ORIGINAL RESEARCH PAPER

Volume - 9 | Issue - 9 | September - 2020 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

RIGHT VENTRICULAR PERFORMANCE AFTER MITRAL VALVE REPLACEMENT IN CHRONIC RHEUMATIC MITRAL REGURGITATION

Cardiology

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ABSTRACT

Objectives: To evaluate the effect of mitral valve replacement on functional tricuspid regurgitation and right ventricular function.

Methods: Through Nov and Dec 2018, 25 patients with chronic Rheumatic mitral valve regurgitation, and a structurally normal tricuspid valve, underwent mitral valve replacement(MVR). Right ventricular function (myocardial performance index and tricuspid annular plane systolic excursion[TAPSE]) and Tricuspid regurgitation(TR) was measured before and after surgery using trans-thoracic echocardiography.

Results: In patients with all grades of preoperative tricuspid regurgitation, mitral valve replacement was associated with reduced tricuspid regurgitation and improved right ventricular function. The echocardiographic indices of RV function, I.e TAPSE and MPI showed statistically significant improvement after MVR, mean pre-operative TAPSE was 15+/-1.8 mm, while the mean post-operative TAPSE showed a statistically significant improvement 21+/-2.3 mm, ($p<0.001$), for right ventricular index of myocardial performance, the mean preoperative value was 0.41 +/- 0.18 while the mean post operative value was 0.34 +/- 0.11, ($p<0.001$). Improvement in RV function was paralleled by a reduction in PASP, 49+/-13 pre-operatively to 33+/-10 post-operatively ($p<0.001$). The number of patients with moderate RV dysfunction reduced from 14 (56%) pre-operatively to 4(16%) after MVR, while patients with mild RV dysfunction increased from 8(32%) to 17(68%) after MVR. The number of patients with severe TR reduced from 8(32%) to 1(4%) after MVR, while patients with mild TR increased from 7(28%) to 12(48%).

Conclusions: In patients with mitral valve disease and tricuspid regurgitation, mitral valve replacement was associated with immediate and short term improvement in all grades of tricuspid regurgitation and right ventricular function.

KEYWORDS

INTRODUCTION:

Right ventricular (RV) dysfunction results due to a complex interaction of various factors : the remodelled and enlarged left ventricle (LV), septal performance, and pulmonary artery systolic pressure (PASP) [1-3]. Le Tourneau and colleagues [5] have shown that opearations o n the mitral valve lead to rapid improvement of the right ventricular function. RV dysfunction is common in chronic MR and, in combination with reduced LV ejection fraction, is a strong predictor of poor cardiovascular and overall survival [5]. However it can be inferred that mitral valve replacement should lead to an improvement in right ventricular function.

An echocardiographic RV evaluation is often part of the preoperative workup, but the complex geometry of the RV makes it difficult to assess the performance of this cardiac chamber. In addition, the echocardiographic measurements for assessment of RV dysfunction [2,6] may be difficult to interpret after cardiothoracic operations according to the results of previous studies showing postoperative disruption of the native RV contractile pattern [7, 8]. RV function was markedly abnormal in patients with moderate and severe TR.[9] This was true for the myocardial performance index (MPI), which reflects global RV systolic and diastolic function, and tricuspid annular plane systolic excursion (TAPSE), which reflects longitudinal systolic function.[11] Whether the TR was caused by RV dysfunction or vice versa remained unclear. The decreased function suggested by MPI and TAPSE, both being load-sensitive indexes, could reflect true RV dysfunction or altered pre- and afterload.[11]

All our patients underwent mitral valve replacement (MVR) for their mitral regurgitation(MR).Tricuspid valve repair was not added to the procedure irrespective of the degree of TR. It is well known that MVR reduces pulmonary pressure and RV afterload; mitral valve replacement (MVR) could also influence the right heart by changing the atrial and ventricular septal positions from the shifting volume and pressure loads.

Therefore, in this study, we attempted to study the effect of mitral valve replacement in patients with chronic severe MR of rheumatic origin, with no evidence of either organic tricuspid valve disease or coronary artery disease by comparing the post operative echocardiographic parameters of right ventricular function with the pre operative values.

Patients and methods:

This was a prospective observational study wherein a random sample of consecutive 25 patients undergoing Mitral Valve Replacement for chronic Rheumatic Mitral Regurgitation were selected, patients included 17 males and 8 females between the ages of 24 and 52 with a mean age of 36. Exclusion criteria was patients having concomitant Aortic, tricuspid or pulmonary valve disease of more than mild degree of stenosis or regurgitation, patients having concomitant coronary artery disease, patients undergoing mitral valve replacement in an emergency setting or as a redo surgery.. Pre operative Trans thoracic Echocardiographic assessment was done for all patients, assessment of RV function was performed with the apical four-chamber and parasternal RV inflow and outflow tract views. The following quantitative conventional indices were measured: tricuspid annular plane systolic excursion, RV index of myocardial performance, PASP. All echocardiographic measurements were taken into consideration, and an overall RV dysfunction was graded qualitatively as normal, mild, moderate, or severe by two different cardiologists.

All patients underwent Midline sternotomy under general anesthesia, standard aortic and bicaval cannulation, antegrade cardioplegic arrest with the Del Nido cardioplegia solution, moderate hypothermia upto 28degree celsius was maintained in all cases as a means for myocardial protection. Sorin Carbomedics Mechanical Mitral Valve prosthesis was inserted in all patients. The patients were further assessed on the same parameters immediately before discharge.

Categoric variables were expressed as proportions and percentages and continuous variables as mean +/- 1 standard deviation. Student's t test was used where appropriate for continuous variables. Categoric data were compared with the χ^2 test.Statistical significance was defined as $p < 0.001$. Statistical analysis was performed with IBM SPSS software.

RESULTS:

Table 1 shows the pre-operatve characteristics of the patients included in the study, the mean age of the patients was 36 years +/- 4.2 years with a range between 24 to 52 years, 17 (68%) of the patients were males and 32% were females. 23(92%) of the patients were severely symptomatic in NYHA class 3-4, 12 (48%) patients were in sinus rhythm while 13 (52%) patients were in atrial fibrillation. 18 (72%) patients were on pre operative ACE inhibitors, while all patients (100%) were on diuretics pre-operatively.3 (12%) patients had diabetes mellitus while 4(16%) patients had hypertension as other comorbidities

Mean aortic crossclamp time was 48+/-5.1 minutes, while the mean CPB time was 78+/-6.3 minutes, 10 (40%) patients received a size 27 Carbomedics valve, 9 (36%) patients received a size 29 carbomedics valve and 6(24%) patients received a size 31 carbomedics valve. All patients had uneventful recoveries, underwent pre discharge echocardiography on the seventh post operative day.

Table 1. Preoperative and Perioperative Characteristics

Characteristic	n (%) or Mean SD		
Preoperative data		36	+/-4.2
Age, y			
Male		17	(68)
COPD		1	(4)
NYHA class III–IV	23	(92)	
Atrial Fibrillation on ECG	13	(52)	
Sinus rhythm	12	(48)	
Hypertension	4	(16)	
Beta-blocker use	4	(16)	
ACE inhibitor use	18	(72)	
Diuretic use	25	(100)	
Diabetes mellitus type II	3	(12)	
Perioperative data			
ECC (minutes)	78	+/-6.3	
Cross clamp time (minutes)	48	+/-5.1	
Valve size used			
# 27 Sorin Carbomedics	10	(40)	
# 29 Sorin Carbomedics	9	(36)	
# 31 Sorin Carbomedics	6	(24)	

ACE= angiotensin converting enzyme; COPD = chronic obstructive pulmonary disease; ECC = extracorporeal circulation; NYHA = New York Heart Association; SD = standard deviation.

Table 2. Echocardiographic Data

	Preoperative		Postoperative		
Variable	n or Mean	(%) or SD	n or Mean	(%) or SD	**p Value**
TAPSE, mm	15	1.8	21	2.3	<0.001
RIMP	0.41	0.18	0.34	0.11	<0.001
RV dysfunction					
Normal	3	(12)	4	(16)	0.061
Mild	8	(32)	17	(68)	<0.001
Moderate	14	(56)	4	(16)	<0.001
Severe		0		0	
TR					
Mild	7	(28)	12	(48)	<0.001
Moderate	10	(40)	12	(48)	0.045
Severe	8	(32)	1	(4)	<0.001
CVP, mm Hg	6	3	5	2	0.023
PASP, mm Hg	49	13	33	10	<0.001
LVEF, %	65	10	62	10	0.028

CVP = central venous pressure; LVEF = left ventricular ejection fraction; PASP = pulmonary artery systolic pressure; RIMP= right ventricular index of myocardial performance; RV = right ventricular; ; TAPSE =tricuspid annular plane systolic excursion; TR = tricuspid regurgitation

Table 2 reveals a comparision of the pre and post operative echocardiographic data for all patients, while the mean pre operative TAPSE (tricuspid annular plane systolic excursion) was 15+/-1.8 mm, the post operative mean TAPSE showed a statistically significant improvement 21+/-2.3 mm, the right ventricular index of myocardial performance also showed a statistically significant improvement, the mean preoperative value was 0.41 +/- 0.18while the mean post operative value was 0.34 +/- 0.11. Preoperatively RV dysfunction was graded as moderate in 14 (56%) patients while it was mild in 8(32%) patients, while after MVR only 4(16%) patients were found to have moderate RV dysfunction and 17(68%) patients had mild RV dysfunction, in both cases the result was statistically significant.

Pre-operatively tricuspid regurgitation was graded as severe in 8(32%) patients while post-operatively only 1 (4%) patient was found to have severe TR, Similarly 7(28%) patients were found to have mild TR pre-operatively while 12(48%) patients had mild TR on post-operative assessment, again the results were statistically significant. However the prevalence of moderate TR on pre and post-operative evaluation was not found to be statistically significant.

There was also a slight fall in left ventricular ejection fraction post-operatively which was not however statistically significant.

DISCUSSION

Functional TR secondary to mitral valve disease is a result of alterations in the size and shape of the TV annulus, the relative displacement of papillary muscles and in RV geometry,[9,11,12] Hence it is to be inferred that eliminating MR should initiate reverse RV remodeling and reduce TR. Furthermore MVR would result in an immediate decrease in PASP leading to an improvement in RV function. In the present study, the prevalence of RV dysfunction, as reflected by conventional echocardiographic indices, decreased after mitral valve replacement. Our findings confirmed that MVR alone reduced RV systolic pressure and improved TR of every severity grade in the immediate post operative period.

The interaction between TR and RV function appears to be in both directions; not only does RV dysfunction affect the severity of TR, but reduced TR is also associated with improved RV function. Functional TR is secondary to RV dysfunction and vice versa. RV dysfunction has a very consistent association with severe functional TR than any other measure of RV remodeling. In patients with all grades of TR, MVR induced an early improvement of RV function; however, the results were most marked in patients with severe TR, MVR improved RV function in parallel with improvement in TR;

The RV performance may be influenced by elevated PASP, which is a common finding in severe chronic MR of rheumatic origin[4]. Grose and colleagues [13]showed that at least part of the RV impairment in patients with elevated PASP was reversible, and elevated PASP is often reduced or normalized after mitral valve repair or replacement.[14]

A quantitative approach to assess RV function is the measurement of the tricuspid annular plane systolic excursion (TAPSE). The TAPSE estimates RV systolic function by measuring the level of systolic excursion of the lateral tricuspid valve annulus towards the apex in the four chamber view. An excellent correlation between the TAPSE and RV ejection fraction as assessed by radionuclide angiography was shown.[15] The approach appears reproducible.

The Doppler index of myocardial performance (Tei index or myocardial performance index) is yet another parameter that can be used for evaluation of RV performance.[16] It is expressed by the formula [(isovolumic contraction time + isovolumic relaxation time)/RV ejection time. It is established that is actually unaffected by heart rate, loading conditions or the presence and the severity of tricuspid regurgitation.[10]

An additional important question relates to how well TAPSE and MPI reflect RV function and changes in RV function after surgery. TAPSE measures longitudinal systolic function and has been shown to correlate highly with MRI-derived volumes[17] and radionuclide ejection fraction.[18] The MPI primarily measures contractility, and its calculation involves consideration of energy-dependent periods of contraction, ejection, and diastolic relaxation.[19] The temporal pattern of TAPSE and MPI was very similar, with a significant positive relationship between the pre- and postoperative values. Our findings are similar to a recent MRI study in which RV volumes and ejection fraction were measured in patients undergoing surgical repair of severe TR.[20] This indicates that TAPSE and MPI are equally useful measures of RV function postoperatively as well as preoperatively in our group of patients,.

Limitations of the study:

The study population was patients with rheumatic mitral valve disease and secondary "functional" TR. Therefore, the results might not be applicable to other patient categories with TR and RV dysfunction. validation of the selected measures of RV function, TAPSE and MPI, against other qualitative and quantitative measures of RV function needs additional study. In particular, validation of RV function measures after cardiac surgery is important, because the surgery and perioperative management include so many manipulations that could affect these measures.

The study has other limitations in the form of a very limited number of patients, all echocardiographic measures are subject to intra- and interobserver variability, all patients received the same mechanical prosthesis, hence the results cannot be applied to other mechanical and bioprosthetic mitral valves, the study is limited in its scope of examining the RV function in a very short follow up period, longer follow up needs to be done to evaluate whether the improvement in RV function is sustained in the medium and long term.This was a single-institution, observational study; thus, echocardiographic follow-up was, to an unknown extent, opportunistic rather than systematic

CONCLUSIONS:

In patients with chronic severe mitral regurgitation of rheumatoid etiology, mitral valve replacement results in a definite improvement of tricuspid regurgitation and right ventricular function, in the early post operative period. It needs further evaluation with longer follow up periods whether the improvement in RV function is sustained and progressive.

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