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Correlation between dP/dt and dP/dt max with right ventricle functional capacity in patients with rheumatic heart disease before and after valve replacement surgery

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ABSTRACT

In this study, we investigated correlation between right ventricle function with dp/dt in patients with rheumatic heart diseases before and after the valve replacement surgery. Forty-four patients with rheumatic heart disease with involvement of mitral, tricuspid or aortic valves with detectable tricuspid regurgitation were candidates for valve replacement surgery and they were studied. Transthoracic echocardiography indices that were measured before and after the surgery were right ventricle function, dP/dt, dP/dt max, and tricuspid regurgitation severity. Mean (\pm SD) functional class (NYHA) of the patients before surgery was 2.1 (\pm 0.5). This improved after surgery and decreased to 1.2 (\pm 0.5) ($P= 0.001$). Thirty-six patients had normal pulmonary artery pressure after surgery. RV function demonstrated significant improvement after surgery and 36 patients had normal RV function. Mean (\pm SD) dP/dt before surgery was 613 (\pm 201) which increased to 935 (\pm 321) after surgery ($P= 0.0001$). Mean (\pm SD) dP/dt/max before surgery was 19 (\pm 9) which increased to 63 (\pm 39) after surgery ($P= 0.001$). Both indices had significant correlation with RV function. dP/dt and dp/dt/max were both useful non-invasive echocardiographic indices in assessment of RV function in patients with RHD who underwent valve replacement surgery.

Key words: Rheumatic heart disease, right ventricle, function; dP/dt,dP/dt/max

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1. INTRODUCTION

Despite widespread usage of penicillin for treatment of infections with streptococcus group A, acute rheumatic fever and consequently rheumatic heart disease (RHD) is still considered as an important public health issue in developing countries (1). RHD is the most common acquired cardiac disease in younger patients in developing countries. The most important cardiac complication of RHD is fibrosis of cardiac valves, which eventually leads to symptomatic heart failure via alteration in cardiac hemodynamic status. Mitral valve is roughly involved in all patients and leads to mitral stenosis (MS). Aortic valve can also be involved in half of patients in the form of aortic regurgitation (AR) or aortic stenosis (AS).

When valvular disease is severe and patient has symptoms in spite of receiving medications, surgery to replace the diseased valve is inevitable. Although a decrease has been reported in RHD occurrence due to improvement of economic and health status, such decrease has not been seen in terms of surgeries done for RHD (2, 3). In the far past, it was believed that right ventricle (RV) function has a trivial role in emulation of heart function. However, with demonstration of RV failure in the setting of many symptoms, considerable revisions were made in clinical decision-makings in RHD patients with considering the role of RV failure (4, 5). Recent studies have noted that RV function can be affected in valvular diseases. MS because of RHD can raise pulmonary artery pressure and cause RV failure. RV failure can affect patients' symptoms, pre-operation evaluations, and clinical outcome after

surgery (6). In such cases, tricuspid regurgitation (TR) which occurs due to RV failure co-exists. Despite these facts, RV function is not well understood or studied in valvular diseases, especially RHD. Even though RV functions, evaluation is one of the most critical assessments in clinical outcome of patients, the question that how RV function changes in RHD and after its surgical correction it's still not understood completely. Since valuation of different stages of RV failure is difficult clinically or by echocardiography, some specific indices have gained attention in evaluating RV function. Ventricular pressure change during isovolumic contraction, which is known as dP/dt (i.e., isovolumic contraction period), is a documented index to evaluate myocardial contractions and is used extensively in studying contractions of the left ventricle (7, 8). However, there is limited information about dP/dt of RV and this index is not used routinely in clinical practice, some researchers have mentioned usefulness of dP/dt in studying RV contractions (9, 10). Most studies, which have applied this index for studying RV function, have implemented this index in patient population with primary pulmonary hypertension. So far, no study has used this index in patients with RHD. Therefore, in this study the authors intended to study correlation between RV dP/dt with functional capacity and RV function in patients with RHD before and after valve replacement surgery. In case of finding a significant correlation between dP/dt index and RV function before and after surgery, this index could be introduced as a clinically useful and non-invasive method in studying RV function in patients with RHD undergoing valve replacement surgery.

2. MATERIALS AND METHODS

Forty-four patients (7 males and 37 females) with mean

Table 1 shows echocardiographic findings related to

Table 1. Comparison of pulmonary artery pressure and tricuspid regurgitation severity before and after valve replacement surgery in patients with rheumatic heart disease

		Before surgery	After surgery	P value*
Pulmonary artery pressure	Normal	7	36	0.001
	High normal	8	4	
	Mild hypertension	13	3	
	Moderate hypertension	7	1	
	Severe hypertension	9	0	
Tricuspid regurgitation	Mild	28	42	0.001
	Moderate	13	2	
	Severe	3	0	

*P value<0. 001

As depicted, the changes detected in these two parameters after surgery are statistically significant. Thirty- six patients had normal pulmonary artery pressure after surgery.

(standard deviation, SD) age of 50.8 (±9.4) years who were diagnosed with RHD and suffered involvement of mitral, aortic or tricuspid valve and had detectable TR who were undergoing valve replacement surgery were recruited. Of 44 patients, 33 cases had mitral regurgitation (MR), 41 had MS, 25 had AR, and six cases had AS. Exclusion criteria were coronary artery disease and congenital heart defects. The patients were studied using two-dimensional and Doppler echocardiography using Vivid 4 echo. Functional class of the patients was assessed before and after surgery using recommendations of New York Heart Association (NYHA). Echo was done in all patients before surgery and then two months following surgery. Echocardiographic parameters documented included RV function, dP/dt, dP/dt max, and severity of TR. The severity of TR was assessed in several views according to the recommendations of the American Society of Echocardiography and was categorized as mild, moderate, or severe (11). RV function was also categorized as normal, mild dysfunction, moderate dysfunction or severe dysfunction. To express data, descriptive indices such as mean and its SD were used. To compare data before and after surgery the t-test was used. To assess correlation between RV function and dP/dt, dP/dt/max, and NYHA class the logistic regression test was applied. The significance level was set at 0.05. The Research Deputy of our university regarding medical ethics approved the proposal of this study.

3. RESULTS AND DISCUSSION

Mean (±SD) functional class (NYHA) of the patients before surgery was 2.1 (±0.5). This improved after surgery and decreased to 1.2 (±0.5) (P= 0.001).

pulmonary artery pressure and TR before and after surgery.

Table 2 presents RV function and size as well as TAPSE and s tissue velocity indices.

Table 2. Comparison of right ventricle function and size as well as TAPSE and s tissue velocity before and after valve replacement surgery in patients with rheumatic heart disease

		Before surgery	After surgery	P value*
Right ventricle function	Normal	8	36	<0.0001
	Mild dysfunction	16	8	
	Moderate dysfunction	12	0	
	Severe dysfunction	8	0	
TAPSE, mm	>24	14	1	<0.0001
	20-24	20	34	
	16-20	3	7	
	<16	7	2	
Right ventricle size	Normal	28	36	<0.0001
	Mild dilation	9	8	
	Moderate dilation	6	0	
	Severe dilation	1	0	
S tissue velocity	Normal (>12)	16	0	<0.0001
	Abnormal (<12)	28	44	

*P value≤0. 001

As shown, RV function demonstrated significant improvement after surgery and 36 patients had normal RV function. Even though eight patients had severe RV failure before surgery, this condition was not detected in any patient after surgery. Mean (±SD) dP/dt before surgery was

(613 ±201) which increased to (935 ±321) after surgery (P=0.0001). Mean (±SD) dP/dt/max before surgery was (19 ±9) which increased to (63 ±39) after surgery (P=0.001). In

Table 3, correlation between RV function and dP/dt, dP/dt/max, and NYHA class is shown. As presented, all three indices has significant correlation with RV function

and this significance level was more prominent regarding dP/dt/max and NYHA functional class.

Table 3. Correlation between right ventricle function and he studied echocardiography indices

	Right ventricle function	
	P value	Correlation coefficient
dP/dt	0.02	0.350
dP/dt max	<0.001	0.645
Functional capacity (NYHA class)	<0.001	0.523

The findings obtained here demonstrated that both dP/dt and dP/dt/max improved after surgery in patients with RHD who underwent valve replacement surgery. The changes detected in both indices were significant and had significant correlation with RV function. Limited studies have been done regarding RV function deterioration in RHD and its improvement after surgical intervention despite this fact that RV function is a major determinant in clinical outcome. All studies agree that in case of RV function impairment and dilation, echocardiography evaluation is difficult. This difficulty is attributed to the crescentic shape, separate infundibulum and prominent trabeculation of the RV. Besides, RV function is load dependent, subject to pericardial effects, and volume and pressure overload (12). Pande et al. studied

echocardiographic Tei index in RHD patients and showed that this index increased after surgery (13). In another study Burger et al. determined the effect of balloon mitral valvuloplasty in patients with rheumatic mitral valve stenosis (14). They reported that a complete improvement was observed in terms of RV function after balloon valvuloplasty. They used thermo-dilution catheter in their study and showed that RV ejection fraction increased from 41% to 48% at rest and from 30% to 43% during exercise. In another study (12) on 70 patients with RHD and mean age of 35 years who underwent mitral valve replacement surgery. They made use of echocardiographic indices including TAPSE, RV systolic pressure, myocardial performance index (MPI) and tricuspid annular shortening (TV shortening). They reported that TV shortening was the

only significant factor in predicting outcome of surgery. dP/dt and $dP/dt/\max$ indices have been used in the past for examining RV function. In a study on 14 patients with evidence of TR on Doppler echocardiography, the authors calculated the rate of increase in RV pressure was calculated between 2 points situated on the ascending limb of the velocity profile of the tricuspid regurgitation and compared with the dP/dt max measured simultaneously at right heart catheterization. They reported a significant correlation between dP/dt max and the rate of increase in pressure measured by Doppler. Based on this finding, they concluded that Doppler echocardiography could be used for non-invasive assessment of RV systolic function in clinical practice (15). In another study, Sadeghpour et al. evaluated RV contractility and systolic function in 56 patients with RHD with moderate to severe mitral stenosis using RV function, dP/dt , and $dP/dt/\max$ (16). They found a significant correlation between RV dP/dt and RV function ($P=0.001$) and between RV dP/dt and NYHA class ($P<0.001$). According to their study, TR severity and pulmonary artery hypertension did not have significant effect on RV dP/dt and RV function. RV $dP/dt/\max$ had also significant relationship with RV function and functional capacity. Kanzaki et al. (17) also reported that $dP/dt/\max$, but not $dP/dt/\max$, it is useful in clinical evaluation of RV contractile function. They reported that dP/dt max did not correlate with NYHA class. Limitations we encountered included low sample size which prohibited us to analyze and compare subgroups of the patient population. In addition, we recommend that in future studies, the usefulness of these indices also assessed in longer times of follow-up.

4. CONCLUSION

In conclusion, dP/dt and $dp/dt/\max$ were both useful non-invasive echocardiographic indices in assessment of RV function in patients with RHD who underwent valve replacement surgery.

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AUTHORS CONTRIBUTION

This work was carried out in collaboration between all authors.

CONFLICT OF INTEREST

The authors declared no potential conflicts of interests with respect to the authorship and/or publication of this article.

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