Original Article

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Incidence and factors associated with pericardial effusion after cardiac valve surgery

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ABSTRACT

Introduction: Pericardial effusion (PE) is a postoperative complication of cardiac valve surgery, related to early hospital readmissions and death. We aimed to describe its incidence and to identify predictive factors of moderate-to-severe PE in a contemporary cohort.

Methods: We retrospectively reviewed medical records of all consecutive patients submitted to cardiac valve surgery in a tertiary teaching hospital from January 2012 to July 2014, where echocardiography was routinely performed before patient discharge. Moderate-to-severe PE was defined as ≥ 10 mm of thickness, or signs of cardiac tamponade on echocardiography. Additional clinical and perioperative data were extracted from medical records using a standardized protocol.

Results: Of 353 patients, 335 underwent a predischarge echocardiography. From these, 27 patients (8%; mean age: 62 years; standard deviation 12 years; 70% male) had moderate-to-severe PE. These patients had a higher prevalence of previous stroke (22% vs. 8%; p = 0.009) and oral anticoagulation (international normalized ratio > 2) prior to the surgery (11 vs. 2%; P = 0.002). In patients with moderate-to-severe PE, surgeries had longer ischemia (p < 0.001) and cardiopulmonary bypass (p < 0.001) times, and the prevalence of postoperative atrial fibrillation was higher (56% vs. 32%; p = 0.011) than in patients with absent or small PE. Hospital mortality was also higher (15% vs. 3%; p = 0.002) in patients with moderate-to-severe PE.

Conclusions: Eight percent of patients submitted to cardiac valve surgery developed moderate-to-severe PE. Moreover, PE was associated with pre- and post-surgery conditions likely related to the coagulation state, though a cause-effect relationship could not be inferred. Noteworthy, this condition was associated with higher in-hospital morbidity and mortality.

Keywords: *Adult; pericardium; postoperative care*

Pericardial effusion (PE) is a postoperative complication of open-heart surgery. It may lead to cardiac tamponade, early readmissions and reinterventions, and increased mortality rates[1]. The reported incidence of postoperative PE varies from 1% to 77%[2,3] depending on the type of surgery, clinical characteristics, and the criteria used for identification and quantification. Cardiac valve surgery is one of the procedures most related to the development of PE[3]. A higher risk for postoperative PE has been associated with higher body surface area, pulmonary thromboembolism, hypertension, renal failure, immunosuppression, emergency surgery status, type of cardiac operation other than coronary artery bypass grafting, and prolonged cardiopulmonary bypass[4,5]. As a consequence, identifying predictors for the development of PE after cardiac valve surgery may help to prevent or reduce its occurrence.

In this study, we aimed to determine the incidence of moderate-to-severe PE after cardiac valve surgery and the risk factors associated with this condition in a tertiary teaching hospital.

METHODS

In this cross-sectional analysis, we studied patients submitted to cardiac valve surgery who underwent predischarge echocardiographic examination between January 2012 and July 2014, in the Hospital de Clínicas de Porto Alegre. The institutional review board approved the study and waived written informed consent.

Data were extracted from medical records and the Department of Cardiac Surgery administrative registry using a standardized form. We collected preoperative data about previous comorbidities, medication use, blood tests, imaging exams, and surgical indication; intraoperative data about surgery time and surgical technique; and postoperative data about thoracic drainage, medication use, atrial fibrillation, stroke, severe bleeding, reinterventions, readmissions, and mortality.

Of the 353 identified patients, 335 were included in this study (16 patients died and two patients did not undergo a predischarge echocardiography). Patients were categorized into two groups: moderate-to-severe PE and absent or small PE (figure 1). Moderate-to-severe PE was defined as ≥ 10 mm of thickness[6], or signs of cardiac tamponade on echocardiography. Patients who did not match these criteria were classified as absent of small PE.

Statistical Analysis

Data were presented as mean and standard deviation or median and interquartile range (IQR) (continuous data) or as count and proportion (categorical and ordinal data). Continuous variables were compared using the independent-samples *t* test and categorical variables were compared using the chi-square test. After univariate screening, multivariable linear regression was used to adjust for selected clinically and statistically significant pre-and intraoperative covariates (age, sex, history of stroke, preoperative international normalized ratio (INR) levels, and surgery time).

All statistical analyses were performed with PASW 18.0 (SPSS Inc, Chicago). All tests were two-sided and p-values of < 0.05 were considered statistically significant.

RESULTS

Patients

The majority of echocardiographic examinations were conducted up to 6 days of after surgery (median: 6.0 days; IQR: 5.0-7.0). From January 2012 to July 2014, moderate-to-severe PE occurred in 27 (8%) of 335 patients submitted to cardiac valve surgery (mean age: 62; standard deviation 12 years; 70% male). Five of those presented with echocardiographic signs of increased intrapericardial pressure or clinical cardiac tamponade. Patients with moderate-to-severe PE had more history of stroke and asthma than absent or small PE patients, but were similar to those with respect to other preoperative clinical and echocardiographic characteristics (table 1). The group with moderate-to-severe PE had lower hemoglobin and hematocrit levels, higher INR, and a higher prevalence of INR greater than 2 compared to the absent or small PE group (table 2). The association between moderate-to-severe PE and preoperative INR levels remained statistically significant after adjustments.

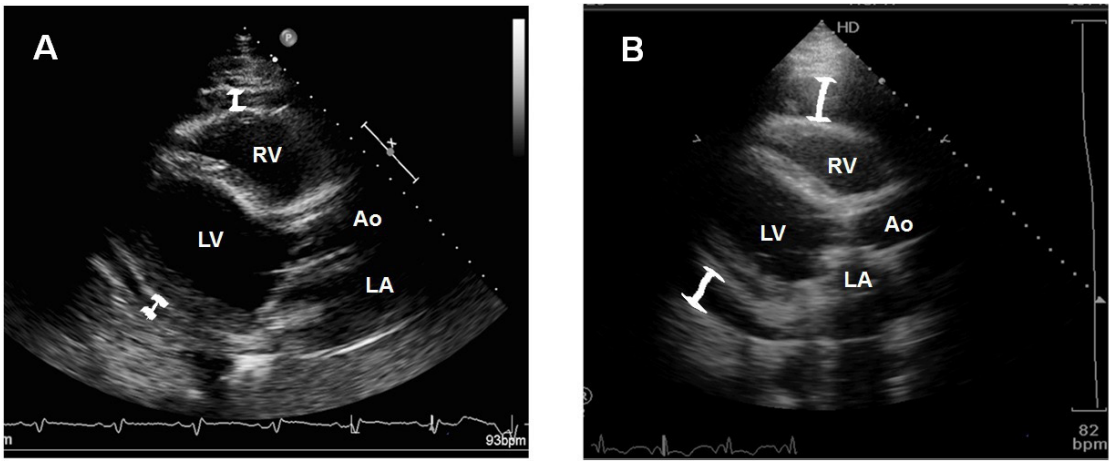

Figure 1: **(A)** Small pericardial effusion (< 10 mm) and **(B)** Large pericardial effusion (≥ 10 mm) on the postoperative echocardiographic examination. RV: right ventricule, LV: left ventricule, Ao: Aorta, LA: left atrium.

Table 1: Preoperative characteristics.

	Moderate-to-Severe PE (n=27)	Absent or Small PE (n=308)	*p* value
Age, years	62±12	61±14	0.108
Male	19 (70)	156 (51)	0.049
BMI, kg/m^2	27.3±5.1	27.6±5.1	0.629
Body surface area, m^2	1.85±0.23	1.79±0.22	0.800
Skin color, white	27 (100)	290 (94)	0.434
Diabetes	7 (26)	67 (22)	0.616
Dyslipidemia	6 (22)	48 (16)	0.368
Hypertension	16 (59)	214 (70)	0.272
Heart Failure	13 (48)	173 (56)	0.421
Ischemic Heart Disease	6 (22)	81 (26)	0.643
Stroke	6 (22)	23 (8)	0.009
Immunosuppression	1 (4)	4 (1)	0.323
Chronic Renal Disease	2 (7)	24 (8)	0.943
Asthma	3 (11)	8 (3)	0.017
COPD	3 (11)	13 (4)	0.107
Atrial fibrillation			0.586
Paroxysmal	2 (7)	11 (4)	
Persistent/Permanent	4 (15)	41 (13)	
Previous Cardiac Surgery	3 (11)	29 (9)	0.774
Preoperative medications			
Antiplatelet agents*	9 (33)	110 (36)	0.804
Oral anticoagulants**	5 (19)	29 (9)	0.133
Nitrate	0 (0)	23 (8)	0.141
Antihypertensive drugs***	22 (82)	248 (81)	0.904
Digitalis	4 (15)	39 (13)	0.748
Antiarrhythmic agents	1 (4)	17 (6)	0.688
Echocardiographic findings			
Aortic diameter, cm	3.3±0.6	3.4±0.6	0.870
Left atrium diameter, cm	4.9±0.8	4.6±0.8	0.648
LV diastolic diameter, cm	5.7±1.2	5.4±1.0	0.696
LV systolic diameter, cm	3.7±1.0	3.6±1.0	0.606
Septum thickness, cm	1.1±0.2	1.1±0.3	0.113
LV posterior wall, cm	1.0±0.2	1.0±0.2	0.217
Ejection fraction, %	62±14	61±12	0.824
RV diameter, cm	2.4±0.4	2.3±0.5	0.660

BMI: Body Mass Index; COPD: Chronic Obstructive Pulmonary Disease; LV: Left Ventricle; PE: Pericardial Effusion; RV: Right Ventricle. *Antiplatelet agents: Aspirin or clopidogrel. **Anticoagulants: Warfarin or new oral anticoagulants. ***Antihypertensive drugs: beta-blockers, angiotensin converting enzyme inhibitors, angiotensin receptor blockers, calcium channel blockers, diuretics. Data are presented as mean ± SD or n (percentage).

Table 2: Preoperative laboratory data.

	Moderate-to-Severe PE (n=27)	Absent or Small PE (n=308)	*p* value
INR	1.27±0.75	1.05±0.19	< 0.001
INR > 2	3 (11)	7 (2)	0.002
Platelets, x 10^3 mg/dL	212±60	216±71	0.673
Hematocrit, %	37.2±7.5	38.1±5.3	0.038
Hemoglobin, mg/dL	12.4±2.7	12.8±2.0	0.027
Creatinine, mg/dL	1.3±1.5	1.2±1.0	0.091

INR: International Normalized Ratio; PE: Pericardial Effusion. Data are presented as mean ± SD and n (percentage).

Surgery

The most performed surgery was aortic valve replacement (70%) and the most common indication for the procedure was aortic valve stenosis (55%). Ninety-three (28%) patients were submitted to multiple procedures (for example, aortic valve replacement and coronary artery bypass graft surgery) during the surgery. Patients with moderate-to-severe PE had longer surgeries, as well as longer periods of ischemia and cardiopulmonary bypass (table 3). Surgical status (elective or urgent/emergent surgery) did not differ between groups, nor did the proportion of patients submitted to multiple procedures.

Postoperative Parameters

Postoperative data are presented in Table 4. Patients with moderate-to-severe PE had longer periods with thoracic drain than patients with absent or small PE, with a mean difference of 5.3 hours (33.6 hours vs. 28.3 hours; p = 0.001), though the total drained volume

Table 3: Surgical parameters.

	Moderate-to-Severe PE (n=27)	Absent or Small PE (n=308)	*p* value
Surgical status			0.363
Elective	24 (89)	288 (93)	
Urgent/Emergent	3 (11)	20 (7)	
Multiple indications	6 (22)	97 (32)	0.317
Multiple procedures	6 (22)	87 (28)	0.503
Total surgery time, min	183±62	159±50	0.041
Ischemia time, min	71±30	58±22	< 0.001
CPB time, min	88±35	74±26	< 0.001

CPB: Cardiopulmonary Bypass. Data are presented as mean ± SD or n (percentage).

Table 4: Postoperative parameters.

	Moderate-to-Severe PE (n=27)	Absent or Small PE (n=308)	*p* value
Days with drain	1.4±0.9	1.18±0.5	0.001
Atrial fibrillation	15 (56)	97 (32)	0.011
New onset atrial fibrillation	10 (37)	62 (20)	0.038
Medications			
Anticoagulants*	19 (70)	179 (58)	0.214
Antiplatelet agents**	7 (26)	168 (55)	0.004
NSAIDs	6 (22)	34 (11)	0.086
Colchicine	8 (30)	11 (4)	< 0.001
Corticosteroids	5 (19)	9 (3)	< 0.001
Echocardiographic findings			
Aortic diameter, cm	3.4±0.5	3.4±0.6	0.143
Left atrium diameter, cm	4.9±0.7	4,5±0.8	0.551
LV diastolic diameter, cm	5.1±0.6	5.1±0.9	0.155
LV systolic diameter, cm	3.6±0.8	3.5±0.9	0.290
Septum thickness, cm	1.1±0.2	1.1±0.3	0.113
LV posterior wall, cm	1.1±0.2	1.1±0.2	0.307
Ejection fraction,%	58±12	58±13	0.842
RV diameter, cm	2.3±0.3	2.3±0.5	0.300
Reoperation for bleeding	4 (15)	14 (5)	0.023
Reoperation for other causes	3 (11)	7 (2)	0.010
Days of hospitalization	24±17	15±13	0.007
Deaths	4 (15)	9 (3)	0.002

*Anticoagulants = Warfarin or Heparin or Enoxaparin. **Antiplatelet agents: Aspirin or Clopidogrel. NAIDs: Nonsteroidal anti-inflammatory drugs; LV: Left ventricle; RV: Right Ventricle. Data are presented as mean ± SD or n (percentage).

did not differ. Moderate-to-severe PE patients had a lower postoperative prescription of antiplatelet agents, i.e. aspirin or clopidogrel (p = 0.004), and a similar use of anticoagulants compared to patients with absent or small PE. Additionally, Moderate-to-severe PE patients had a higher use of colchicine (p < 0.001) and corticosteroids (p < 0.001) due to suspected postpericardiotomy syndrome. The time to start the postoperative medications, including oral anticoagulant therapy, and postoperative blood test results were similar between the groups. There was also no difference in postoperative echocardiographic measures. The moderate-to-severe PE group had more reintervention for bleeding (15% vs. 5%; p=0.023) and for other causes (11% vs. 2%; p=0.01), and three patients developed clinical cardiac tamponade. This group also had more episodes of postoperative atrial fibrillation (56% vs. 32%, p=0,011). The hospitalization was longer in patients with moderate-to-severe PE compared to those with absent or small PE (24±17 days vs. 15 ± 13 days; p = 0.007). The rate of postoperative deaths was significantly higher in patients from the group with moderate-to-severe PE (15% vs. 3%; p = 0.002).

DISCUSSION

In this study, the incidence of moderate-to-severe PE following cardiac valve surgery was 8%. We found that patients who develop moderate-to-severe PE had a higher prevalence of previous stroke, higher levels of preoperative INR, longer surgery times, and higher prevalence of new and recurrent postoperative atrial fibrillation than patients with absent or small PE. Moreover, the group with moderate-to-severe PE underwent more reinterventions (for bleeding and for other causes) and had a greater number of deaths.

The high variability of the reported PE incidence after cardiac surgery is related to the different definitions for this condition[3,7,8]. Our study used only echocardiographic parameters to define PE, while others used clinical presentation and echocardiographic data[7]; however, our incidence of PE is in the lower range of published incidence rates. This may be attributed to the fact that echocardiograms were systematically performed in all patients, regardless of symptoms.

Preoperative Considerations

We identified that history of stroke was a risk factor for the development of moderate-to-severe PE. This association could be attributed to a higher use of antiplatelet agents and anticoagulants aiming at secondary prevention. Although not statistically significant, the prevalence of anticoagulated patients was almost twice as high in the group with moderate-to-severe PE, which is likely to be clinically relevant. Besides that, higher levels of preoperative INR was the most important factor associated with moderate-to-severe PE. Some studies have found association between the previous use of immunosuppressive therapy and the development of postoperative PE[4,9], although we only had two patients taking these drugs. The protective association between history of previous cardiac surgery and PE reported in other studies[4,10,11] was not present in our analysis.

Intraoperative Considerations

Patients with moderate-to-severe PE were more likely to have longer surgeries, with longer periods of ischemia and cardiopulmonary bypass. This finding has already demonstrated to be an important risk factor for PE[3,12], which may be related to changes in coagulation parameters during these periods. We did not find differences in the types of cardiac valve replacement and the type of prosthesis (mechanic or biologic). Some authors have shown that aortic root and aortic aneurysm surgery are independent risk factors for the development of significant postoperative PE due to prolonged cardiopulmonary bypass and extensive dissection of the heart and the aorta[4,13,14]. In this study, we analyzed the combination of aortic root with cardiac valve replacement, but we did not find a higher risk to develop moderate-to-severe PE in this subgroup.

Postoperative Considerations

Patients with moderate-to-severe PE presented higher rate of postoperative atrial fibrillation than absent or small PE patients, similarly to the results described by Ikäheimo et al.[8] Arrhythmia can be a marker of higher risk of adverse outcomes in these patients[15,16] which may have mediated a higher incidence of clinical endpoints regardless the presence of PE.

Aspirin reduces the risk of death and ischemic complications[12] after coronary artery bypass grafting, but it is associated with a higher risk of postoperative PE[3,17]. In our analysis, patients with moderate-to-severe PE used less aspirin and had a similar use of anticoagulants compared to absent or small PE patients. This finding reinforces the safety of early postoperative aspirin administration regarding PE risk.

The efficacy of anticoagulation after cardiac valve surgery depends on a delicate balance between the risk of thromboembolic events and risk of bleeding, and the appropriate time to start these drugs is not clear[18,19]. Although PE is one of the main concerns regarding proper anticoagulation initiation, our data

are not enough to suggest a specific recommendation in this aspect.

The association between the time of chest tube removal and PE is a controversial topic. Most of our patients had their chest drainage removed on the second postoperative day. Some authors showed that there is no difference between early (< 24 hours) and late (≥ 24 hours) chest tube removal[20,21]. Chest tube withdrawal delay would increase the risk of infection and would cause more discomfort to patients[22,23], but its early removal could predispose to the development of PE[24]. In our study, we did not find significant difference between the groups with respect to time of chest tube removal.

The development of moderate-to-severe PE was related to higher risk of reinterventions and death. The causes of deaths were related to cardiogenic shock and septic shock. Only patients from the group of moderate-to-severe PE presented cardiac tamponade. Although, Kuvin et al.[3] reported a high rate of cardiac tamponade after postoperative moderate-to-severe PE (74%), we found a rate of 11% among patients with moderate-to-severe PE. This discrepancy may be due to differences in the definition of cardiac tamponade.

Study Limitations

Some limitations of this analysis should be noted. Although most of our results are consistent with what was reported in the literature, our sample of moderate-to-severe PE patients was small and our study was based on a retrospective analysis of medical records limited to one study center. We analyzed only cardiac valve surgeries, since all these patients should have undergone an echocardiographic examination before hospital discharge as a routine of our service. Additionally, we lack information about the high risk group, since we excluded patients who died before performing the hospital discharge routine.

CONCLUSION

In our study, the incidence of moderate-to-severe PE in patients submitted to cardiac valve surgery is not low, but still in the lower range of previous reports. This condition may be associated with preoperative coagulation state, and also with prolonged surgery and postoperative higher morbidity and mortality. Identifying risk factors associated with moderate-to-severe PE may help to better prevent or reduce the occurrence of this condition.

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