



Original Article

Percutaneous closure of post-myocardial infarction ventricular septal rupture – A single centre experience



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ABSTRACT

Background: Post-infarction ventricular septal rupture (VSR) is a rare but lethal mechanical complication of an acute myocardial infarction (AMI). Survival to 1 month without intervention is 6%. Given high surgical mortality, transcatheter closure has emerged as a potential strategy in selected cases. Indian data on percutaneous device closure of post AMI-VSR is scarce hence we report our single-centre experience with ASD occluder device (Amplatzer and lifetech) for closure of post-AMI VSR.

Methods and results: In this single-centre, retrospective, cohort study, patients who underwent transcatheter closure of post-MI VSR between 2005 and 2015 at KIMS Hospital were included. Primary outcome was mortality rate at 30 days. Seven patients were included in the study (mean age, 58.29 ± 9.8 years). 5 patients had anterior wall myocardial infarction (AWMI) & 2 had inferior wall myocardial infarction (IWMI). None of the patients received thrombolytic therapy. Device was successfully placed in 5 patients (71.4%) with minimal residual shunt in 2 patients (40%). Out of 7 cases 2 patients survived (29% survival rate) and are doing well on follow up at 1 and 5 years respectively. Cardiogenic shock, IWMI and serpigenous form of VSR were associated with poor outcomes. Delayed revascularization (PCI) was associated with better outcomes.

Conclusion: Percutaneous closure is a potential technique in a selected group of patients. The presence of cardiogenic shock, IWMI and serpigeneous form of VSR constitutes important risk factors for mortality. Device implantation is in general successful with few procedure-related complications and should be applied on a case-by-case basis.

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1. Introduction

Post-infarction ventricular septum rupture (VSR) is a potentially lethal mechanical complication of an acute myocardial infarction (AMI). Due to the implantation of early revascularisation strategies, the incidence of post-infarction VSR has decreased from 1–2% to 0.25–0.31%.¹ However, when it does occur is commonly associated with extensive comorbidities, and results in poor cardiac output, multiorgan failure, and death. When conservative treatment is applied, mortality rates are as high as 87–100% within 2 months of diagnosis.^{2,3} Expert opinion and professional guidelines suggest that immediate closure, often combined with (multiple) coronary artery bypass grafting should be considered to reduce the duration of poor systemic perfusion that results from left-to-right shunting, pulmonary over circulation, and systemic hypoperfusion that may eventuate in refractory multiple organ

failure and death.⁴ Despite this awareness, there is a tendency for surgeons to wait several weeks before operating to allow tissue healing and more complete rupture remodelling, contributing to high inter-stage mortality and positive selection of more favourable cases. Due to the high mortality rate, less invasive alternative treatments, such as the use of percutaneous occluders, have been investigated. The advent of the Amplatzer family of ventricular septal defect (VSD) closure devices offers a potentially attractive alternative to surgical repair. A few case reports in Indian literature has been published but as such no case series reported.^{5,6} Though data is available in form of case reports and series world-wide.^{7,8} We hereby report our case series on percutaneous closure of post MI VSR using the ASD occluder device (Amplatzer and lifetech) who presented between 2005 and 2015.

2. Method

Device closure for VSR after acute MI has been attempted at our centre since December 2005. We analysed the case records available from the first case in December 2005 until June 2015. Data

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was collected regarding patient demographics, clinical features, pre-procedural clinical condition, echocardiographic features, procedural characteristics, procedural complications, in-hospital and 30 days mortality and long term follow up result. Cardiogenic shock was defined according to the Should We Emergently Revascularize Occluded Coronaries for Cardiogenic Shock (SHOCK) trial.⁹ Coronary artery disease was defined as >70% stenosis in 1 of the 3 major epicardial coronary arteries.

As per hospital data records from 2005 to 2015, 25 patients were admitted with post MI-VSR. Out of these 7 cases (non consecutive) underwent percutaneous device closure and 11 cases underwent surgery.

3. Clinical parameters of the cases studied

In this single-centre, retrospective, cohort study where 7 non consecutive cases (4 females and 3 males) of post-MI VSR were included. The demographic data is summarised in Table 1. The mean age of the population was 58.29 ± 9.8 years (57.67 ± 10.2 years in males and 58.75 ± 11.08 years in females). Majority of the patients in our series had an anterior wall MI (5 of 7 cases; 71.43%) and the remaining 2 had an inferior wall MI. All the patients did not receive thrombolytic therapy or any other form of intervention for the AMI. All cases had late presentation (>12 h to >38 h from the onset of chest pain). The mean duration from onset of pain to presentation at our centre was 22.14 h. Presence of ventricular septal rupture was identified clinically with the presence of a pansystolic murmur along the lower left sternal border and confirmed by performing an echocardiogram (Fig. 1a). All patients were managed by placing an intra aortic balloon pump (IABP) for afterload reduction and consequent reduction of the left to right shunt. 4 patients presented with cardiogenic shock (57.14%) and required inotropic support with dopamine and noradrenaline. Of the two patients with IWMI one developed complete heart block and needed temporary pacemaker insertion (TPI) and one needed Continuous renal replacement therapy (CRRT) for acute kidney injury. Mean duration from acute MI to procedure for attempted device closure was 5.29 ± 2.73 days.

4. Procedure

The technique of percutaneous closure of a VSR is based upon the well proven and widely used percutaneous technique for closing a congenital ventricular septal defect. Transesophageal echocardiography (TEE) with colour Doppler is used to determine the size and anatomy of the VSR (Fig. 1b). Left Ventricular angiogram was done to determine the exact location of the VSR. Cannulation of the right femoral artery and right internal jugular vein is performed using the Seldinger technique. A guidewire (035''

Table 1
Demographic data.

Demographic	Data
Total cases	7
Male:female	2:5
Mean age (years)	58.29 ± 9.8
Diabetic	4
Hypertensive	5
Anterior MI	5
Inferior MI	2
Mean duration from MI onset to presentation (hours)	22.14 h
Mean duration from MI to procedure (days)	5.29 ± 2.73
Cardiogenic shock	4 (57.1%)

Terumo glidewire) is introduced from the femoral artery, through the aorta into the left ventricle and is advanced through the VSR into the right ventricle and pulmonary artery. A second snaring wire is introduced through the vein to connect to the guidewire in the pulmonary artery. By retracting the snared wires, the guidewire now forms an arteriovenous (AV) loop (Fig. 2a). The delivery sheath is advanced from the venous side loop over the guidewire through the VSR into the left ventricle. Correct positioning of the delivery sheath is confirmed in fluoroscopy/TEE. The guidewire is then retracted leaving the delivery sheath in position. After echocardiographic confirmation an ASD occluder device (liftech in 3 cases and amplatzer in 4 cases) was deployed across VSR using the delivery sheath. The distal disc is opened, the device is retracted, so that it will be secured against the septal tissue at the side of the left ventricle. The second (proximal) disc is opened on the right ventricular side by further retracting the delivery sheath (Fig. 2b). Correct positioning of the device and closure is confirmed by echocardiography and/or fluoroscopy. If placement is satisfactory, the occluder is released. Post procedure Left ventricular angiography & Echocardiography was done to confirm the position and to rule out presence of any residual shunt. In all the cases, we made use of the femoral-jugular mode of access and created an AV loop. The veno-venous loop though described in literature was not used in this study. VSR Closure in all these cases was attempted using an ASD occluder device (3 Lifetech and 4 Amplatzer), the size depending upon the size of the VSR.

5. Results

All patients included in this study were cases with VSR in whom previous attempts at closure had not been done (primary closure). Of the 7 cases in this study the device was successfully placed in 5 patients (71.4%). Post procedural result was good with a minimal residual shunt in 2 patients (40%). Out of 7 cases 3 patients were

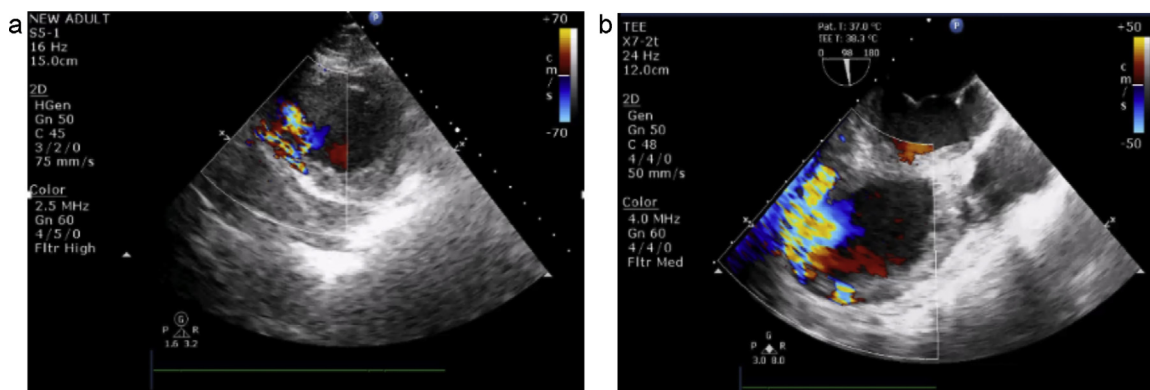


Fig. 1. (a) PSAX and (b) transesophageal echocardiogram showing the VSR in a patient with AWMI.

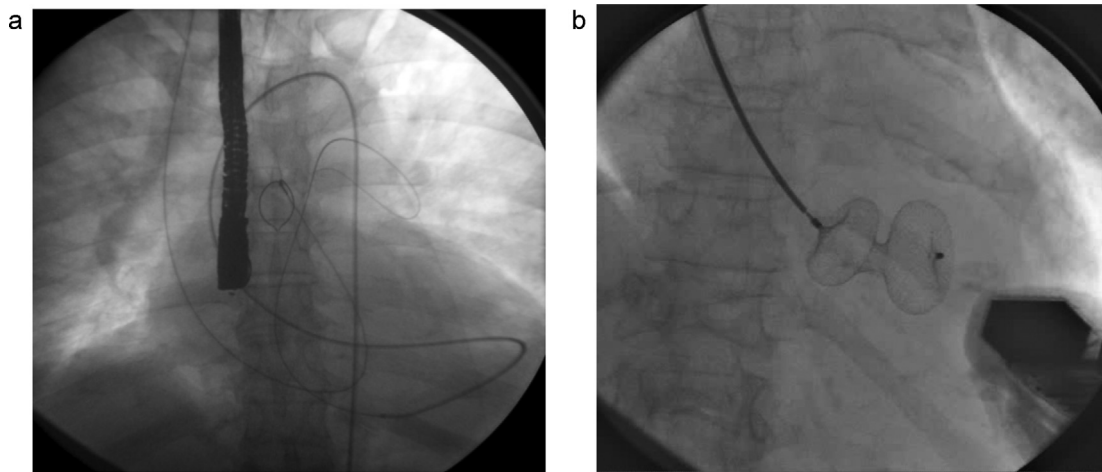


Fig. 2. (a) Creating an AV loop and (b) device placed across VSR.

successfully discharged (42.8% survival) and 1 patient succumbed to death within 30 days. In patients with in-hospital mortality, mean duration from procedure to mortality was 3.46 ± 2.12 days. Of the 4 patients who had cardiogenic shock on presentation, 3 had in hospital mortality (75%). There were 5 cases with anterior wall MI + VSR and 2 cases with inferior wall MI + VSR. In patients with anterior wall VSR, 40% (2 cases) survived >30 days while those with inferior wall VSR (2 cases) died in hospital post procedure.

One patient with inferior wall VSR had a large serpiginous VSR with associated hypotension, ARF and complete heart block for which a TPI was done. Due to the serpiginous nature of the VSR device placement was not successful. The other patient with IWMI also had a failure of device placement due to difficult location of the VSR. Both these patients developed severe haemodynamic compromise and needed intervention within 3 days of VSR. Surgical closure was considered but due to extreme surgical risk, interventional device closure was attempted but failed and both succumbed on table.

In this series, all patients with anterior wall MI (5 cases) had a successful device placement with minimal residual shunt in two patients. Out of 5 cases 3 patients were discharged successfully but only 2 patients survived till 30 days. One case died during IABP removal (which was wrongly oversized) due to external iliac artery tear leading to haemodynamic compromise and other case developed haemothorax and water shed zone infarct due to which he had respiratory arrest, could not be extubated and expired after a prolonged course. Patient who died after discharge was readmitted with worsening dyspnoea had a VSR expansion post device closure and developed worsening of the left to right shunt, leading to refractory heart failure and death.

The nature of the underlying coronary artery disease in patients in this study was extremely variable with 3 patients having single vessel disease (SVD), 3 patients having two vessel (DVD) and 1 patient having triple vessel disease (TVD).

The 2 patients who survived also had a stormy post device closure course in the ICCU with one patient developing acalculous cholecystitis and severe sepsis with multiorgan dysfunction. With aggressive medical therapy the patient recovered and was discharged on day 7 after device closure. Both the patients who survived had a good post discharge recovery and are on regular follow up. The coronary lesions (SVD in one case and 2VD in another) in these 2 patients were stented 4 weeks after discharge with good results. Both cases are doing well on 1 and 5 years follow-up respectively.

As per hospital data out of 25 patients (2005–2015) admitted with post MI VSR 11 patients underwent surgical closure along

with CABG. All cases were intervened more than 7 days of VSR. 4 of 11 cases died in hospital (36.3%) while 2 died in 1 year follow up (18.18%).

6. Discussion

Ventricular septum rupture (VSR) complicating AMI is a relatively rare event associated with high mortality with an incidence of 0.2% in current era. In patients with cardiogenic shock, VSR is the underlying cause in 3.9%, and mortality can be as high as 87.3%, as was seen in the SHOCK trial registry.⁹ Without surgical repair of postinfarction VSR reported mortality is 90% within 2 months.¹⁰

In two prospective registries, the mortality rates were as high as 81–100% for patients with VSR and shock.^{2,3} As a result of the high mortality and suboptimal surgical results with a postoperative residual shunt found in up to 20% of the treated patients, the technique of percutaneous VSR device closure has been developed.^{2,11–13} Currently, data is limited for post-infarction VSR interventional closure in Indian literature.

In this series, the success rate of device placement for VSR closure was 71.4% which is comparable to the global reportable success rate of 85%.¹⁰ The largest single-centre experience with device closure of primary VSR reported was in 29 patients,¹³ which found a survival rate at 30 days of 35%. In this series the 30 day survival rate was comparable at 29%. Although one of the largest multicenter study on percutaneous device closure of post MI VSR (both primary and post surgery residual VSR included) reported survival of 58% at the time of discharge which reduced to 51.5% on 1 year of follow up.¹⁴ But even in this study mean duration from MI to percutaneous closure of VSR was 13 days while in our study patients were intervened in acute settings (<7 days). A comparison with the currently available world data on primary VSR device closure is given in Table 2. The mortality rate in VSR with cardiogenic shock has been reported at 88%¹³ while in our study we had 75% mortality. In patients with RV dysfunction and inferior wall VSRs, mortality had been reported to be close to 100% and surgery is reported to be futile in these patients.¹⁵ Even in this series it was found that patients with inferior wall VSRs and RV dysfunction had a mortality of 100%. Even those patients who have a successful device closure of the VSR often succumb to antecedent causes. The post VSR closure course in the ICCU is often stormy and requires careful monitoring to detect complications early and manage them appropriately. This study highlights that coronary lesions should be addressed on later date for better results and primary focus should be on correction of mechanical complication.

Table 2

Comparison of results of world experience with our series1.

	Total patients	Acute (n)	Subacute/chronic (n)	Success rate	30 days survival (acute)	30 days survival (s/c)	Residual shunt (small)	Residual shunt (mod/sev)
Chessa 2002	12	3	9	11/12	0/3	8/9	0	0
Szkutnik 2003	7	0	7	5/7	–	4/5	3	1
Goldstein 2003	4	0	4	3/4	–	3/3	2	2
Haizer 2004	18	5	13	16/18	2/5	9/13	8	2
Demikow 2005	11	3	8	10/11	0/2	8/8	4	0
Martinez 2007	5	3	2	5/5	2/3	2/2	3	1
Bialkowski 2007	19	1	18	14/19	0/1	9/13	9	3
Marinakis 2007	8	6	2	7/8	0/6	1/2	0	0
Ahmed 2008	5	2	3	4/5	0/1	3/3	3	1
Maltais 2009	12	12	0	11/12	7/11	–	10	1
Thiele 2009	29	29	0	25/29	10/29	–	6	4
Total no	130	64	66	111/130	21/61	47/58	48/111	15/111
Total (%)				85	34	81	43	14
Premchand RK 2015	7	7	0	5/7	2/7	–	2/5	0
Total (%)				72	29	–	33	0

Author's experience towards approach to post-MI VSR device closure is highlighted at the end of study. The limited number of patients in this series precluded any meaningful multivariable analysis to identify independent predictors of mortality hence future studies with larger sample size are recommended.

7. Conclusion

Post-AMI VSR remains a lethal complication of acute coronary syndromes. The detrimental interplay of cardiogenic shock, intracardiac shunting, and increased pulmonary circulation frequently results in severe multiorgan failure and leads to high risk of mortality. Percutaneous closure is a potential technique in a selected group of patients. The presence of cardiogenic shock, IWMI and early revascularization (PCI) in the acute phase after VSR diagnosis are important risk factors of mortality. Device implantation is in general successful with few procedure-related complications and should be applied on a case-by-case basis.

Authors' contribution

Rajendra Kumar Premchand – Assisting with the work up and evaluation of the case and procedure. Acquisition of data and revision of the manuscript for critically important intellectual content. 'Guarantor' for integrity of the work done.

Dr. Ravikanth Garipalli – Assisting with the work up and evaluation of the case and procedure.

Dr. T.N.C. Padmanabhan – Assisting with the work up and evaluation of the case and procedure. Intellectual inputs on drafts of manuscript, critical revisions.

Dr. Geetesh Manik – Accumulating case data and preparation of the draft. Intense study of reported case series with critical revisions of the manuscript.

Conflicts of interest

The authors have none to declare.

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I gratefully acknowledge the support of Pete Christy Editor-In-Chief and Nikolaos kakourous for granting the permission to publish **Table 2** for comparison of world data on device closure of VSD in acute settings (Cardiac Interventions Today-Nov 2009).

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at [doi:10.1016/j.ihj.2016.10.004](https://doi.org/10.1016/j.ihj.2016.10.004).

References

- Moreyra AE, Huang MS, Wilson AC, et al. Trends in incidence and mortality rates of ventricular septal rupture during acute myocardial infarction. *Am J Cardiol*. 2010; 106(8):1095–1100.
- Crenshaw BS, Granger CB, Birnbaum Y, et al. Risk factors, angiographic patterns, and outcomes in patients with ventricular septal defect complicating acute myocardial infarction, GUSTO (Global Utilization of Streptokinase and TPA for Occluded Coronary Arteries) Trial Investigators. *Circulation*. 2000;101(1): 27–32.
- Menon V, Webb JG, Hillis LD, et al. Outcome and profile of ventricular septal rupture with cardiogenic shock after myocardial infarction: a report from the SHOCK Trial Registry. Should we emergently revascularize Occluded Coronaries in cardiogenic shock? *J Am Coll Cardiol*. 2000;36(3 suppl A):1110–1116.
- Ryan TJ, Antman EM, Brooks NH, et al. 1999 update: ACC/AHA guidelines for the management of patients with acute myocardial infarction. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Management of Acute Myocardial Infarction). *J Am Coll Cardiol*. 1999;34(3):890–911.
- Ahmed J, Ruygrok PN, Wilson NJ, Webster MW, Greaves S, Gerber I. Percutaneous closure of post-myocardial infarction ventricular septal defects: a single centre experience. *Heart Lung Circ*. 2008;17:119–123.
- Ranjan A, Malik K, Chopra M, Shukla A, Patel K. Periventricular device closure of post-myocardial infarction ventricular septal defect: can it combine best of both worlds. *Int J Case Rep Images*. 2016;7(4):272–274.
- Demkow M, Ruzyllo W, Kepka C, et al. Primary transcatheter closure of postinfarction ventricular septal defects with the Amplatzer septal occluder: immediate results and up-to 5 years follow-up. *EuroIntervention*. 2005;1:43–47.
- Holzer R, Balzer D, Amin Z, et al. Transcatheter closure of postinfarction ventricular septal defects using the new Amplatzer muscular VSD occluder: results of a U.S. Registry. *Catheter Cardiovasc Interv*. 2004;61:196–201.
- Hochman JS, Sleeper LA, Webb JG, et al. SHOCK Investigators. Should we emergently revascularize occluded coronaries for cardiogenic shock. Early revascularization in acute myocardial infarction complicated by cardiogenic shock. *N Engl J Med*. 1999; 341:625–634.
- Thiele H, de Waha. ACC. Expert consensus. How should we treat VSDs and Acute MR Post MI? http://www.acc.org/latest-in-cardiology/articles/2015/06/11/10/57/how-should-we-treat-vsds-and-acute-mr-post-mi?w_nav=TI.
- Caputo M, Wilde P, Angelini GD. Management of postinfarction ventricular septal defect. *Br J Hosp Med*. 1995;54:562–566.
- Deja MA, Szostek J, Widenka K, et al. Post infarction ventricular septal defect – can we do better? *Eur J Cardiothorac Surg*. 2000;18:194–201.
- Thiele H, Kaulfersch C, Daehnert I, et al. Immediate primary transcatheter closure of postinfarction ventricular septal defects. *Eur Heart J*. 2009;30:81–88.
- Calvert PA, Cockburn J, Wynne D, et al. Percutaneous closure of post-infarction ventricular septal defect: in-hospital outcomes and long-term follow-up of UK experience. *Circulation*. 2014;129:2395–2402.
- Moore CA, Nygaard TW, Kaiser DL, Cooper AA, Gibson RS. Postinfarction ventricular septal rupture: the importance of location of infarction and right ventricular function in determining survival. *Circulation*. 1986;74(July (1)):45–55.