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Original Article

Surgery Section

Survival in Patients with Post-myocardial Infarction Ventricular Septal Rupture: A Retrospective Observational Study

SHILPA SURESH[1], SRUJAN SINGANAMALA[2], RAGHAVENDRA MURTHY[3], RAVIKALYANI NAGASHETTY[4]

ABSTRACT

Introduction: Post-myocardial infarction ventricular septal rupture (post-MI-VSR) is a dreaded complication with high mortality. There is a varied survival pattern among patients who have undergone surgical repair.

Aim: To assess the survival rates in patients who underwent surgical repair for post-MI-VSR in a single centre.

Materials and Methods: A retrospective observational study was conducted in the Department of Cardiothoracic Surgery at Jayadeva Institute of Cardiovascular Sciences and Research, Bangalore, Karnataka, India. The patient records from January 2005 to December 2020, who underwent surgical repair of post-MI-VSR, were reviewed. The perioperative variables, mortality, and survival data were analysed. Kaplan-Meier analysis was performed to assess the survival time.

Results: The mean age of the studied patients was 58.4±7.5 years. A total of 73 patients underwent surgery for post-MI-VSR. A total of 40 (55.80%) were males and 33 (45.20%) were females. Overall, 36 (49.32%) patients had diabetes, and 27 (36.99%) had hypertension. Anterior Myocardial Infarction (MI) (n=56, 76.71%) was the most common location of MI. The mean Cardiopulmonary Bypass (CPB) and clamp times were 144.05±59.09 and 105.38±38.34 minutes, respectively. The mean survival time was 2619.564 days {95% Confidence Interval (CI) 2105.936 to 3133.192}.

Conclusion: As revascularisation confers a significant survival advantage, VSR repair with concomitant Coronary Artery Bypass Graft (CABG) appears beneficial.

Keywords: Cardiac, Complications, Surgery, Ventricle

INTRODUCTION

Ventricular Septal Rupture (VSR) is an uncommon but dreaded complication of Acute Myocardial Infarction (AMI) [1]. Post-MI-VSR is a fatal complication that shows poor outcomes with medical treatment and is associated with high morbidity and mortality (42.9%) when surgical interventions are performed [2]. The incidence of VSR following ST-segment elevation MI has decreased from 1%-3% in the pre-reperfusion era to 0.17%-0.31% following primary percutaneous coronary intervention [3-8]. Optimal reperfusion of the infarct-affected artery prevents VSR by salvaging myocardial tissue and limiting infarct expansion. In contrast, late reperfusion is associated with an increased risk of complications [5]. The most common cause of VSR is full-thickness (transmural) MI in one of the following coronary arteries: Left anterior descending coronary artery (apical VSR), Dominant right coronary artery (basal VSR), and dominant left circumflex artery. Partial-thickness infarcts can also increase the risk of VSR [9]. VSR frequently occurs within the first week post-MI (3-5 days). The clinical symptoms of VSR range from a symptomless cardiac murmur to cardiogenic shock [10].

The outcome is poor and is seen in old age, female sex, unstable haemodynamics at presentation, and delay in surgery. Perioperative haemodynamic shock and incomplete revascularisation are strong predictors of poor survival [11]. The first open repair of a VSR was performed by Cooley DA et al., in 1957 [12]. Since then, techniques have improved, leading to better outcomes [13,14]. It is challenging to determine the exact border between infarcted and healthy myocardium, making suture placement difficult in such conditions. Therefore, considering this literature background, the present study was planned to assess the survival pattern of post-MI-VSR patients who underwent surgery in a single centre.

MATERIALS AND METHODS

A retrospective observational study was conducted in the Department of Cardiothoracic Surgery at Sri Jayadeva Institute of Cardiovascular Sciences and Research, Bangalore, Karnataka, India. The records of patients with Post-MI-VSR were retrospectively retrieved from the hospital database. The records were retrieved over a period of 15 years (from January 2005 to December 2020). Institutional Ethical Clearance (IEC) was obtained (ref: SJICR/EC/2020/026).

Inclusion criteria: All patients who underwent surgery for VSR were included in the study.

Exclusion criteria: Incomplete records and patients who were managed medically were excluded from the study.

Study Procedure

The post-MI-VSR patients were admitted and evaluated by cardiologists, following the hospital protocol, and then referred for surgery. As the study site was a tertiary care set-up, the patients presented at different stages of the disease. Elective surgery was planned for haemodynamically stable patients, while emergency surgery was planned for haemodynamically unstable patients or those showing a trend of clinical deterioration (falling blood pressure, raising creatinine, decreasing oxygen saturation). In most cases, an Intra-aortic Balloon Pump (IABP) was inserted.

Patient demographics, including age, sex, diagnosis, and co-morbidities such as diabetes, hypertension, and renal dysfunction, were reviewed. Timing of IABP insertion and preoperative evaluation details of coronary angiogram and echocardiogram findings were noted. All patients underwent surgery with conventional CPB established, and VSR repair was performed using an exclusion technique with a Gore-Tex patch and interrupted sutures. The left ventricular cavity was closed using interrupted sutures with the buttressing technique. Patients who had non-graftable target vessels, complete occlusion, and large infarct areas did not undergo concomitant CABG, while this was performed in the remaining cases based on indications. Some patients also underwent additional procedures such as mitral valve replacement and the

Dors procedure [15]. Postoperative mortality was considered as the outcome variable, and CPB time, revascularisation of the culprit vessel, preoperative status, and surgical characteristics were studied as relevant variables.

STATISTICAL ANALYSIS

Data analysis was performed using Statistical Package for Social Sciences (SPSS) version 22.0. Descriptive analysis of categorical variables was done using frequency and percentage, while mean and Standard Deviation (SD) were used for continuous variables. Kaplan-Meier survival analysis was conducted to evaluate cumulative survival and time to event for outcome variables. Mean survival was calculated for the study participants.

RESULTS

A total of 73 patients were included in the study. The mean age of the studied patients was 58.4±7.5 years (range: 35 to 72 years), and 40 (55.80%) of them were males. The mean serum creatinine in the preoperative evaluation was 1.97±0.94 mg/dL, and 44 (60%) of them had renal dysfunction with serum creatinine levels >1.5 mg/dL. Overall, 65 (89.04%) of the patients underwent IABP insertion. Among the patients, 36 (49.32%) had one-vessel disease, 12 (16.44%) had two-vessel disease, and 17 (23.29%) had three-vessel disease. A total of 19 (26.03%) patients experienced postoperative complications, including renal failure (n=9), residual VSR (n=5), respiratory failure (n=3), and bleeding (n=2) [Table/Fig-1].

Parameters		n (%)
Demographics	Age (mean±SD)	58.4±7.5 (range 35 to 72)
Gender	Male	40 (55.80)
	Female	33 (45.20)
Co-morbidities	Diabetes mellitus	36 (49.32)
	Hypertension	27 (36.99)
	Renal dysfunction	44 (60.30)
Myocardial Infarction (MI)	Anterior wall MI	56 (76.71)
	Inferior wall MI	16 (21.92)
	Posterior wall MI	1 (1.37)
Number of vessels involved (n=65)+	1 vessel disease	36 (49.32)
	2 vessel disease	12 (16.44)
	3 vessel disease	17 (23.29)
	LV ejection fraction	39.5±6.80 (range 27 to 60)
Surgical characteristics	CABG plus VSR	36 (49.32)
	VSR	27 (36.98)
	VSR DOR	5 (6.85)
	VSR CABG DOR	3 (4.11)
	VSR CABG MVR	1 (1.37)
	VSR MVR	1 (1.37)
	CPB time (minutes)	144.05±59.09 (range 64 to 385)
	Clamp time (minutes)	105.38±38.34 (range 46 to 275)
Intra-aortic Balloon Pump (IABP) inserted	IABP	65 (91.78)
Insertion timing	Preoperative	52 (71.23)
	Intraoperative	14 (19.18)
	Postoperative	1 (1.37)
Revascularisation of the culprit vessel	No revascularisation possible	36 (49.32)
	LAD	31 (42.47)
	LAD (recancalised)	1 (1.37)
	RCA	5 (6.85)
No of grafts	0	33 (45.21)
	1.0	21 (28.77)
	2.0	16 (21.92)
	3.0	3 (4.11)
Postoperative complications		19 (26.03)
Alive or dead	Dead	31 (42.47)
	Alive	42 (57.53)
Survival time (in years)	<5	44 (60.3)
	5 and above	29 (39.7)

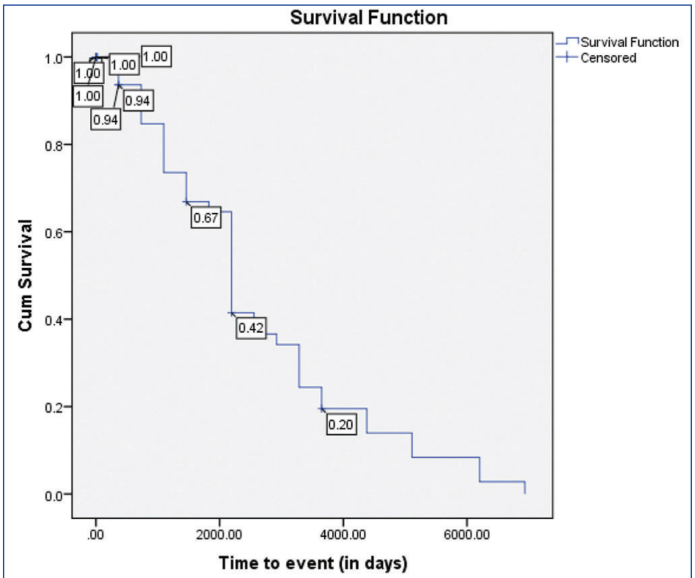
[Table/Fig-1]: Summary of baseline parameters (N=73).
CABG: Coronary artery bypass graft; VSR: Ventricular septal repair; DOR: DOR procedure; MVR: Mitral valve repair; CPB: Cardiopulmonary bypass; LAD: Left anterior descending; RCA: Right coronary artery; +- Only for patients who have undergone IABP

The mean survival time was 2619.564 days (95% CI 2105.936 to 3133.192) [Table/Fig-2,3].

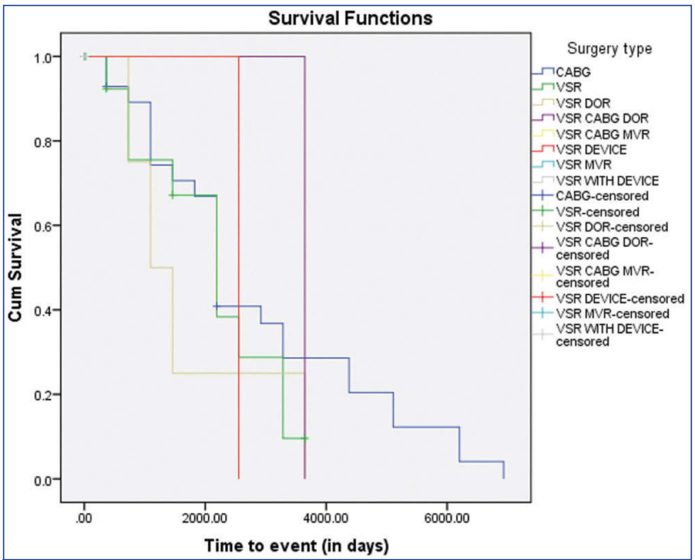
The median survival time was 2190.000 days for patients who underwent CABG and VSR repair [Table/Fig-4,5].

Mean survival time (in days)	Std. Error	95% confidence interval	
		Lower bound	Upper bound
2619.564	262.055	2105.936	3133.192

[Table/Fig-2]: Summary of overall survival time in the entire study population.



[Table/Fig-3]: Kaplan-Meier curve of overall survival time in the entire study population.



[Table/Fig-4]: Kaplan-Meier curves comparing the survival time between different surgeries.

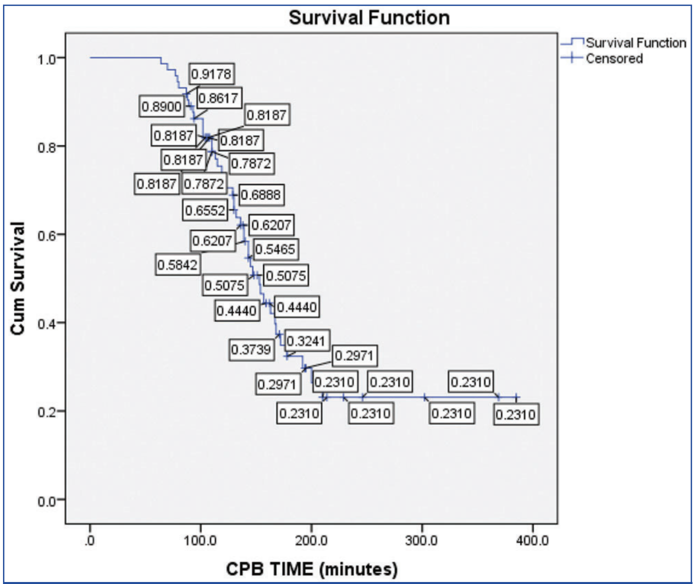
Surgery type	25th percentiles		Median		75th percentiles	
	Estimate	Std. Error	Estimate	Std. Error	Estimate	Std. Error
CABG	4380.000	715.382	2190.000	132.861	1095.000	412.099
VSR	3285.000	345.816	2190.000	373.998	1460.000	587.647
VSR DOR	1460.000	1106.347	1095.000	365.000	730.000	-
VSR CABG DOR	3650.000	-	3650.000	-	3650.000	-
VSR DEVICE	2555.000	-	2555.000	-	2555.000	-
Overall	3285.000	329.229	2190.000	117.615	1095.000	268.393

[Table/Fig-5]: Summary of survival time between different surgeries.
CABG: Coronary artery bypass graft; VSR: Ventricular septal repair; DOR: DOR procedure; MVR: Mitral valve repair

The mean CPB time was 194.024 minutes (95% CI 162.936 to 225.112) [Table/Fig-6,7]. The univariate logistic regression analysis had shown statistically significant association with survival time (odds ratio;1.002 and p<0.001) [Table/Fig-8].

Mean CPB Time (minutes)	Std. Error	95% Confidence interval	
		Lower bound	Upper bound
194.024	15.861	162.936	225.112

[Table/Fig-6]: Summary of overall CPB time in the entire study population.



[Table/Fig-7]: Kaplan-Meier curve of overall CPB time in the entire study population.

Parameter	Unadjusted odd ratio	95% CI		p-value
		Lower	Upper	
Survival time (in days)	1.002	1.001	1.003	<0.001

[Table/Fig-8]: Odds ratio of survival time in the study population (univariate logistic regression).

DISCUSSION

The VSR is a rare and life-threatening complication that can occur after AMI [2,8]. The incidence of AMI-VSR has decreased with the introduction of reperfusion procedures [15]. However, the mortality rate associated with VSR remains high [4]. VSR typically occurs within 2-8 days of MI, and if not diagnosed and surgically treated, patients may die from congestive cardiac failure [16]. Even with timely surgery, the in-hospital mortality rate remains high, and there has been no significant reduction in this rate over the years, making VSR the most lethal cardiac surgical condition [2,3,17]. However, due to the relatively low incidence of post-MI-VSR, there is limited available literature on the topic [2,18-20]. Clear guidelines on management and timing of surgical intervention are also lacking [3,17,21,22].

Haemodynamic instability in these patients can lead to cardiogenic shock, with involvement of the right ventricle and friable tissue around the infarct area, resulting in complex defects that can expand over time. Therefore, preoperative stabilisation of the patient is critical. Management of haemodynamically compromised patients involves decreasing left-to-right shunt with afterload reducing agents and insertion of an IABP. IABP increases coronary blood flow, reduces stress on the ventricular walls, and decreases oxygen demand [8]. In the present study, the majority of patients (91.78%) underwent IABP insertion. However, more evidence from prospective studies is needed to confirm the association between IABP insertion and patient survival.

The role of concomitant CABG in post-MI-VSR is debated. While CABG can address the underlying coronary artery disease and protect against long-term ischaemic risk, it also carries the risk of longer CPB and cross-clamp times [23]. Revascularisation of the culprit vessel can be technically challenging, especially if it is located within the infarcted segment and cannot be preserved within the repair zone. In such cases, CABG may be necessary, but it is associated with higher mortality in patients with multivessel CAD [23]. In the present study, revascularisation of the culprit vessel was possible in only 50.68% of the patients. The findings of the present study were compared with published literature in [Table/Fig-9] [2,3,16,24-27].

Title	Authors	Place of study	Duration of study	Sample size	Results	Conclusion and recommendation
Current study	Current study	South India	2005-2020	73	Mean survival time was 2619.564 days. CABG with VSR offered survival advantage	VSR repair with concomitant CABG in patient with post MI VSR is recommended
Survival and risk factors associated with surgical repair of VSR after AMI: A single-center experience [3]	Zhao K et al.,	China	2012-2021	45	Overall mortality rate was 20%. The time CPB was longer in the death group than in the survival group	Surgical repair resulted in good outcomes
Treatment strategies for VSR after MI: A single-centre experience [2]	Ma D et al.,	China	2017-2021	23	Overall in-hospital mortality rate was 21.7%. Surgical group had a lower mortality rate than the interventional closure group	Surgical operation is the most effective treatment
Outcome and profile of VSR with cardiogenic shock after MI: a report from the SHOCK Trial Registry [24]	Menon V et al.,	USA	2000	939	High in hospital mortality, 19% survival in patients undergone CABG	Even though prognosis is poor surgery remains the best therapeutic option
VSR complicating AMI: clinical characteristics and contemporary outcome [25]	Poulsen SH et al.,	Denmark	2008	64	Five year mortality was 95%, survival at five-year was 32%	Overall short- and long-term mortality remains high in the reperfusion era

What is the best timing of surgery in patients with post-infarct VSR? [26]	Papalexopoulou N et al.,	London, UK	2013	3238	Early surgery conferred survival advantage over late surgical correction	Based on the patients haemodynamic status timing of surgery to be decided
Surgical repair of postinfarction VSR: systematic review and meta-analysis [27]	Matteucci M et al.,	Italy	2021	6361	Operative mortality was 38.2%. Pooled ORs showed increased odds of operative mortality in patients with preoperative or perioperative intraaortic balloon pump insertion	Patients with right ventricular dysfunction, intra-aortic pump support had higher mortality
Surgical repair of post-infarction ventricular septal rupture: Determinants of operative mortality and survival outcome analysis [16]	Khan MY et al.,	Pakistan	2018	31	Operative mortality- 25.8%, preoperative Ejection Fraction (EF) and cardiogenic shock were risk factors	The patients in cardiogenic shock pre-operatively have a high operative mortality

[Table/Fig-9]: Comparison of current study's findings with literature [2,3,16,24-27].

Limitation(s)

The present retrospective study conducted in a single centre provides insights into the post-MI-VSR condition and its survival. However, it is important to note that the current study has certain limitations due to its retrospective nature. One limitation is the potential presence of confounding variables, such as other systemic diseases or infections, which may have not been addressed or accounted for in the analysis. Additionally, other factors that could influence mortality, such as liver and kidney functions, may have been missed due to the extraction of only study-relevant variables from the hospital records.

To overcome these limitations and gain a more comprehensive understanding of post-MI-VSR, it is recommended to conduct prospective studies with a larger sample sizes and in multicentre settings. Such studies would allow for better control of confounding variables and provide more robust and Generalisable results.

CONCLUSION(S)

In conclusion, the present analysis of post-MI-VSR repair using a single-centre database demonstrates that post-MI-VSR remains a devastating complication. Repairing post-MI-VSR is still associated with a high-risk, particularly in cases requiring emergency surgery, which has a higher mortality rate. The present study findings indicate that prolonged CPB time and postoperative complications are factors significantly associated with mortality. Patients in whom CABG was feasible showed a survival advantage. Given that revascularisation offers a survival benefit, the authors recommend VSR repair with concomitant CABG.

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PARTICULARS OF CONTRIBUTORS:
1. Associate Professor, Department of Cardiothoracic Surgery, Sri Jayadeva Institute of Cardiothoracic Sciences and Research, Bangalore, Karnataka, India.
2. Senior Registrar, Department of Cardiothoracic Surgery, Sri Jayadeva Institute of Cardiothoracic Sciences and Research, Bangalore, Karnataka, India.
3. Associate Professor, Department of Cardiothoracic Surgery, Sri Jayadeva Institute of Cardiothoracic Sciences and Research, Bangalore, Karnataka, India.
4. Professor, Department of Cardiothoracic Surgery, Sri Jayadeva Institute of Cardiothoracic Sciences and Research, Bangalore, Karnataka, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Shilpa Suresh,
2092, Prestige South Ridge, Hosakerehalli, Banashankari 3rd Stage,
Bangalore-560085, Karnataka, India.
E-mail: shilpa.suresh@gmail.com

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