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Relationship between Complete Revascularization and Survival after Post-Infarction Ventricular Septal Rupture

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Original Article

Abstract

INTRODUCTION: A well-known and fatal complication of myocardial infarction (MI) is post-infarction ventricular septal rupture (VSR). The benefits and risks associated with coronary angiography and subsequent coronary artery bypass grafting in these patients have sparked controversy. The aim of this study was to determine the outcome of revascularization following MI.

METHOD: Patients aged between 55 and 78 years were considered for the post-infarction ventricular septal rupture from 2011 to 2017. Factors such as age, sex, anthropometric measurements, systolic and diastolic blood pressure (SBP and DBP), and biochemical parameters like CPK-MB, cholesterol, low-density lipoprotein, high-density lipoprotein, and triglycerides were measured using standard methods.

The estimated Glomerular Filtration Rate (eGFR), a measure of kidney function, was also determined. Additionally, coronary angiographic factors including ECG changes, left ventricular (LV) systolic function, right ventricular (RV) function, Pulmonary Artery Pressure (PAP), proximal coronary lesions in VSR, systolic PAP, Right Atrial Pressure (RAP), and mortality rate were determined.

RESULTS: The study enrolled a total of 81 patients who had been surgically treated for post-infarction VSR. These patients were divided into two groups: survivors (n=35) and non-survivors (N=41). The mean systolic and diastolic blood pressure was higher in the survivor group (115.3 ± 18.7 vs. 96.3 ± 25.3 and 74.6 ± 12.2 vs. 61.2 ± 19.0, P=0.001). PCI was performed in 2.9% of survivors and 9.8% of non-survivors. Angiographic data revealed that 17 (33%) and 33 (63%) patients had single and multiple coronary artery diseases, respectively. CPK-MB levels were significantly higher in the non-survivors group (P<0.05). Echocardiographic findings, including LV ejection fraction, RV ejection fraction, systolic PAP, and the anatomic location of VSR, did not significantly differ between survivors and non-survivors.

CONCLUSION: Based on these findings, it is recommended to avoid complete revascularization during surgical repair of post-infarction ventricular septal rupture, as it would not improve the outcome.

Keywords: Revascularization, Post-infarction ventricular septal rupture, Coronary angiography, CABG, MI, VSR

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Introduction

Ventricular septal rupture (VSR) is an infrequent consequence of acute myocardial infarction (AMI), occurring in 1–2% of AMI patients[1]. VSR is highly associated with mortality and morbidity following AMI[2]. Myocardial Infarction (STEMI). However, VSR is associated with specific hospital mortality rates, and the reported survival is less than 10% after a

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month without surgical treatment[3, 4]. Therefore, the American College of Cardiology and the American Heart Association recommend surgical treatment of post-infarction VSR. Despite advances in surgical techniques and perioperative management, there is controversy about the overall condition of patients following surgical repair of post-infarction VSR[5], which is generally due to preoperative hemodynamic instability affected by preoperative right and left ventricular dysfunction and a left-to-right shunt[6, 7].

Despite advances in critical care and surgical techniques, mortality remains high, with 30-day mortality ranging from 19% to 54% [8]. There is no consensus regarding the indication for concomitant coronary angiography and coronary revascularization. However, information on the benefits of concomitant coronary angiography and subsequent coronary artery bypass grafting for immediate postoperative outcomes and long-term survival has become available [9]. Patients with post-infarction VSR are critically ill and often hemodynamically unstable, with an increased risk for renal impairment [10]. Moreover, decision-making regarding culprit lesions and the need for complete revascularization is consistently challenging. Thus, the importance of performing coronary angiography and revascularization has been studied, but the complexity of coronary anatomy has not been evaluated in previous studies [11]. Consequently, reducing early mortality rates is associated with improved long-term surgical outcomes. Therefore, identifying predictors for modest early and late outcomes is crucial. The current study refers to the experience with patients who underwent VSR repair at a single institution. Additionally, clinical outcomes related to the identification of potential treatment strategies were assessed to improve the poor results associated with VSR.

Materials and Methods

The Ethics Committee accepted this retrospective study of Shaheed Rajaie Cardiovascular, Medical & Research Center. Patients have a legal right to be told information about their medical condition and treatment. The signed consent was obtained after their agreement. Eighty-one consecutive patients with VSR diagnosis and history of surgery were identified between 2011 and 2017. Inclusion criteria were having ventricular septum with a history of a left-to-right shunt which Color Doppler Echocardiography typically diagnoses, and a history of having left-to-right shunt was confirmed by cardiac catheterization ventriculography. Any missing data related to the study variables consider as exclusion criteria. In addition, baseline characteristics such as age and sex, clinical status, laboratory data, the complexity of coronary artery anatomy, and echocardiographic findings were collected.

Critical Preoperative State

Patients with ventricular tachycardia, ventricular fibrillation, aborted sudden death, preoperative cardiac massage, preoperative ventilation before entering the anesthetic room, preoperative inotropes or IABP, and preoperative acute renal failure (anuria or oliguria < 10 ml/hr) are considered to be in a critical preoperative state.

MI Diagnosis

Electrocardiographic (ECG) changes and a rise in cardiac biomarkers for myocardial necrosis are considered diagnostic tests for MI. In all cases, post-infarction VSR was confirmed by echocardiography features of the coronary arteries obtained from the angiogram and angiogram notes.

Coronary Angiography

Coronary angiography was performed, and a significant coronary lesion was defined as a luminal narrowing with a diameter stenosis of more than 70%. A coronary lesion was labeled proximal when it was located proximal to the first major side branch.

Echocardiography

Transthoracic echocardiography using a commercial GE Vivid 3 with a 3-MS variable frequency harmonic phased-array transducer

was carried out for all patients according to the American Society of Echocardiography guidelines. The echocardiographic parameters, including left ventricular (LV) systolic function, right ventricular (RV) function, pulmonary artery pressure (PAP), and location of VSR, were studied. The LV systolic function was evaluated visually using the ejection fraction (LVEF). RV systolic function was estimated using the tissue doppler-derived tricuspid lateral annular systolic velocity (S') and tricuspid annular plane systolic excursion (TAPSE). Systolic PAP was estimated by calculating the systolic transtricuspid gradient using the modified Bernoulli equation and then adding an expected or considered correct atrial pressure (RAP).

Statistical Analysis

Continuous and categorical variables were represented as the mean ± standard deviation and absolute and relative (%) values, respectively. A normality assumption was verified using the Kolmogorov–Smirnov test. Differences between groups were assessed using Chi-square or Fisher's exact tests (where appropriate) and one-way ANOVA or the Kruskal–Wallis test. A p-value of less than 0.05 was considered statistically significant (SPSS for Windows, Version 16.0. Chicago, SPSS Inc).

Results

Eighty-one patients with post-infarction VSR who underwent surgical treatment were enrolled in the study and divided into two groups: survivors and non-survivors. In total, five patients were excluded due to incomplete records. Table 1 summarizes baseline characteristics such as age, sex, clinical status, laboratory data, the complexity of coronary artery anatomy, and echocardiographic findings. Males comprised 51.3% (39 patients) of the sample, and females 48.7% (37 patients).

Table 1. Baseline characteristics of study population

Variables	Survivor N=35	Non-survivors N= 41	P value
Male gender	13(37.1%)	26(63.4%)	0.83
Age(year)	66.6 ±2.2	66.2 ±10.2	0.65
body mass index	25.1 ±4.1	25.2 ±5	0.88
EURO Score	9 ±7.5	19.5 ±14	0.001
Systolic blood pressure , (mmHg)	115.3 ±18.7	96.3 ±25.3	0.001
Diastolic blood pressure (mmHg)	74.6 ±12.2	61.2 ±19.0	0.001
eGFR(ml/min)	63.1 ±21.5	49 ±26.1	0.06
Creatinine(mg/dl)	1.1 ±0.2	2.1 ±1.2	0.001
Fasting blood sugar(mg/dl)	131.4 ±63.2	178.4 ±94	0.007
Total cholesterol(mg/dl)	138.4 ±41.8	152.6 ±29.4	0.07
LDL cholesterol(mg/dl)	83.5 ±39.6	85 ±27.2	0.42
HDL cholesterol (mg/dl)	32.8 ±6.4	30.9 ±10.4	0.71
Triglyceride(mg/dl)	119.4 ±68.1	130.4 ±55.3	0.11
Troponin I (ng/ml)	2.2 ±2.8	13.3 ±26.2	0.03
CPK-MB(IU/L)	27.6 ±24.8	111.5 ±136.8	0.001
NYHA class			
I	0	0	
II	10(28.5%)	4(9.7%)	0.22
III	14(40.0%)	13(31.7%)	
IV	9(25.7%)	13(31.7%)	
Thrombolysis treatment	9(25.7%)	12(29.3%)	0.75
MI territory			

Variables	Survivor N=35	Non-survivors N= 41	P value
Unknown	5(19.2)	11(22%)	0.05
Anterior	16(61.5)	37(74)	
Inferior	5(19.2)	1(2)	
RV MI	0	1(2)	
PCI(Yes)	1(2.9%)	4(9.٧%)	0.23
Mortality rate(in Critical preoperative state)	6 (27.3%)	16 (72.7%)	0.03

Chi-square (fisher exact test) and ANOVA were used for categorical and continuous variables.
Data were reported as mean SD and absolute number(percent) for continuous and categorical variables

There were no significant differences in age, BMI, eGFR, total cholesterol, LDL, HDL, and triglycerides. The mean systolic and diastolic blood pressure was higher in the survivor group (115.3 ±18.7 vs. 96.3 ±25.3 and 74.6 ±12.2 vs. 61.2 ±19.0, P=0.001). MI and VSR were the most dominant causes of mortality.

In total, 55% of the included patients were treated with lytic before revascularization. The mortality rate in patients in the critical preoperative state was 72%, P=0.03.

PCI was performed in 2.9% and 9.8% of survivors vs. non-survivors, respectively. The median interval between AMI and surgical intervention was eight days (data not shown). The angiographic information indicated that 17 (33%) and 33 (63%) of the patients had single and multiple coronary artery diseases, respectively (data not shown). CPK-MB levels were significantly higher in the non-survivors group (P<0.05). The septum ruptured in the anteropical septum in forty patients and the poster basal septum in three patients. Echocardiographic findings, including LV ejection fraction, RV ejection fraction, systolic PAP, and anatomic location of VSR, were not significantly different between survivors and non-survivor patients [Table 2].

Table 2. Echocardiographic findings of study population

	Survivors N=35	Non-survivors N=41	P value
LVEF(%)	33.8 ±8.8	30.5 ±7.7	0.1
PAP(mmHg)	50.2 ±13.9	50.3 ±12	0.9
VSR Location			
Unknown	8(22.8)	21(51.2)	
Anterior	16(45.7)	28(39.4)	0.6
Muscular	2(5.71)	2(4.87)	
Apical	8(22.8)	14(34.1)	
Inferior	2(5.71)	1(2.43)	
RV Dysfunction			
No	4(11.4)	10(2.43)	
Mild	13(37.1)	23(56.1)	0.4
Moderate	17(48.6)	16(39.02)	
Severe	1(2.9)	4(9.75)	

LVEF: Left ventricular Ejection Fraction, PAP: Pulmonary Arterial Pressure, VSR : ventricular septal rupture
Chi-square (fisher exact test) and ANOVA were used for categorical and continuous variables.
Data were reported as means and absolute number(percent) for continuous and categorical variables

Discussion

The findings of this study suggest that VSR is more likely to occur in patients with higher levels of troponin I and CPK-MB prior to the operation. Previous research has indicated that early surgical repair is the preferred treatment, despite a high mortality rate of 50% [1-6]. There is no general consensus on the need for coronary angiography and the benefits of complete revascularization in patients with post-infarction VSR [8]. Typically, these patients are hemodynamically unstable and are prone to developing contrast-induced nephropathy. As a result, angiography is omitted in some patients, and the surgeon opts to perform concurrent revascularization during surgery. This study completed revascularization for 22 patients, and 14 underwent culprit revascularization.

Perotta et al. demonstrated the benefits of concurrent CABG in patients with post-infarction VSR [9]. However, this study found no mortality advantage in those who underwent concurrent CABG. Most patients with VSR rupture currently do not have extensive disease of the coronary arteries near the blocked infarct-related artery.

In contrast, in other cases, those with another coronary artery disease may derive significant benefit from appropriate revascularization [10–12]. The incidence of VSR has declined with the introduction of new management strategies for AMI. Previous findings indicated that VSR occurred in patients after AMI by 1–2% before the initiation of thrombolytic therapy [1, 2]. Additionally, other researchers have also noted that performing PCI during AMI reduces the incidence of VSR [15, 16]. However, data from the New Jersey Myocardial Infarction Data Acquisition System showed a persistently higher death rate of VSR despite advancements in treatment and revascularization techniques over the past two decades [17].

Takahashi et al. established that the mean time between myocardial infarction and surgical intervention was significantly longer in patients who survived for 30 days than in those who did not (27±25 vs. 5±6 days, P<0.01, respectively). They suggested that patients with VSR would receive the maximum benefit from timely and aggressive surgical therapy [18]. Currently, prompt identification and immediate cardiac support, such as an IABP, are recommended in patients with VSR [9]. An IABP as hemodynamic support is widely accepted in the management of VSR since preoperative IABP will improve cardiac output, reduce the left-to-right shunt, and increase coronary perfusion. Presurgical cardiogenic shock surgery influenced initial survival, indicating that improving patients' hemodynamic status before surgery is crucial. The fragile necrotic myocardium is a critical concern during emergency surgery. Deja et al. showed a third of postoperative residual shunts in 40% of patients necessary for reoperation [19]. On the other hand, some data suggested that associated myocardial revascularization with post-infarction VSR increases late survival [20-21]. Takahashi et al. identified partial coronary revascularization as a significant risk factor for 30-day death. Patients with post-infarction VSR are regularly evaluated by preoperative coronary angiography, which is mandatory to identify stenotic coronaries. Numerous limitations are associated with the current study, the number of patients was too small to draw definite inferences concerning which factors contributed to the postoperative course; our subjects were not prospectively randomized, and surgical approaches were not consistent throughout the series; and few subjects could be measured over a 31-year follow-up, that makes any attempt to identify independent predictors difficult. A review of related studies established that optimal revascularization of the residual viable myocardium could improve recovery [22].

Conclusion

Based on these findings, it is recommended to avoid complete revascularization during the surgical repair of post-infarction ventricular septal rupture, as it would not improve the outcome.

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