

Compared to the traditional single-patch repair, the sandwich technique provides greater mechanical stability by reinforcing the closure from both the left and right ventricular sides. The single-patch technique, while effective in some cases, has a higher risk of suture dehiscence and residual shunting due to the lack of additional reinforcement. The infarct-exclusion technique, another alternative, involves suturing infarcted tissue to exclude it from circulation; however, this method can be technically challenging and may not provide sufficient reinforcement in large or irregular defects. The sandwich technique, by directly addressing the friability of the infarcted septum and distributing mechanical stress across both ventricular walls, reduces the likelihood of postoperative complications and recurrent defects [6].

In both cases presented, the sandwich technique was chosen due to its superior mechanical stability, especially given the apical location of the VSR, where infarcted tissue is more prone to disruption.

3.4. Role of intra-aortic balloon pump (iabp) in cardiogenic shock and vsr

IABP plays a critical role in the stabilization of patients with cardiogenic shock secondary to VSR by reducing left ventricular afterload, improving coronary perfusion, and decreasing left-to-right shunting [5]. In Case 2, IABP was used as a bridge to definitive surgical intervention, helping to maintain hemodynamic stability before surgery. While IABP does not correct the underlying septal defect, it can temporarily improve cardiac output, buying time for the myocardium to fibrose or for definitive intervention to be performed under more favorable conditions.

3.5. The role of the heart team in complex vsr cases

The management of post-myocardial infarction VSR requires a multidisciplinary Heart Team approach, involving interventional cardiologists, cardiac surgeons, heart failure specialists, and critical care physicians. This collaborative approach ensures optimal decision-making regarding the timing and type of intervention, selection of appropriate circulatory support devices, and comprehensive postoperative management [4] (Figure 6).

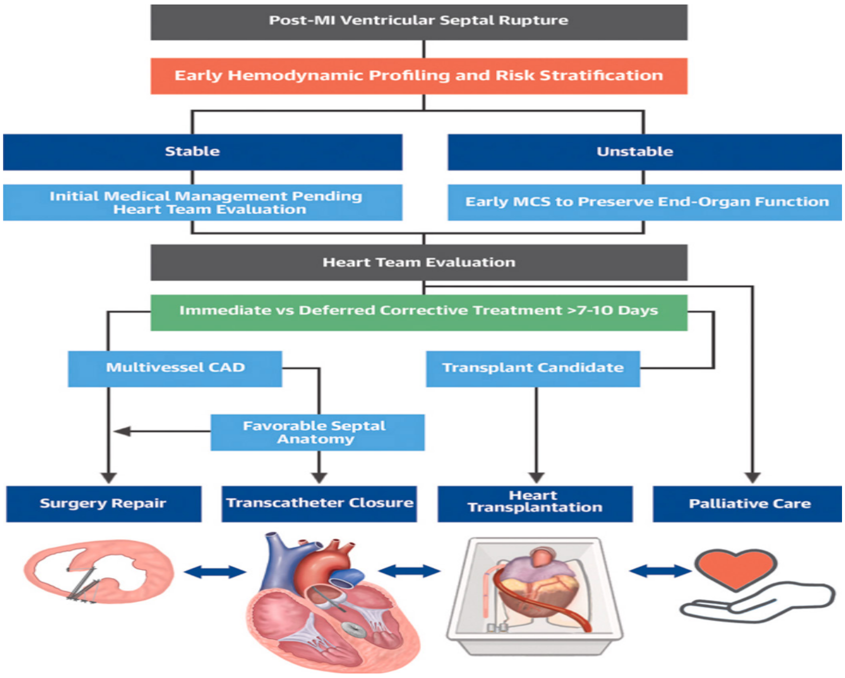

Figure 6: Collaboration among members of an interdisciplinary heart/shock team can help estimate the chances of viability vs futility, determine the role of mechanical circulatory support, and determine the timing of intervention [4].

In both cases, the Heart Team played a pivotal role in determining the necessity of IABP placement before proceeding with surgical closure. The involvement of a multidisciplinary team is especially critical in borderline cases where both percutaneous and surgical options must be carefully weighed.

IV. CONCLUSION

These cases underscore the need for individualized strategies in VSR management. The Sandwich technique offers durable repair in infarcted myocardium, while IABP support and a multidisciplinary Heart Team are vital for optimal outcomes.

Declaration of conflicting interests

The authors declare no conflicts of interest with respect to the research, authorship, and/or publication of this article

Ethical approval

All details, medical records and figures were used with the written consent for publication from the patient. This case report was approved by the Research Ethics Committee of Hue Central Hospital

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