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Risk factors of mortality after surgical correction of ventricular septal defect following myocardial infarction: Retrospective analysis and review of the literature

Alexandre Cinq-Mars [a], Pierre Voisine [b], François Dagenais [b], Éric Charbonneau [b], Frédéric Jacques [b], Dimitris Kalavrouziotis [b], Jean Perron [b], Siamak Mohammadi [b], Michelle Dubois [a], Florent Le Ven [c], Paul Poirier [c], Kim O'Connor [c], Mathieu Bernier [c], Sébastien Bergeron [c], Mario Sénéchal [c,*]

[a] Research Center, Institut Universitaire de Cardiologie et de Pneumologie de Québec, Québec City, Canada
[b] Department of Cardiac Surgery, Institut Universitaire de Cardiologie et de Pneumologie de Québec, Québec City, Canada
[c] Department of Cardiology, Institut Universitaire de Cardiologie et de Pneumologie de Québec, Québec City, Canada

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ABSTRACT

Background: Rupture of the ventricular septum following acute myocardial infarction (AMI) is an uncommon but serious complication, usually leading to congestive heart failure and cardiogenic shock. Surgical repair is the only definitive treatment for this condition.
Methods: We review our experience of surgical repair of post-infarction ventricular septal defects (VSDs), analyze the associated risk factors and outcomes, and do a complete review of the literature. A retrospective study was performed on 34 consecutive patients who had undergone surgical repair for VSDs following AMI from December 1991 to July 2014. Preoperative, clinical and echocardiographic variables were studied by uni-and multivariate analyses.
Results: Mortality was analyzed for the entire group of patients. Mean age was 69 ± 7 years with 44% women. VSDs were anterior in 11 (32%) and posterior in 23 (68%) patients. A majority, 24 (71%) patients were in cardiogenic shock. Median interval from myocardial infarction to VSDs repair was 7 days. The 30 days operative mortality was 65%. Mortality within the posterior VSDs group was 74% and the anterior VSDs group was 46% ($P = 0.14$). Concomitant coronary artery bypass graft (CABG) did not influence early or late survival. Multivariate analysis identified older age (HR = 1.11, $P = 0.0001$) and shorter time between AMI and surgery (HR = 0.90, $P = 0.015$) as independent predictors of 30-day and long-term mortality.
Conclusion: In conclusion, surgical repair of post-AMI VSDs carries a high operative mortality. An algorithm of treatment for the management of these patients is suggested.

1. Introduction

Despite significant improvements in overall mortality for patients with acute myocardial infarction (AMI) over the last two decades, the outcome of patients who develop ventricular septal defects (VSDs) remains poor. Rupture of the ventricular septum following myocardial infarction is an uncommon complication, with contemporary series reporting an incidence ranging between 0.17 and 0.31% of patients presenting with AMI [1]. Transmural AMI generating a VSDs affects ventricular function and has the potential to generate a macro-reentry circuit, inducing congestive heart failure, ventricular tachyarrhythmia and cardiogenic shock. Unpredictable hemodynamic deterioration is the norm in most patients in the days and weeks following VSDs, and reports of long-term survival without corrective surgery are extremely rare. In fact, surgical repair is the only definitive treatment for these patients since medical management has 30-day mortality approaching 100% [2]. However, complex surgical repairs are characterized by mortality near 50% in multicentre reports [3–6]. Many risk factors have been identified to explain the poor outcomes of surgical repair for post-AMI VSDs [7]. Cardiogenic shock with hemodynamic instability, emergency surgery, early repair, right ventricular dysfunction, VSDs of posterior location, renal impairment and complex VSDs represent common potential risk factors [3]. Under optimal management, 30-day mortality rates range from 19 to 54% [2–7].

In this retrospective study, we have analyzed our experience regarding the surgical treatment of patients with VSDs following AMI in the past decades. In addition, a review of the literature has been performed to identify key points in the management of patients with post-AMI VSDs.

* Corresponding author at: Institut Universitaire de Cardiologie et de Pneumologie de Québec, 2725, Chemin Sainte-Foy, Quebec, Quebec G1V 4G5, Canada.
E-mail address: mario.senechal@criucpq.ulaval.ca (M. Sénéchal).

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2. Methods

A retrospective chart review for presentation, management and outcomes was carried out in a cohort of 34 patients who underwent surgery for post-AMI VSDs between December 1991 and July 2014 at the "*Institut Universitaire de Cardiologie et de Pneumologie de Quebec*". Pre- and peri-operative variables were collected from the cardiac surgeons' database. Primary outcome was 30-day mortality. Clinical and echocardiographic data were assessed to identify significant risk factors for early and late mortality. We certify that the study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a priori approval by the institution's human research committee.

2.1. Definitions

Cardiogenic shock was defined as; 1 — systolic blood pressure ≤ 80 mm Hg or mean arterial pressure ≤ 60 mm Hg, with evidence of end-organ hypoperfusion (obtundation, decreased urine output, elevated creatinine levels or elevated blood urea nitrogen, or cool, clammy skin), or 2 — the requirement for mechanical or pharmacological interventions to maintain blood pressure and end-organ perfusion [8]. Renal impairment was defined as reduction in kidney function characterized by an absolute increase in serum creatinine ≥ 150 μmol/l, or a reduction in urine output (documented oliguria of <0.5 ml/kg/h for >6 h) [9]. Pulmonary hypertension was defined as mean pressure ≥ 25 mm Hg. Operative mortality was defined as death within 30 days of surgery, either in hospital or after hospital discharge.

2.2. Statistical analysis

Continuous variables were tested for distribution normality with the Shapiro–Wilk test and expressed as mean ± SD or median and interquartile range. Differences between groups were assessed using t-test for continuous variables and χ^2 test or Fisher exact test for categorical variables. Long-term survival was presented with a Kaplan–Meier curve. The impact of clinical and Doppler echocardiographic variables on in-hospital and overall mortality was assessed with logistic and Cox proportional-hazard regression models, respectively. Clinically relevant variables with a P-value ≤ 0.05 on individual analysis were included in backward stepwise multivariable models. P-value ≤ 0.05 was considered statistically significant.

3. Results

Patient demographic and clinical characteristics are presented in Tables 1 and 2. Mean age was 69 years with 44% women. The VSDs was anterior in 11 (32%) and posterior in 23 (68%) patients. Sixteen (47%) patients had a single vessel coronary artery disease. Mean ejection fraction was 44 ± 14%, and 24 patients (71%) were in cardiogenic shock. Mean systolic blood pressure was 97 ± 19 mm Hg and mean diastolic blood pressure was 60 ± 13 mm Hg. Pre-operative intra-aortic balloon pump was inserted in 22 patients (65%). Twenty-seven patients (79%) were intubated before the operation and 12 (35%) presented with right ventricular dysfunction. Median interval from AMI to VSDs repair was 7 days.

Operative and post-operative data are listed in Table 3. Mean aortic cross clamp and cardiopulmonary bypass times were 94 and 141 min, respectively. Coronary artery bypass grafting (CABG) was performed in 15 patients (44%).

Outcomes are presented in Table 4. Thirty days operative mortality was 65%. Mortality for the posterior VSDs group was 74% and the anterior VSDs group 46%. Univariate analysis identified age, body mass index (BMI), diastolic blood pressure, posterior localization of VSDs, bypass time, cross-clamp time, reoperation during hospitalization and time between AMI and surgery as predictors of long-term mortality.

Table 1
Patients demographic data.

Variables	Survivors	Non-survivors	Total	P
	n = 12 (%)	n = 22 (%)	n = 34 (%)	
Age	64 ± 8	72 ± 4	69 ± 7	<0.001
Gender (Female)	3 (25)	12 (55)	15 (44)	0.152
Diabetes	4 (33)	7 (32)	11 (32)	1
Arterial hypertension	6 (50)	11 (50)	17 (50)	0.535
Smoking	1 (8)	8 (36)	9 (27)	0.113
BMI	28 ± 4	25 ± 4	26 ± 4	0.0096
History of CAD	9 (75)	20 (91)	29 (85)	0.329
History of stroke	1 (8)	1 (5)	2 (6)	1
COPD	4 (33)	3 (14)	7 (21)	0.211
Renal impairment (Créat > 150)	5 (42)	5 (23)	10 (29)	0.271

Table 2
Patients clinical data.

Variables	Survivors	Non-survivors	Total	P
	n = 12 (%)	n = 22 (%)	n = 34 (%)	
AMI location (inferior)	6 (50)	17 (77)	23 (68)	0.138
Thrombolysis	4 (33)	7 (32)	11 (32)	1
EF (ejection fraction)	42 ± 11	44 ± 16	44 ± 14	0.572
Cardiogenic shock	6 (50)	18 (82)	24 (71)	0.110
Right ventricular failure	3 (25)	9 (41)	12 (35)	0.465
Systolic pressure (mm Hg)	99 ± 16	97 ± 21	97 ± 19	0.759
Diastolic pressure (mm Hg)	66 ± 12	56 ± 13	60 ± 13	0.027
Pulmonary hypertension	3 (25)	7 (32)	10 (29)	1
Mitral regurgitation	9 (75)	11 (50)	20 (59)	0.275
Mitral regurgitation ≥ 2/4	2 (17)	3 (14)	5 (15)	1
Tricuspid regurgitation	6 (50)	13 (59)	19 (56)	0.724
Tricuspid regurgitation ≥ 2/4	5 (42)	10 (46)	15 (44)	1
VSD diameter (mm)	17 ± 10	15 ± 6	16 ± 7	0.765
VSD location (posterior)	6 (50)	17 (77)	23 (68)	0.138
IABP	10 (83)	20 (91)	30 (88)	0.602
Preoperative IABP	7 (58)	15 (68)	22 (65)	0.711
Perioperative IABP	2 (17)	4 (18)	6 (18)	1
Postoperative IABP	1 (8)	1 (5)	2 (6)	1
Preoperative intubation	9 (75)	18 (82)	27 (79)	0.677
Time interval AMI-VSD (d)	7.21	1.79	3.91	0.014
Time interval VSD-OP (d)	4.44	2.74	3.38	0.198
Time interval AMI-OP (d)	11.65	4.4	7.03	0.013

Table 3
Operative and post-operative data.

Variables	Survivors	Non-survivors	Total	P
	n = 12 (%)	n = 22 (%)	n = 34 (%)	
Cardioplegia vs. perfused heart	11 (92)	20 (91)	31 (91)	1
Cardioplegia type (blood)	11 (92)	22 (100)	33 (97)	0.353
Normothermia vs. hypothermia	7 (58)	14 (64)	21 (62)	1
Concomitant CABG	4 (33)	11 (50)	15 (44)	0.476
Concomitant LV repair (aneurysm or pseudoaneurysm repair)	5 (42)	8 (36)	13 (38)	1
Cross clamp time (min)	83 ± 21	100 ± 44	94 ± 38	0.215
Bypass time (min)	115 ± 29	156 ± 62	141 ± 56	0.042
Cardioplegia volume use (ml)	3937 ± 4520	4381 ± 2540	4145 ± 3286	0.722
Glue use	4 (33)	7 (32)	11 (32)	1
Low cardiac output syndrome (cardiac index, 2.0 l/min per m^2)	6 (50)	14 (64)	20 (59)	0.487
Residual VSD	3 (25)	6 (27)	9 (27)	1
ECMO	0	1 (5)	1 (3)	1
Renal failure	6 (50)	11 (50)	17 (50)	1
Stroke	1 (8)	2 (9)	3 (9)	1
Reoperation	4 (33)	3 (14)	7 (21)	0.211