Long-term results after surgical treatment of postinfarction ventricular septal rupture

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Abstract

OBJECTIVES: Postinfarction ventricular septal rupture is a serious complication associated with high hospital mortality rates. The present study aimed to identify predictors of early and late outcome in patients with postinfarction ventricular septal defect over a period of 30 years.

METHODS: We retrospectively analysed clinical and operative data, predictors of early mortality and long-term survival in a series of 52 consecutive patients (male, n = 26; mean age, 67 ± 10 years) with postinfarction ventricular septal rupture that was surgically repaired at our institution between September 1982 and December 2012. The overall logistic EuroSCORE was 41 ± 24% and the follow-up rate was 100%.

RESULTS: The 30-day mortality rate was 36% (n = 19), and these 19 survivors were followed up for a mean of 7.8 ± 7.7 (median, 6.0) years. The actuarial survival rates of these 19 patients at 1, 5 and 10 years were 91, 75 and 31%, respectively. Univariate predictors of 30-day mortality comprised renal insufficiency, shock at surgery, emergency surgery, logistic EuroSCORE, three-vessel disease, significant left circumflex coronary arterial stenosis, significant right coronary arterial stenosis, incomplete revascularization, surgical duration and cardiopulmonary bypass time and multivariate analysis selected only incomplete coronary revascularization as an independent risk factor of 30-day mortality.

CONCLUSIONS: Early mortality rates after surgical repair of postinfarction septal rupture remained poor in this series. Most patients who survived for <30 days had a preoperative shock status. Preoperative improvement in shock status and aggressive coronary revascularization are mandatory for patients with ventricular septal rupture.

Keywords: Myocardial infarction • Coronary artery bypass grafting • Coronary percutaneous interventions (PCI) • Revascularization

INTRODUCTION

Ventricular septal rupture (VSR) is a rare and serious complication of acute myocardial infarction (AMI) that occurs in 1–2% of patients after AMI [1, 2]. However, VSR is associated with high hospital mortality rates, and the reported survival is <10% after 1 month without surgical treatment [2, 3]. The current guidelines of the American College of Cardiology and the American Heart Association recommend immediate surgical treatment of postinfarction VSR [4]. Despite improvements in surgical techniques and perioperative management, the outcome after surgical repair of postinfarction VSR remains disappointing [5–7], and this is mainly due to preoperative haemodynamic instability caused by preoperative right and/or left ventricular dysfunction and a left-to-right shunt. The reported 30-day mortality rates during the first decade of this century range from 35 to 62% [8–14]. Thus, reducing early mortality rates are likely to be associated with better long-term outcomes. Therefore, identifying predictors for poor early and late outcome is essential. The present report describes our experience with 52 consecutive patients who underwent VSR repair at a single institution. We also applied risk factor analysis to identify potential treatment strategies to improve the poor outcomes associated with VSR.

PATIENTS AND METHODS

Patients

The study was approved by our Institutional Ethics Committee. Being a retrospective study, individual patient informed consent was waived. We retrospectively identified a total of 52 patients with VSR who underwent surgery at Heidelberg University between September 1982 and December 2012. This was a consecutive series of all patients who underwent surgery for VSR in this period (Fig. 1). A disrupted ventricular septum with evidence of a left-to-right shunt was typically diagnosed by colour Doppler echocardiography and/or evidence of a left-to-right shunt was confirmed by cardiac catheterization ventriculography. The patients were medically treated at the Department of Cardiology and subsequently transferred to our department.

Their mean age was 67 ± 10 (range 42–83) years and 26 of them were male. The median interval between AMI and surgical intervention was 8 days. All patients were assessed by preoperative coronary angiography and echocardiography. The angiographic data showed that 17 (33%) and 33 (63%) of the patients had single and multiple coronary artery disease, respectively. Seven (13.5%) patients required preoperative acute percutaneous
coronary intervention (PCI). The shunt size was estimated by echocardiography or angiography in 35 (67%) patients and the mean left to right shunt volume was 64 ± 16%. Twenty-four (46%) and 28 (54%) patients presented with anterior and posterior VSR, respectively. Thirty (58%) of the patients had shock at the time of surgical intervention. Renal insufficiency defined as serum creatinine >2 mg/dl was found in 18 (35%) patients. An intra-aortic balloon pump (IABP) was preoperatively introduced in 20 (38%) patients and 29 (56%) underwent emergency surgery. The overall logistic EuroSCORE was 41 ± 24%.

Surgical treatment

All operations proceeded via a standard median sternotomy with a moderately hypothermic cardiopulmonary bypass. An antegrade crystalloid cardioplegic solution was applied to induce cardiac arrest in all except 3 patients who underwent surgery with a fibrillating heart. The VSR was closed in 7 patients with buttressed mattress sutures without a patch, as described by Daggett et al. [5]. A simple septal patch was applied to 36 patients, a double patch was applied to both sides of the septum in 4 and the patch exclusion technique as described by David and colleagues [6, 7] was applied in 5 patients. The VSR was approached through the infarcted area of the left ventricle, the right ventricle and the right atrium in 23, 22 and in 7 patients, respectively. The ventriculotomy was closed with direct sutures buttressed on felt strips in 45 (87%) patients and the VSR was repaired through the right atrium in 7 (13%).

Concomitant coronary artery bypass grafting (CABG) was applied to 34 (65%) patients with a mean of 1.4 distal anastomoses, and the left internal thoracic artery and saphenous vein were used for grafting. The infarct-related coronary artery was revascularized in 25 patients (left anterior descending coronary artery, n = 15; left circumflex coronary artery, n = 6; right coronary artery, n = 11). Eighteen (35%) patients underwent complete coronary revascularization and 14 (27%) required concomitant left ventricular aneurysectomy. One patient with severe mitral regurgitation required concomitant mitral valve repair and the aortic valve of another with severe aortic valve stenosis was replaced. All patients were postoperatively assessed by echocardiography.

Statistical analysis

Data are expressed as means ± standard deviation and categorical data are expressed as frequencies or ratios of patients. Demographic and baseline variables were analysed by using the Mann-Whitney U-test for continuous variables and Fisher’s exact test for qualitative variables. Univariate associations with 30-day mortality among clinical variables were obtained with 2 × 2 tables and the χ², Fisher’s exact and the Mann-Whitney U-test. The end-points were 30-day and total mortality (all deaths including those at 30 days). Variables that reached P < 0.05 in the univariate analysis or that were considered clinically important were included in a multivariate logistic regression analysis to determine predictors of 30-day mortality. The following variables were included in the logistic regression analysis: renal insufficiency, shock at surgery, emergency surgery, three-vessel disease, significant left circumflex coronary arterial stenosis, significant right coronary arterial stenosis, incomplete revascularization, surgical duration and cardiopulmonary bypass duration. The preoperative shunt volume was excluded as a variable because data were incomplete. Survival was analysed using the Kaplan–Meier method. Statistical differences in Kaplan–Meier survival estimates were determined using the log-rank test. Values of P < 0.05 were considered to indicate statistical significance. Data were analysed using StatView 5.0 for Windows (SAS Institute, Inc., Cary, NC, USA).

RESULTS

Thirty-day mortality and morbidity rates

Table 1 summarizes the preoperative and operative clinical risk factors associated with 30-day mortality. A comparison between 30-day survivors and non-survivors using univariate analysis revealed renal insufficiency, shock at surgery, emergency surgery, preoperative shunt volume (%), three-vessel disease, significant left circumflex coronary arterial stenosis, significant right coronary arterial stenosis, incomplete revascularization, surgical duration and cardiopulmonary bypass duration as significant risk factors. Concomitant CABG tended to be required more frequently among the patients who did not survive for 30 days. The anterior or posterior location of the VSR did not influence early mortality. The causes of death were low cardiac output syndrome in all patients. The logistic EuroSCORE was significantly higher for 30-day non-survivors than survivors (57 ± 19 vs 34 ± 23%, P < 0.01).

The 30-day mortality rate for the entire cohort was 37%. These deaths occurred after surgical repair of postinfarction VSR at a median of 8.1 postoperative days (range 0–30), and 12 of the patients died within 5 days of surgery. Residual ventricular shunts were surgically treated in 4 patients.

Multiple logistic regression analysis selected only incomplete coronary revascularization as the best predictor of 30-day mortality [odds ratio (OR) 4.76; 95% confidence interval (CI) 1.42–714.89; P = 0.029].

Results after different types of surgical ventricular septal rupture repair

Ventricular septal defects were closed with buttressed mattress sutures without a patch as described by Daggett et al. [5] in 7 patients and with Dacron or polytetrafluoroethylene patches in 40 (simple
septal patch, n = 36; double patch on both sides of the septum, n = 4). Patch exclusion as described by David and colleagues [6, 7] was done in 5 patients. Furthermore, 4 (8%) patients with septa that were traditionally reconstructed with patches had residual postoperative shunts, and all of them required reoperation. One patient with a residual postoperative shunt that was treated by reoperation on postoperative day (POD) 2 died of persistent low cardiac output on POD 16 after the reoperation. Furthermore, there was no patient with percutaneous transluminal coronary angioplasty or stenting after surgery.

Long-term outcome

The 30-day survivors were followed up for a mean of 7.8 ± 7.7 (median, 6.1) years. The actuarial survival rates of these patients were 91, 75 and 31% at 1, 5 and 10 years, respectively (Fig. 2A). The cumulative survival rates of the 52 patients after repair of postinfarction ventricular septal defects were 58, 47 and 20% at 1, 5 and 10 years, respectively (Fig. 2B). Figure 3 shows a significant difference in the cumulative survival rates of all patients with or without concomitant CABG (log-rank, P = 0.04), but not in the mortality rates of such patients who survived for 30 days (log-rank, P = 0.45).

DISCUSSION

The occurrence of VSR has decreased with the introduction of new treatment strategies for AMI. Reports indicate that VSR occurred in patients after AMI at a rate of 1–2% before the introduction of thrombolytic therapy [1, 2]. According to the Global Utilization of Streptokinase and Tissue Plasminogen Activator for Occluded Coronary Arteries (GUSTO-I) trial, the incidence rate of postinfarction VSR has remarkably decreased to 0.3% since the introduction of thrombolytic therapy [3]. Some studies also found that primary PCI during AMI significantly reduces the incidence of VSR [15, 16], but the number of patients who underwent primary PCI in our series was too small to study this aspect here. However, a study of the New Jersey Myocardial Infarction Data Acquisition System database has revealed a persistently high mortality rate of VSR despite improvements in medical treatment and revascularization techniques during the last two decades [17].

We found 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). Surgical intervention was often delayed for several weeks in the past to ensure firmer tissues for...
surgery, and earlier operation was associated with a worse cardiac condition [9, 10]. Furthermore, all of our patients were initially treated in other departments and referred to us only after medical management failed. However, a delay in surgical indication to repair VSR might result in multiple organ failure and early death before surgery is even attempted [12]. Therefore, we believe that patients with VSR will derive the maximal benefit from early and aggressive surgical therapy. Actually, the logistic EuroSCORE was significantly higher over the past 15 years in our cohort, compared with those during the initial 16 years (52 ± 23 vs 29 ± 20%, $P < 0.01$, respectively). These findings indicate that we tended to operate on VSR earlier within the last 15 years even when patients were haemodynamically unstable. Surgery could be delayed with good results for stable patients without haemodynamic support. However, general consensus indicates a need for early surgery before haemodynamic deterioration.

Currently, a prompt diagnosis and immediate introduction of cardiac support such as an IABP is recommended in patients with VSR [9]. An IABP as haemodynamic support is widely accepted in the management of VSR because preoperative IABP will increase cardiac output, decrease the left to right shunt and improve coronary perfusion. Presurgical cardiogenic shock surgery influenced early survival, indicating that improving the haemodynamic status of patients before surgery is crucial.

The fragile necrotic myocardium is a major concern during emergency surgery. Deja et al. found that a third of postoperative residual shunts in 40% of patients required reoperation [11]. Ventricular septal defects in the present study were mostly closed with a simple patch as described by Daggett et al. [5]. Four (8%) of our patients had residual postoperative shunts and all of them required reoperation, which was similar to previous findings [5, 11].

The approach through the right atrium reduces the risk of bleeding by avoiding a ventricular incision and reduces surgical duration due to being technically straightforward [18, 19]. This approach was taken for 7 (13%) of our patients. Because the right atrial approach also reduces impaired ventricular contractile function, it might be an alternative technique that could be applied depending on the location of the rupture and the degree of myocardial damage.

The role of CABG during VSR repair remains controversial. Several studies have not found a relationship between CABG and perioperative mortality [20–22]. Conversely, some data suggest that concomitant myocardial revascularization in patients with postinfarction VSR improves late survival [10, 13]. We identified incomplete coronary revascularization as a major risk factor for 30-day mortality. However, we could not find any influence of concomitant CABG upon long-term survival, or that mortality rates were any higher in patients with, than without concomitant CABG ($P = 0.04$, Fig. 3). We suppose that patients who required concomitant CABG had more serious preoperative coronary artery lesions and more severe ventricular dysfunction, which could have led to higher mortality. Based on our risk factor analysis of 30-day mortality, we believe that CABG should be applied whenever possible to reduce a further ischaemic risk. Patients with postinfarction VSR are routinely assessed by preoperative coronary angiography and this is mandatory to identify stenotic coronaries.

Several limitations are associated with the present study: the number of patients was too small to draw definite conclusions regarding which factors contributed to the postoperative course; our patients were not prospectively randomized and surgical techniques were not consistent throughout the series; and few patients could be assessed over a 31-year follow-up, which makes any attempt to identify independent predictors difficult. However, we believe that our results can provide a reference value for statistical discussion.

**CONCLUSIONS**

In conclusion, 30-day mortality after surgical repair of postinfarction septal rupture remained poor in our series. Most of our
patients who did not survive for 30 days after initial surgery had preoperative shock. Complete revascularization significantly and positively affects early outcomes. These results support the notion that shock status should be preoperatively improved and aggressive coronary revascularization should be undertaken to enhance the prognosis of patients with VSR.

**Conflict of interest:** none declared.

**REFERENCES**


