DOI: 10.4149/BLL_2021_088

Bratisl Med J 2021; 122 (8)
555 – 558

CLINICAL STUDY

Mortality and risk factors after a surgical repair of postinfarction ventricular septal defect

Artemiou P, Gasparovic I, Bezak B, Hudec V, Glonek I, Hulman M

Medical Faculty of the Comenious University, National Institute of Cardiovascular diseases, Clinic of Cardiac Surgery, Bratislava, Slovakia. **panayiotisartemiou@yahoo.com**

ABSTRACT

BACKGROUND: The aim of this study was to present our experience in the treatment of post-myocardial infarction ventricular septal defect and examine the various risk factors.

METHODS: This is a retrospective study. From January 2010 to December 2018, 20 patients underwent an urgent /emergency surgical repair of post-myocardial infarction ventricular septal defect.

RESULTS: The mortality in our group of patients was 45 %. Non-survivors compared to the survivors were all in cardiogenic shock (p=0.0098), had an emergency/salvage operation (p=0.0055), preoperative mechanical ventilation (p=0.0081), shorter time between intraaortic balloon pressure insertion and surgery (p=0.0115), shorter median time between ventricular septal defect and surgery, postoperative renal replacement therapy (p=0.0498), and more patients had a residual effect (p=0.0022). In multivariate analysis, preoperative mechanical ventilation (p=0.0001), postoperative renal replacement therapy (p=0.0021) and residual defect (p=0.0000027) were shown to be strong predictors for hospital mortality.

CONCLUSION: This analysis showed that post-myocardial infarction ventricular septal defect repair is a devastating complication and preoperative mechanical ventilation, postoperative renal replacement therapy and residual defect were identified to be the predictors of mortality. Initial stabilization of the patients, when it is possible, and a delayed repair, may improve the outcome of these patients *(Tab. 3, Ref. 17)*. Text in PDF *www.elis.sk*

KEY WORDS: myocardial infarct, mortality and risk factors, surgical repair, postinfarction ventricular septal defect, cardiogenic shock, emergency/salvage operation, preoperative mechanical ventilation.

Introduction

Ventricular septal defect (VSD) is a rare, but life-threatening complication of acute myocardial infarction (MI), which usually occurs during the first 10 days, following acute MI. Despite progress in invasive cardiology and surgical techniques, the mortality rate after the development of this complication is high, 94 % with medical management and 43 % with surgical treatment (1, 2).

Many risk factors have been identified to explain the poor outcomes of surgical repairs for post –MI VSD. Cardiogenic shock, emergency surgery, early repair, right ventricular dysfunction, VSD of posterior location, renal impairment and complex VSD s represent potential risk factors (3).

In this study, we have analysed our experience regarding the surgical treatment of patients with post-MI VSD, in the last decade.

Medical Faculty of the Comenious University, National Institute of Cardiovascular diseases, Clinic of Cardiac Surgery, Bratislava, Slovakia

Address for correspondence: P. Artemiou, MD, PhD, Medical Faculty of the Comenious University, National Institute of Cardiovascular Diseases, Pod krasnou horkou 1, SK-831 01 Bratislava, Slovakia.
Phone: +421.917665774, Fax: +421.259320287

Patients and methods

This is a retrospective study. From January 2010 to December 2018, 20 patients underwent urgent or emergency surgical repair of post-MI VSD. Data for the following variables were collected from the hospital records: age, gender, body mass index, EuroSCORE II, hypertension, hyperlipidaemia, chronic renal failure, diabetes mellitus, stroke, smoking, preoperative atrial fibrillation, chronic obstructive pulmonary disease, previous MI, previous percutaneous coronary intervention, cardiogenic shock, New York Heart Association (NYHA) class, Canadian Cardiology Society (CCS) class, prior cardiac surgery, urgency of operation, extend of coronary disease, diameter and localization of the VSD, preoperative intra-aortic balloon pressure pump (IABP), time between IABP and surgery, and time between VSD and surgery. The outcomes of our study were: hospital mortality, and postoperative complications such as re-exploration for bleeding, renal replacement therapy, gastrointestinal complications, postoperative atrial fibrillation, sternal wound infection, postoperative pneumonia, need for tracheostomy and need for postoperative cardiopulmonary support.

An approval of the ethics committee and patient written consent were obtained, to present this study.

The operation was performed through the median sternotomy with the use of a cardiopulmonary bypass with aortic and bicaval

Tab. 1. Comparison between survivors and non-survivors (baseline characteristics).

Variable	Total n=20	Survivors n=11	Non-survivors n=9	p
Age(years, mean±SD)	63.65±8.75	61.27±6.40	66.56±10.64	0.4613
Gender(male)	10 (50%)	6(54.55%)	6(66.66%)	0.6699
BMI, (kg/m2)	28.30±3.56	29.08±3.70	27.34±3.44	1
EuroSCORE II (mean±SD)	11.67±4.25	9.67±5.05	14.67±7.84	0.4462
Hypertension	10(50%)	8 (72.73%)	2 (22.22%)	0.0698
Hyperlipidemia	4 (20%)	3 (27.27%)	1 (11.11%)	0.5913
Chronic renal failure	2 (10%)	2 (18.18%)	0 (0%)	0.4789
Diabetes Mellitus	7 (35%)	5 (45.46%)	2 (22.22%)	0.3742
Stroke	1 (5%)	1 (9.09%)	0 (0%)	1
Smoker	2 (10%)	1 (9.09%)	1 (11.11%)	1
Atrial fibrillation	1 (5%)	0 (0%)	1 (11.11%)	0.45
COPD	1 (5%)	1 (9.09%)	0 (0%)	1
Previous MI	3 (15%)	3 (27.27%)	0 (0%)	0.2184
Previous PCI	10 (50%)	6 (54.55%)	4 (66.66%)	1
Cardiogenic shock	11(55%)	2 (18.18%)	9 (100%)	**0.0098**
NYHA class (mean±SD)	3±1.15	2.9±1.36	3.11±1.27	0.2529
CCS class	2.53±1.35	2.4±1.66	2.67±1.12	0.5908
Previous cardiac surgery				
Valve surgery	1 (5%)	0 (0%)	1 (11.11%)	0.45
Surgical status				
Urgent	10 (50%)	9 (81.82%)	1 (11.11%)	**0.0055**
Emergency/salvage	10 (50%)	2 (18.18%)	8 (88.82%)	**0.0055**
Preoperative angiography				
1-vessel disease	9 (45%)	4 (36.36%)	5 (55.56%)	1
2-vessel disease	9 (45%)	5 (45.45%)	4 (44.44%)	1
3-vessel disease	2 (10%)	2 (18.18%)	0 (0%)	0.4706
Anterior VSD	8 (40%)	4 (36.36%)	4 (44.44%)	1
Posterior VSD	12 (60%)	8 (72.73%)	4 (44.44%)	1
VSD diameter (mm, mean±SD)	23.77±9.27	19.45±5.96	28.89±10.24	0.2207
Preoperative mechanical ventilation	5 (25%)	0 (0%)	5 (55.56%)	**0.0081**
Preoperative IABP	10 (50%)	3 (27.27%)	7 (77.78%)	0,0698
Time between IABP and surgery (days, mean±SD)	4±3.38	6.3±1.70	3±3.42	**0,0115**
Time between VSD and surgery (days, median)	8.5 (1-170)	14 (1-170)	1 (0-11)	

SD = standard deviation, BMI = body mass index, COPD = chronic obstructive pulmonary disease, MI = myocardial infarct, PCI = percutaneous coronary intervention, NYHA = New York Heart Association, CCS = Canadian Cardiology Society, VSD = ventricular septal defect, IABP = intraaortic balloon pressure pump

cannulation. The following surgical techniques were used: single patch repair in 13 patients and sandwich repair in 7 patients (4).

Statistical analysis

All variables are expressed as the mean ± standard deviation, median values, and qualitative variables as numbers and percentages. Fischer´s exact test was used to compare the categorical variables. For the multivariate analysis, a linear regression analysis was used. The p value lower than 0.05 was considered statistically significant. The statistical analyses were performed using the Rstudio 1.2.5033 statistical software (Rstudio Inc, Boston MA, USA).

Results

The baseline characteristics of the patients, survivors, and non-survivors, are shown in Table 1. The non-survivors compared to the survivors were all in cardiogenic shock (18.18 % vs 100 % p=0.0098), had emergency/salvage operation (18.18 % vs 88.82 % p=0.0055), preoperative mechanical ventilation (0 % vs 55.56 % p=0.0081), shorter time between IABP insertion and surgery (3±3.42 days vs 6.3±1.70 days p=0.0115), and shorter median time between VSD and surgery (1 vs 14 days).

The operative and postoperative outcomes of the patients, survivors, and non-survivors, are shown in the Table 2. The non-survivors compared to the survivors had postoperative renal replacement therapy (9.09 % vs 55.56 % p=0.0498), and more patients had a residual defect (0 % vs 66.67 % p=0.0022).

In multivariate analysis, preoperative mechanical ventilation (p=0.0001), postoperative renal replacement therapy (p=0.0021) and residual defect (p=0.0000027) were shown to be strong predictors for hospital mortality (Tab. 3).

The mortality of the cohort was 45 % (9/20 patients). Ten patients had preoperative IABP insertion and 10 patients were treated without IABP support with the mortality of 70 % (7/10 patients) and 20 % (2/10) respectively.

Discussion

Post-MI VSD is a serious clinical problem with a high mortality rate. In recent years, early and efficient revascularization therapy for myocardial infarction has contributed to a decreased incidence of VSDs (5). However, the management of patients with post-MI VSD remains a challenge. The spectrum of surgical patients seems to switch towards the patients with a more extensive heart failure, hemodynamic compromise, and associated co-morbidities.

Our experience regarding mortality is in accordance with the previously published reports, which is in the range between 20 % and 40 % (6–11).). The mortality was 45 %. In 2005, the national registry from Sweden (12) reported short and long term outcomes in 189 patients in 10 centers during a 7-year period, with a 30-day mortality rate of 41 %. In 2012, national registry data provided by the Society of Thoracic Surgeons (STS) Adult Cardiac Surgery Database (ACSD) (2) examined the risk factors for in-hospital outcomes after a surgical repair of post-MI VSD in 2876 patients from 1999 to 2010 with an operative mortality of 42.5 %. Recent data published by the Japan Adult Cardiovascular Surgery Database (JCVSD) (13) from 1397 patients from 2008 to 2014 showed the operative mortality of 33 %.

Tab. 2. Comparison between survivors and non-survivors (operative characteristics and postoperative outcomes).

Variable	Total n=20	Survivors n=11	Non-survivors n=9	p
CPB (min, mean±SD)	145.1±46.07	123.18±36.79	171.89±43.38	0.7276
ACC (min, mean±SD)	91.85±25.73	82.55±20.57	103.22±27.90	0.9246
Concomitant CABG	12 (60%)	6 (54.55%)	6 (66.67%)	0.6699
Surgical technique				
Single patch repair	13 (65%)	9 (81.82%)	4 (44.44%)	0.1597
Sandwich repair	7 (35%)	2 (18.18%)	5 (55.56%)	0.1597
Residual defect	6 (30%)	0	6 (66.67%)	**0.0022**
Concomitant mitral valve surgery (replacement)	0	0	1 (11.11%)	0.45
Concomitant tricuspid valve surgery (ring annuloplasty)	3 (15%)	2 (18.18%)	1(11.11%)	1
Postoperative percutaneous cardiopulmonary support-ECMO	1(5%)	0	1(11.11)	0.45
Re-exploration for bleeding	3 (15%)	1(9.09%)	2 (22.22%)	0.5658
Renal replacement therapy	6(30%)	1(9.09%)	5 (55.56%)	**0.0498**
Postoperative atrial fibrillation	5 (25%)	5 (45.46%)	0	**0.0379**
Sternal wound infection	1(5%)	0	1(11.11%)	0.45
Postopertive pneumonia	1(5%)	1(9.09%)	0	1
Septicemia	1(5%)	0	1(11.11%)	0.45
Tracheostomy	1(5%)	1(9.09%)	0	1

SD = standard deviation, CPB = cardiopulmonary bypass, ACC = aortic cross clamp, CABG = coronary artery bypass grafting, ECMO = extracorporeal membrane oxygenation

Tab. 3. Multivariate analysis of risk factors.

Variable	95% CI	p
Cardiogenic shock	0.754-1.055	0.2097
Emergency/salvage operation	0.689-1.012	0.0930
Preoperative mechanical ventilation	0.548-0.676	**0.0001**
Postoperative renal replacement therapy	0.691-0.944	**0.021**
Residual defect	0.495-0.676	**0.0000027**

CI = confidence interval

In our study, preoperative mechanical ventilation, postoperative renal replacement therapy and a residual defect seemed to be the predictors of mortality in post-MI VSD repair. In contrast to other published studies, the presence of cardiogenic shock and emergency/salvage operation were not identified as the predictors of mortality in multivariate analysis. Moreover, other different risk factors were identified as the predictors of mortality by previously published reports. In the report by Cinq-Mars et al (1), older age and shorter time between MI and surgery were identified as the independent predictors of mortality. The study by Malhorta et al (14) showed that a low mean blood pressure with IABP, higher EuroSCORE II, higher Killip class and shorter intervals between MI and VSD as well as VSD and surgery were strong predictors of mortality. In the recent report by the JCVSD (9), also an advanced age and an emergency/salvage operation were identified as the strong predictors of mortality. Ejection fraction ≤30 %, renal failure, preoperative shock and 3-vessel disease were also independently associated with greater odds of operative death. Finally, data from the STS-ACSD registry (2) identified preoperative dialysis, advance age, female gender, shock, preoperative IABP, mitral insufficiency (moderate or severe), redo cardiac surgery, emergent status and a shorter time interval between MI and surgical repair as the predictors of mortality. Moreover, an incomplete revascularization during VSD repair and a prolonged cardiopulmonary bypass were also described by different authors as the predictors of mortality (8, 9).

Residual ventricular septal defect was found in the previous publications to be a predictor of congestive heart failure and a reason for reoperation (7, 9). In our study, it was identified to be a strong predictor of mortality.

Debate remains concerning the effect of concomitant coronary artery bypass grafting (CABG) in the setting of post- MI VSD repair. Although that in our study CABG was not identified as a predictor of mortality, earlier STS reports (2, 6) documented a higher operative risk in patients undergoing concomitant CABG, however other single-centre series have reported the opposite finding(15, 16). Although many surgeons do not revascularize the culprit vessel, other coronary lesions are often grafted at the time of VSD repair. Moreover, Malhotra et al (13), proposed that if a patient with anterior VSD has a well- visualized first septal with left main disease or proximal significant disease of the left anterior descending artery (LAD), CABG with graft to the proximal LAD should be performed.

The publication from the STS-ACSD database showed that mortality of the patients varied significantly depending on timing of surgery. Patients, who underwent surgery within 7 days from the symptoms onset, had a 54 % mortality compared to 18 % mortality if the repair was delayed more than 7 days after VSDs post initial presentation (2). Our data as data from other authors (1, 12, 13) confirmed that a shorter time between VSD and surgery is a significant factor for mortality. The improved outcome may be related to the healing and stabilization of the infracted myocardium and stabilized preoperative hemodynamic of the patient. Early surgery is usually performed in individuals with a marked hemodynamic instability and circulatory compromise, making an immediate surgical management the only viable option for them. Moreover, according to our data and data from the JCVSD database (13), an emergency/salvage operation was a risk factor for operative death in univariate analysis.

The wide application of mechanical support IABP can stabilize hemodynamic in a considerable number of patients (17). If

circulation is still unstable after an aggressive treatment such as IABP, emergency surgery should be performed. This is the case in our cohort where 10 patients had a preoperative insertion of IABP, unfortunately with a high mortality.

If the patient has no shock, the VSD-surgery time interval can be extended to 3 to 4 weeks or longer on the basis of strict monitoring. If the hemodynamic tends to be stable after an aggressive treatment with IABP, the VSD-surgery time interval should be extended and the elective operation should be selected (17).

Because of the retrospective design of the study, we cannot be certain that all the potential confounders have been examined, and secondly, the sample size is being smaller than in other trials.

In conclusion, this analysis showed that post MI-VSD repair was a devastating complication after MI and preoperative mechanical ventilation, postoperative renal replacement therapy and residual defect were identified to be the predictors of mortality in post-MI VSD repair. After confirming the diagnosis, when possible, prompt attempts should be made to stabilize the patients since surgical repair has proven to be more efficient when delayed from the initial acute phase.

References

1. Cinq-Mars A, Voisine P, Dagenais F et al. Risk factors of mortality after surgical correction of ventricular septal defect following myocardial infarction: retrospective analysis and reviews of the literature. Int J Cardiol 2016; 206: 27–36.

2. Arnaoutakis GJ, Zhao Y, George TJ et al. Surgical repair of ventricular septal defect after myocardial infarction: outcomes from the Society of Thoracic Surgeons National Database. Ann Thorac Surg 2012; 94: 436–443.

3. Pang PY, Sin YK, Lim Ch et al. Outcome and survival analysis of surgical repair of post-infarction ventricular septal rupture. J Cardiothorac Surg 2013; 8: 44.

4. Isoda S, Osako M, Kimura T et al. Surgical repair of postinfarction ventricular septal defects- 2013 update. Ann Thorac Cardiovasc Surg 2013. DOI: 10.5761/atcs.ra.12.02201.

5. 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-I (Global Utilization of Streptokinase and TPA for occluded Arteries). Trial Investigators. Circulation 2000; 101: 27–32.

6. Arnaoutakis GJ, Kilic A, Conte JV et al. Longitudinal outcomes after surgical repair of postinfarction ventricular septal defect in the Medicare population. Ann Thorac Surg 2020; 109: 1243–1250.

7. Fukushima S, Tesar PJ, Jalali H. et al. Determinants of in-hospital and long-term surgical outcomes after repair of postinfarction ventricular septal rupture. J Thorac Cardiovasc Surg 2010; 140: 59–65.

8. Takahashi H, Arif R, Almashhoor A, Ruhparwar A, Karck M, Kallenbach K. Long-term results after surgical treatment of postinfarction ventricular septal rupture. Eur J Cardiothorac Surg 2015; 47: 720–724.

9. Park SJ, Kim JB, Jung SH, Choo SJ, Chung CH, Lee JW. Surgical repair of ventricular septal defect after myocardial infarction: a single center experience during 22 years. Korean J Thorac Cardiovasc Surg 2013; 46: 433–438.

10. Papadopoulos N, Moritz A, Dzemali O et al. Long-term results after surgical repair of postinfarction ventricular septal rupture by infarct exclusion technique. Ann Thorac Surg 2009; 87: 1421–1425.

11. David TE, Armstrong S. Surgical repair of postinfarction ventricular septal defect by infarct exclusion. Semin Thorac Cardiovasc Surg 1998; 10: 105–110.

12. Jeppsson A, Liden H, Johnsson P, Hartford M, Radegran K. Surgical repair of post infarction surgical defects. A national experience. Eur J Cardiothorac Surg 2005; 27: 216–221.

13. Sakaguchi G, Hiroaki M, Motomura N et al. Surgical repair of postinfarction ventricular septal defect-Findings from a Japanese National Database. Circ J 2019; 25: 83(11): 2229–2235.

14. Malhotra A, Patel K, Sharma P et al. Techniques, timing and prognosis of post infarct ventricular septal repair: a re-look at old dogmas. Braz J Cardiovasc Surg 2017; 32(3): 147–155

15. Barker TA, Ramnarine JR, Woo EB et al. Repair of postinfarct ventricular septal defect with or without coronary artery bypass grafting in the northwest of England: a 5-year multi-institutional experience. Eur J Cardiothorac Surg 2003; 24: 940–946.

16. Muehrcke DD, Daggett WM Jr, Buckley MJ, Akins CW, Hilgenberg AD, Austen WG. Postinfarct ventricular septal defect repair: effect of coronary artery bypass grafting. Ann Thorac Surg 1992; 54: 876–882.

17. Li H, Zhang S, Yu M et al. Profile and outcomes of surgical treatment for ventricular septal rupture in patients with shock. Ann Thorac Surg 2019; 108: 1127–1132.

Received February 3, 2021.
Accepted March 3, 2021.