RIGHT VENTRICULAR DYSFUNCTION IN PATIENTS AFTER CARDIAC SURGERY

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ABSTRACT

Objective: Aim of current study was to determine the frequency of right ventricular dysfunction and its associated factors in patients after cardiac surgery.

Study Design: Cohort study

Place and Duration: The design of this study was a cohort study design and this study was conducted in Armed forces Instituted of cardiology / National Institute of Heart Diseases.

Methods: Total 314 patients were included after post-operative cardiac surgery. Treatment and diagnosis of RV dysfunction were implemented. Clinical relevance was the only criterion for RV dysfunction consideration: the presence of hemodynamic instability necessitating catecholamine support and the use of sildenafil to relay inhaled nitric oxide. SPSS 22.0 was used to analyze all data.

Results: There were 190 (60.5%) males and 124 (39.5%) females among all patients. Patients mean age was 67.8±7.17 years. Frequency of RV dysfunction was found in 18 (5.7%) cases. Very severe outcomes were observed among cases of RV dysfunction included prolong ICU stay, mortality, reintubation and stroke. Patients of RV dysfunction had mean age 70.5±3.12 years, mostly were females with more history of atrial fibrillation and greater euro score II.

Conclusion: The rate of patients experiencing clinically severe RV dysfunction after surgery was 5.7% in this cohort analysis. Death, strokes, reintubation, and extended stays in the critical care unit were among the worst unfavorable events linked to RV dysfunction.

Keywords: Nitric Oxide, Sildenafil, Cardiac Surgery, Right Ventricular Dysfunction

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INTRODUCTION

Even while RVF is rare after standard cardiac surgery, it is nonetheless a major cause of complications during and after the procedure. first to third Cardiotomy has a 0.1 percent risk of severe acute perioperative RVF, orthotopic heart transplantation (OHT) a range of 18 percent to 30 percent, and left ventricular assist device (LVAD) installation a range of 20 to 30 percent. RVF usually manifests itself during surgery as trouble separating from cardiopulmonary bypass (CPB), and in the immediate aftermath of surgery, it can cause low cardiac output syndrome or malfunction in several organs. In patients with pulmonary hypertension (PH), obstructive heart disease (OHT), left ventricular assist device (LVAD) implantation, ischemic [5] surgery, or adult congenital heart disease, RVF is more common after valve surgery.[6]

In order to control RVF after surgery, one must take measures such as administering pulmonary vasodilators, managing fluids optimally, providing inotrope support, and, if required, administering systemic vasopressors to restore a damaged RV myocardial perfusion pressure. There is a lack of strong research supporting these therapies at this time. Although there is no evidence in concrete clinical outcomes, inhaled nitric oxide (iNO) is used off-label for cardiac post-operative RV failure [7]. It has an authorised application for chronic pulmonary hypertension in newborns. By lowering pulmonary pressures and resistance without changing systemic hemodynamics and oxygenation, sildenafil also shown promise in clinical trials for postoperative care [8,9].

The absence of a universally accepted definition of RVF following surgery is another concern [7]. So yet, the frequency of RVF and the variables that put people at risk for it remain unknown. Despite a few papers detailing RVF risk scores following left ventricular assist device installation, conventional cardiac surgery literature is lacking [5-8]. Clinical situations where RVF can be widespread include cardiac transplant and mechanical support of the left ventricle. Approximately 11% of patients experience RVF following LVAD implantation, and this condition is associated with a significant death rate [9]. According to Ochiai et al., female gender, non-ischemic aetiology, and the need for inotropic support are factors that increase the likelihood that a patient with left ventricular assist device (LVAD) will require a right ventricle assistance device (RVAD) [10]. According to Kormos et al., clinical factors like fever, pulmonary edoema, and transfusions during surgery are better predictors of the need for right mechanical support than pre-implantation measurements of right ventricular function [11]. Disappointing clinical results are associated with RV dysfunction, which is an almost always-present condition in cardiac transplant patients; RVF is a potential source of this acute and severe graft malfunction [11].

According to a study on the RV's role in cardiac surgery, a higher risk of RVF and perioperative mortality is linked to vascular pulmonary resistance (VPR) before the transplant of 6 Woods Units or more and a mean transpulmonary gradient (TPG) greater than 15 mm Hg [12]. The objective of this research was to identify the causes, consequences, and rates of RVF following cardiac surgery.

MATERIALS AND METHODS

The design of this study was a cohort study design and this study was conducted at Armed forces Instituted of cardiology / National Institute of Heart Diseases. Any adult patient having heart surgery with CPB was a part of the research. Age less than 18 years was a criterion for exclusion. Information gathered prospectively, such as perioperative variables, postoperative medications, and outcomes, was analyzed retrospectively. Two criteria were used to characterize post-operative RVF: (1) hemodynamic instability necessitating the use of vasopressors and/or inotropes, and (2) the requirement for pulmonary vasodilators immediately following surgery (iNO followed by sildenafil® per os). Echocardiography was routinely used to examine patients who presented with hemodynamic instability in the postoperative phase.

The RV free wall hypokinesia, RV/LV dependency, or a larger RV with an RV/LV ratio greater than 1 were necessary for RVF. If patients did not receive tricuspid intervention, further optional measures might include a tricuspid annular plane systolic excursion (TAPSE) less than 16 mm and tissue doppler imaging with a peak myocardial velocity at the lateral tricuspid annulus (S wave) less than 9.5 cm/s. At the time of RVF diagnosis, inhaled NO was started. Weaning was accomplished by reducing the dosage by 1 ppm hourly when hemodynamic stability had been maintained for at least 24 hours after administration at 10 ppm. For the first 48 hours following surgery, patients were prescribed sildenafil at a dosage of 20 mg every 8 hours, to be taken orally whenever feasible. The Kolmogorov-Smirnov test with Lilliefors adjustment was used to examine the data distribution. The student t-test or Mann-Whitney U-test were used for comparing the summarized continuous variables, which were expressed as mean ± standard deviation or median (interquartile range), respectively. Whenever possible, we used the chi-square or Fisher exact-test to compare

categorical variables, which were given as counts (percentages).

RESULTS

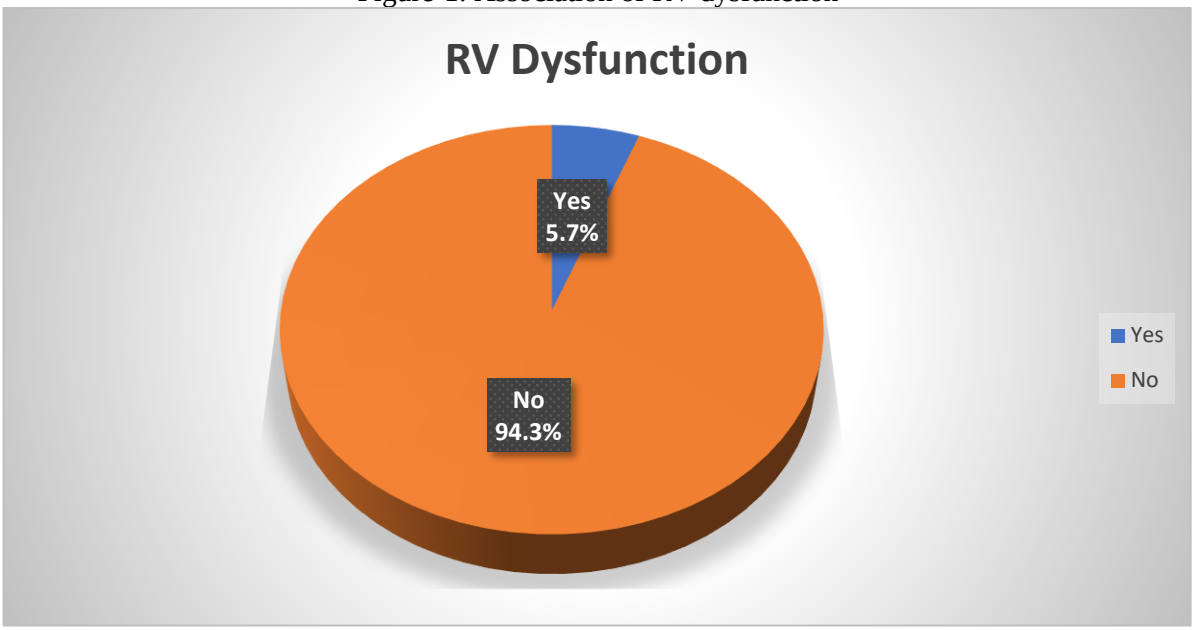
There were 190 (60.5%) males and 124 (39.5%) females among all patients. Patients mean age was 7.8±7.17 years. HTN, COPD and type II DM were the comorbidities among all cases. (table 1)

Table-1: Demographics Of the Enrolled Cases

Variables	**Frequency**	**Percentage**
Gender		
Male	190	60.5
Female	124	39.5
Mean age (years)	67.8±7.17	
Comorbidities		
HTN	185	58.9
COPS	70	22.3
Type II DM	54	17.2

Frequency of RV dysfunction was found in 18 (5.7%) cases. (figure 1)

Figure-1: Association of RV dysfunction



Very severe outcomes were observed among cases of RV dysfunction included prolong ICU stay, mortality, reintubation and stroke. (table 2)

Table-2: Outcomes Of RV Dysfunction Cases

Variables	**Frequency (18)**	**Percentage**
Prolong ICU stay		
Yes	15	83.3
No	3	16.7
Mortality		
Yes	7	38.9
No	11	61.1
Reintubation		
Yes	11	61.1
No	7	38.9
Stroke		
Yes	14	77.8
No	4	22.2

Patients of RV dysfunction had mean age 70.5±3.12 years, mostly were females with more history of atrial fibrillation and greater euro score II. (table 3)

Table-3: Variables Associated with Incidence of RV Dysfunction

Variables	Frequency (18)	Percentage
Mean age (years)	70.5±3.12	
Gender		
Male	5	27.8
Female	13	72.2
History of AF		
Yes	10	55.6
No	8	44.4
Euro score II	5.0±2.9	

DISCUSSION

Reduced heart output following surgery When it comes to echocardiographic right heart evaluation, correct and repeatable information is difficult to get without sternotomy, which is why intensive care unit (ICU) diagnosis is a big reason for worry. Without patent clinical RVF, TAPSE may naturally decrease in the postoperative period as a result of the conventional method to cardiac surgery, which involves accessing the heart's pericardium [13]. Also, it's possible to underestimate RV systolic function following tricuspid annuloplasty if you undergo TAPSE [14]. Consistent with other descriptions, we found that post-operative RVF was linked with mitral valve surgeries and a history of left ventricular ejection fraction (LVEF) below 50% [15]. Particularly if LV was reduced prior to correction, the main mechanism is a sudden rise in afterload as a result of the removal of the reverse flow into the left atrium [16].

Our findings suggest that a more challenging postoperative course may be related with a history of AF [17]. Research conducted by Gorter et al. revealed that in heart failure patients with maintained left ventricular ejection fraction (LVEF), RV and RA functions were significantly impaired in patients with atrial fibrillation (AF) and sinus rhythm patients with a history of AF as compared to patients without an AF history [18]. They further hinted that these results had little to do with pulmonary pressures. Right atrium (RA) enlargement is linked to functional TR in chronic AF, according to recent research [19]. Atrioventricular (AF), tricuspid (TR), and retrograde (RA) enlargement are all factors in the progression of RVF. Then, TR correction may be an important treatment choice; nevertheless, it is associated with an increased risk of RVF following surgery [20].

Unfortunately, we did not have a control group in our data set, thus we cannot analyse the effects of iNO and sildenafil as RVF treatments. Sildenafil, either alone or in combination with iNO, has recently attracted research interest. While no studies have shown differences in clinical outcomes just yet, our experience suggests that combining the two medications in the post-operative period is a safe and effective way to decrease pulmonary circulation pressure and resistance without compromising cardiac output.

At a 3-month follow-up following mitral valve surgery, Tamborini et al. [21] discovered that s' was considerably lower at $17.8 + 4$ cm/s and TAPSE was significantly lower at $25.3 + 4$ mm compared to $15.5 + 3$ mm (all $p < 0.0001$). In fact, there were no discernible changes to RVEF or RV size as seen by 3D echocardiography. Interestingly, TAPSE and s' went back to normal levels at the 6- and 12-month follow-ups in this study. When feasible, Lang et al. [22] further suggests that patients in this context undergo a 3D evaluation of RV function using TAPSE and s'.

CONCLUSION

The rate of patients experiencing clinically severe RV dysfunction after surgery was 5.7% in this cohort analysis. Death, strokes, reintubation, and extended stays in the critical care unit were among the worst unfavorable events linked to RV dysfunction.

REFERENCES

1. Denault AY, Haddad F, Jacobsohn E, Deschamps A. Perioperative right ventricular dysfunction. *Curr Opin Anaesthesiol* 2013; **26**: 71–81.
2. Haddad F, Couture P, Tousignant C, Denault AY. The right ventricle in cardiac surgery, a perioperative perspective: I. Anatomy, physiology, and assessment. *Anesth Analg* 2009; **108**: 407–421.
3. Jabagi H, Mielniczuk LM, Liu PP, Ruel M, Sun LY. Biomarkers in the diagnosis, management, and prognostication of perioperative right ventricular failure in

cardiac surgery—are we there yet? *J Clin Med* 2019; **8**: 559.

4. Fattouch K, Sbraga F, Bianco G, Speziale G, Gucciardo M, Sampognaro R, Ruvolo G. Inhaled prostacyclin, nitric oxide, and nitroprusside in pulmonary hypertension after mitral valve replacement. *J Card Surg* 2005; **20**: 171–176.
5. Yadav H, Unsworth B, Fontana M, Diller GP, Kyriacou A, Baruah R, Mayet J, Francis DP. Selective right ventricular impairment following coronary artery bypass graft surgery. *Eur J Cardiothorac Surg* 2010; **37**: 393–398.
6. Schuuring MJ, van Gulik EC, Koolbergen DR, Hazekamp MG, Lagrand WK, Backx APCM, Mulder BJM, Bouma BJ. Determinants of clinical right ventricular failure after congenital heart surgery in adults. *J Cardiothorac Vasc Anesth* 2013; **27**: 723–727.
7. Fullerton DA, Jones SD, Jaggers J, Piedalue F, Grover FL, McIntyre RC. Effective control of pulmonary vascular resistance with inhaled nitric oxide after cardiac operation. *Cardiovasc Surg.* (1996) 111:11.
8. Pepke-Zaba J, Higenbottam TW, Dinh-Xuan AT, Stone D, Wallwork J. Inhaled nitric oxide as a cause of selective pulmonary vasodilatation in pulmonary hypertension. *Lancet Lond Engl.* (1991) 338:1173–4.
9. Takeda K, Naka Y, Yang JA, Uriel N, Colombo PC, Jorde UP, Takayama H. Outcome of unplanned right ventricular assist device support for severe right heart failure after implantable left ventricular assist device insertion. *J Heart Lung Transplant.* 2014;33(2):141–148.
10. Ochiai Y, McCarthy PM, Smedira NG, Banbury MK, Navia JL, Feng J, Hsu AP. et al. Predictors of severe right ventricular failure after implantable left ventricular assist device insertion: analysis of 245 patients. *Circulation.* 2002;106(12 Suppl 1):I198, 202.
11. Kormos RL, Gasior TA, Kawai A, Pham SM, Murali S, Hattler BG. et al. Transplant candidate's clinical status rather than right ventricular function defines need for univentricular versus biventricular support. *J Thorac Cardiovasc Surg.* 1996;111(4):773, 82; discussion 82-83.
12. Ibrahim M, Hendry P, Masters R, Rubens F, Lam BK, Ruel M, Davies R. et al. Management of acute severe perioperative failure of cardiac allografts: a single-centre experience with a review of the literature. *Can J Cardiol.* 2007;23(5):363–367.
13. Zanobini M, Saccocci M, Tamborini G, Veglia F, Di Minno A, Poggio P, et al.. Postoperative echocardiographic reduction of right ventricular function: is pericardial opening modality the main culprit? *BioMed Res Int*. (2017) 2017:4808757.
14. de Agustin JA, Martinez-Losas P, de Diego JJG, Mahia P, Marcos-Alberca P, Nuñez-Gil IJ, et al.. Tricuspid annular plane systolic excursion inaccuracy to assess right ventricular function in patients with previous tricuspid annulopasty. *Int J Cardiol*. (2016) 223:713–6.
15. Sethi GK, Miller DC, Souchek J, Oprian C, Henderson WG, Hassan Z, et al. Clinical, hemodynamic, and angiographic predictors of operative mortality in patients undergoing single valve replacement. *J Thorac Cardiovasc Surg*. (1987) 93:884–97.
16. Rankin JS, Nicholas LM, Kouchoukos NT. Experimental mitral regurgitation: effects on left ventricular function before and after elimination of chronic regurgitation in the dog. *J Thorac Cardiovasc Surg*. (1975) 70:478–88.
17. Greenberg JW, Lancaster TS, Schuessler RB, Melby SJ. Postoperative atrial fibrillation following cardiac surgery: a persistent complication. *Eur J Cardiothorac Surg*. (2017) 52:665–72.
18. Gorter TM, van Melle JP, Rienstra M, Borlaug BA, Hummel YM, van Gelder IC, et al. Right heart dysfunction in heart failure with preserved ejection fraction: the impact of atrial fibrillation. *J Card Fail*. (2018) 24:177–85.
19. Cho JY, Kim KH, Kim JY, Sim DS, Yoon HJ, Yoon NS, et al. Predictors of reversible severe functional tricuspid regurgitation in patients with atrial fibrillation. *J Cardiol*. (2016) 68:419–25.
20. Spratt JA, Olsen CO, Tyson GS, Glower DD, Davis JW, Rankin JS. Experimental mitral regurgitation. Physiological effects of correction on left ventricular dynamics. *J Thorac Cardiovasc Surg*. (1983) 86:479–89. 10.1016/S0022-5223(19)39112-3
21. Tamborini G, Muratori M, Brusoni D, Celeste F, Maffessanti F, Caiani EG, Alamanni F, Pepi M (2009) Is right ventricular systolic function reduced after cardiac surgery? A two- and three-dimensional echocardiographic study. Eur J Echocardiogr 10:630–634
22. Lang RM, Badano LP, Mor-Avi V, Afilalo J, Armstrong A, Ernande L, Flachskampf FA,

Foster E, Goldstein SA, Kuznetsova T, Lancellotti P, Muraru D, Picard MH, Rietzschel ER, Rudski L, Spencer KT, Tsang W, Voigt JU (2015) Recommendations for cardiac chamber quantification by echocardiography in adults: an update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. J Am Soc Echocardiogr 28:1–39. e14