

ORIGINAL ARTICLE

Comparison of Right Heart Structural and Functional Changes in Patient Undergoing Mitral Valve Replacement with or without Preservation of Subvalvular Apparatus in Patients with Rheumatic Valvular Disease

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Abstract:

Background: Excision of subvalvular apparatus (SVA) during mitral valve replacement (MVR) had its impact not only on left ventricular function, but also on regional and global right-ventricular function. This study was to investigate MVR with subvalvular apparatus preservation (SAP) have any effect on right heart regional or global function or not.

Methods: A total of 50 rheumatic heart disease patients were enrolled who had underwent MVR, with (group-I) or without (group-II) preservation of SVA from January 2013 to June 2014. Preoperative, postoperative and 6 months follow up echocardiographic parameters of the right heart function were taken.

Results: The mean age of the patients were 32±8 years. In both groups female number were predominant. There was significantly improved right atrial, right ventricular dimensions in both the groups at 6 months follow-up but it was more marked in group I. There was no change in right ventricular systolic function before and after surgery in group I patients, group II patients showed deterioration of right ventricular function after surgery.

Conclusion: Deterioration of right ventricular systolic function in non preserved group following MVR. **Key Words:** Subvalvular apparatus, Mitral valve replacement, Right heart function

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Introduction:

Transection of subvalvular apparatus (SVA) during mitral valve replacement (MVR) has its effect not only on left ventricular function but it has effects also on right ventricular regional and global function.¹⁻³ In consequence, the patients undergoing mitral valve replacement may suffer from right ventricular dysfunction, pulmonary hypertension and right ventricular volume overload.

The geometry of RV is complex and consists of inlet, outlet and RV body. Longitudinal shortening is a great contributor to RV stroke volume then circumferential shortening. It is

linked to the left ventricle in many ways; Interventricular septum, mutually encircling epicardial fibers attachment of RV free wall to the anterior and posterior septum and sharing common pericardial space.

Since transection of subvalvular apparatus has its impact on right ventricular regional and global function, Athanasiu T et al in their review article urged for further research or assessment of right ventricular function after MVR with or without subvalvular apparatus preservation. But, systematic assessment of right heart function had not been uniformly carried out until recently.

LeTourneau T and his co-workers had suggested that, further study should include RV measurements and function in patients undergoing MVR with SAP, as they found excision of SVA have its impact not only on left ventricular function, but also on regional and global right-ventricular function.⁵

Methods:

In this study, initially 50 rheumatic heart disease patients were enrolled (consider 10% drop out or missing data rate) who had underwent MVR, with (25 patients) or without (25 patients) preservation of SVA in the cardiac surgery department of BSMMU. Echocardiography was done in cardiology department of BSMMU from January 2013 to June 2014 after assessing the inclusion and exclusion criteria.

Inclusion Criteria: Patients with RHD properly selected for MVR with St. Judes mechanical bileaflet valve. Valve lesions was judged as rheumatic in origin on the basis of echocardiographic findings.⁸ Consecutive patient was taken and mode of surgery was determined by morphology of subvalvular apparatus which dictated the extent of the preservation.

Exclusion criteria: Non Rheumatic mitral valve disease, acute rheumatic carditis, severe LV systolic dysfunction, Re do surgery, previous stroke, emergency surgery, renal failure, pre operative hepatic dysfunction, concomitant procedure like AVR, CABG.

Sampling technique; Purposive sampling.

Group-1 : Patients undergoing MVR with preservation of SVA.

Group-2 : Patients undergoing MVR without preservation of SVA

Grouping was matched so that in each group there was similar type of mitral valvular disease (mitral stenosis and mitral regurgitation) and there was no statistical difference in the groups.

Study procedure: Initial evaluation of the patients was done by history, demographic data (age, sex, occupation), surgical history, clinical examination. Relevant investigations were recorded. Preoperative, postoperative and 6 months follow up echocardiographic data of the different modalities were followed as per the Douglas PS⁶, Rudski LG⁴ and Lang RM⁷ and the following measurements were taken.

2D and M Mode echocardiographic measurements:

- TAPSE- Tricuspid Annular Planner Systolic Excursion.
- 2D RV FAC- Fractional area changes.
- RVOTFS- RV out flow tract fractional shortening.
- RV dimensions (at base and middle)
- Right atrial area.

Pulsed, Continuous and Tissue Doppler measurements:

- Tissue Doppler systolic excursion.
- Right ventricular systolic, diastolic and mean pressure.
- Right atrial pressure.

Post operative Studies: follow up data to measure the outcome was analyzed before discharge and after 6 months.. Echocardiographic parameters were taken as measures for outcome of the procedures.

Statistical analysis: Data was entered and analyzed with SPSS. Descriptive data was calculated for continuous and categorical variables. The chi square test and Fisher's exact test were done to determine the association among the groups for categorical variables. Comparison of continuous variable between the groups was analyzed by unpaired t test. A paired t test was done to compare pre and post operative measures. A p value of less than 0.05 was considered as significant.

Results:

The study was conducted in the department of Cardiac surgery, BSMMU from January, 2013 to June 2014. The mean age of the patients were 32±8 years. In group I, patients age was 29±7 years and in group II 36±9 years. In both the groups female number was dominant, 82% in Group I & 73% in Group II.

Two dimensional and M mode echocardiography, there was improved right atrial, right ventricular dimensions in both the groups at 6 months follow-up but it was more marked in group I, the distribution is shown in table I.

In table II, 2D dimensional and M-mode echocardiographic measurements of right ventricular systolic function between the groups. All though there was no change in right ventricular systolic function before and after surgery in group I patients, group II patients showed deterioration of right ventricular function after surgery.

Doppler measurements for assessing, right ventricular systolic function and pulmonary artery pressure in the groups are shown in table III.

Table-I*Comparison of right atrial, right ventricular dimensions measured by 2D and M mode echocardiography.*

Variable	Patients	Group I	Group II	p value
RA systolic area square cm	Pre operative	22±3.2	23±3.9	NS
	Post operative	21±3.1	23±3.6	NS
	6 month follow up	16±2.6	21±3.01	<0.01
	P value 1	NS	NS	
	P value 2	<0.01	NS	
RA major dimension	Pre operative	59±6.4	56±6.6	NS
	Post operative	53±6.2	56±6.8	NS
	6 month follow up	50±5.8	53±6.1	<0.05
	P value 1	NS	NS	
	P value 2	<0.01	NS	
RA minor dimension	Pre operative	45±4.8	46±4.9	NS
	Post operative	44±4.7	47±5.1	NS
	6 month follow up	40±4.1	44±4.8	<0.05
	P value 1	NS	NS	
	P value 2	<0.01	NS	
RV major dimension	Pre operative	82±7.1	86±6.2	NS
	Post operative	81±7.4	86±8.1	NS
	6 month follow up	76±6.8	83±7.8	<0.001
	P value 1	NS	NS	
	P value 2	<0.01	NS	
RV minor dimension	Pre operative	33±9.1	36±4.8	NS
	Post operative	32±3.9	35±4.9	NS
	6 month follow up	30±3.4	34±3.9	<0.01
	P value 1	NS	NS	
	P value 2	<0.01	NS	

P value Data were analyzed using unpaired t-test presented with mean±SD between the groups

p value1 Data were analyzed using paired t-test (with in the groups before & after MVR)

p value2 Data were analyzed using paired t-test (with in the groups before MVR & at 6 months follow up) Group I: Sub valvular apparatus preserved Group II: Sub valvular apparatus non preserved, n= Number of subjects, NS= Not significant.

Table-II*2D and M mode measurements of right ventricular function in the groups.*

Variable	Periods	Group I	Group II	P value
RVFACE	Pre operative	34±5.2	33±4.8	NS
	Post operative	35±6.1	32±5.8	<0.05
	6 months follow up	42±6.1	30±3.7	<.001
	P value 1	NS	NS	
	P value 2	<0.01	<0.05	
TAPSE	Pre operative	18±4.3	16±4.2	NS
	Post operative	18±4.1	10±3.2	<.001
	6 months follow up	20±4.4	10±3.3	<.001
	P value 1	NS	<0.01	<0.01
	P value 2	NS	<0.01	

P value Data were analyzed using unpaired t-test presented with mean±SD between the groups

p value1 Data were analyzed using paired t-test (with in the groups before & after MVR)

p value2 Data were analyzed using paired t-test (with in the groups before MVR & at 6 months follow up) .Group I: Sub valvular apparatus preserved; Group II: Sub valvular apparatus non preserved .n= Number of subjects ,NS= Not significant

Table-III*Doppler measurments of right ventricular function and pulmonary artery pressure.*

Variable	Period	Group I	Group II	p-value
S prime	Pre operative	12±3.1	9.6±2.9	<0.05
	Post operative	11.6±2.8	7.0±2.4	<0.01
	6 months	12.2±2.7	7.4±2.6	<0.01
	P value 1	NS	<0.05	
	P value 2	NS	<0.05	
IVA m/ sec ²	Pre operative	3.6±0.8	3.45±0.6	NS
	Post operative	3.9±0.7	3.1±0.5	<0.01
	6 months	3.9±0.8	3.0±0.5	<0.01
	p value 1	NS	<0.05	
	P value 2	NS	<0.05	
SPAP mm Hg	Pre operative	58±9	64±10	NS
	Post operative	38±7	44±8	NS
	6 months	30±4	42±5	<0.001
	p value 1	<.001	<.01	
	P value 2	<0.001	<0.01	
MPAP mmHg	Pre operative	28±5	31±6	NS
	Post operative	25±5	29±6	NS
	6 months	19±3	29±5	<0.01
	p value 1	<.001	<.01	
	P value 2	<0.001	<0.01	

P value Data were analyzed using unpaired t-test presented with mean±SD between the groups

p value1 Data were analyzed using paired t-test (with in the groups before & after MVR)

p value2 Data were analyzed using paired t-test (with in the groups before MVR & at 6 months follow up). Group I: Sub valvular apparatus preserved ,Group II: Sub valvular apparatus non preserved. n= Number of subjects ,NS= Not significant.

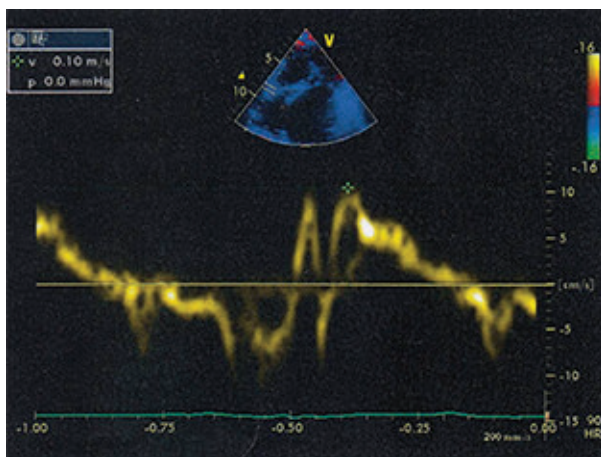


Figure 1 : Tissue Doppler study of right ventricular function before surgery in patients with subvalvular apparatus preservation during MVR.

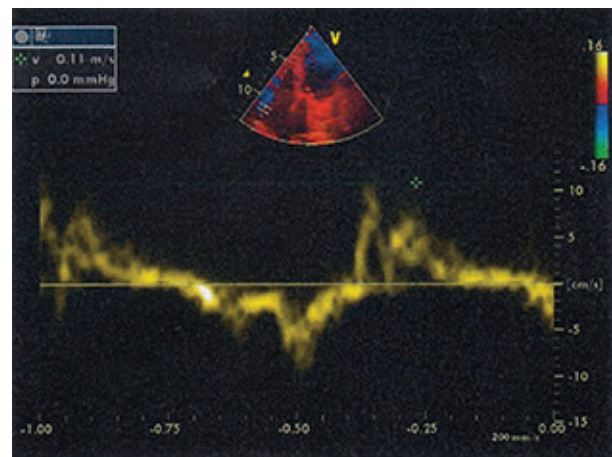


Figure 2 : Tissue Doppler study of right ventricular function after surgery in the same patient with subvalvular apparatus preservation during MVR. There was no change in S prime and IVA before and after surgery.

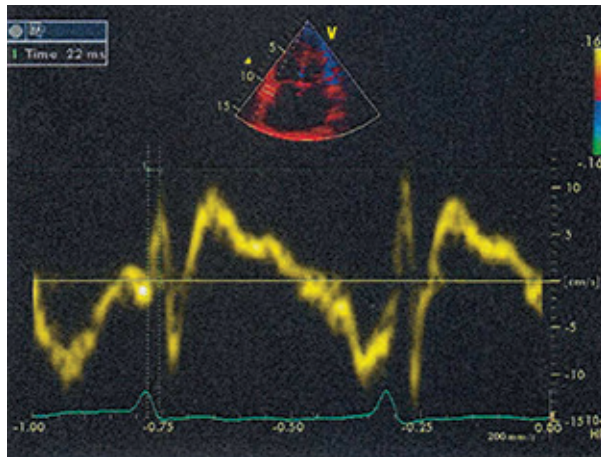


Figure 3 : Tissue Doppler study of right ventricular function before surgery in patients without subvalvular apparatus preservation during MVR.

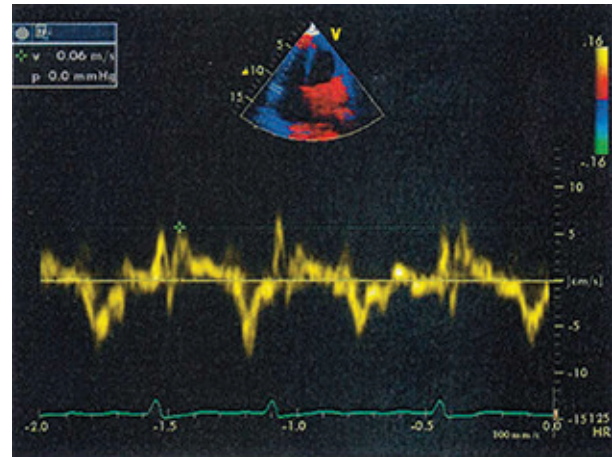


Figure 4 : Tissue Doppler study of right ventricular function after surgery in the same patients without subvalvular apparatus preservation during MVR. There was marked decrease in S prime and IVA after surgery indicating right ventricular dysfunction.

Discussion:

After four decades of introduction of the technique of preservation of subvalvular apparatus during mitral valve replacement and its established unequivocal benefit, there remains some areas of interest related to mechanism, outcome, and effects. There still remains some points to be seen if the similar outcome exists in different patient population. Our study addressed the issues encompassing observation of the outcome of the technique in a population which includes patients with rheumatic origin of our developing country and also looked at the mechanism involved in the outcome. Various newer echocardiographic parameters that reflect right ventricular function have been examined to precisely delineate the effect of subvalvular apparatus preservation on the right ventricle and focusing changes in the parameters of different echocardiographic mode and its interdependence on the left ventricle.

The age of the patient population in our study almost similar to those study done in rheumatic population in developing countries.^(8,9,10,11) On an average, they belong to third decade. But similar studies on the rheumatic population of the developed countries comprised patients with mean age around sixties in Europe and fifties in Japan.^{12, 13}

This difference in age of the candidates requiring valve replacement again reflects the fact that, the rheumatic process in developing countries is more aggressive from those of the developed countries. This justifies the purpose of our study which has reflected a newer population.

Our patient population comprised predominantly female patients and similar pattern has also been found among many other studies where more than seventy percent of the patient population were female.^{13,8, 9,11}

Echocardiographic measures of right heart chambers showed little or no difference in dimensions and surfaces after mitral valve replacement in both the groups. There was significant reduction in right atrial and ventricular dimension in subvalvular apparatus preserved group during 6 months follow up. There was also reduction of above measurements in non preserved group but the changes were statistically insignificant. There was no significant difference in right atrial and ventricular measurement between before and immediately after surgery in both the group but after 6 months follow up the difference was significant as the preserved group showed reduced right atrial and ventricular dimensions and areas.

Although in subvalvular non preserved group there was reduction in systolic pulmonary artery pressure at 6 months follow up, this change has not reflected on right heart chambers. Lack of improvement in the non preserved group is probably attributed to right ventricular systolic dysfunction which was caused by subvalvular apparatus resection. In our study, right ventricular fractional area change was increased in preserved group postoperatively and after 6 month follow up. In non preserved group the RVFA remained unchanged and decreased further at 6 month follow up. In the non preserved group decrease in RVFA despite reduction of pulmonary pressure

indicates transection of mitral subvalvular apparatus impairs right ventricular function, as suggested by Tourneau L et al.¹⁴⁻¹⁶ In their study Radionuclide angiography was used to assess RV function and found improvement in right ventricular function in preserved group and deterioration in non preserved group. The decrease in RV function in non preserved group may also be due to decreased LV systolic function in this group, because there is interdependency of the ventricles.

Talwar S et al suggested in his review article to investigate if in the patient with severe pulmonary hypertension where RV function is impaired, preservation of subvalvular apparatus improves right ventricular function. Our patient population had mean systolic artery pressure of 58 mm of Hg and mild RV systolic dysfunction. We found preservation of subvalvular apparatus improved the RV function in the patients of this group despite severe pulmonary hypertension.

In our study, the 2D and M mode echocardiographic measures could not show any immediate changes in the right ventricular parameter excepting little increase in RVFACE in preserved group. The differences of RV function between preserved and non preserved group was better reflected by the measurements of TAPSE which was significantly decreased after surgery in non preserved group. These changes remained unchanged at 6 months follow up.

Tissue Doppler measurement of RV global function using the parameter S prime and IVA also showed decrease in RV systolic function postoperatively in non preserved group. Our study suggests that the tissue Doppler parameters and TAPSE are paramount in measuring RV global function and reflect considerable dysfunction in non preserved group at early post operative period and at mid term follow up. These tissue doppler parameters are load independent and shows changes in sub clinical stage of right ventricular dysfunction.

In addition to circumferential motion of right ventricle, tissue doppler also reflect longitudinal and torsional motion of the ventricles. Right ventricular movement can be affected by transection of mitral subvalvular apparatus during MVR. Previously, Mankad R et al using MRI showed abnormality in regional myocardial strain in the left ventricle after resection of sub valvular apparatus.¹⁷ Further study by using MRI or tissue Doppler should examine strain pattern in right ventricle before and after MVR in both preserved and non preserved group.

Other newer echocardiographic parameters as used to measure LV mechanics by using ventricular energetics I¹⁸ can be also used to measure right ventricular movement and mechanics in patients undergoing MVR with or without subvalvular apparatus preservation.¹⁸

Conclusion :

Circumferential and longitudinal function deteriorates in right ventricle in non preserved group following MVR.

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