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Right-sided heart evaluation after successful mitral valve replacement

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ABSTRACT

Introduction: It is well-documented that right-sided heart dysfunction and significant tricuspid valve regurgitation (TVR) have adverse effects on patient outcomes after left-sided heart valve surgery. Therefore, the evaluation of right ventriclular (RV) function and TR severity in patients who had undergone mitral valve replacement (MVR), associated with/without concomitant surgery on tricuspid valve, could be helpful for deciding on the necessity of concomitant tricuspid valve intervention before surgery.

Materials and Methods: A total of 222 patients with MVR for rheumatic disease were evaluated in our Echocardiography Lab in Ghaem Hospital, Mashhad, Iran, within 2013-2018. The patients were divided into four groups, according to their type of concomitant TV. The subjects (n=11) with concomitant indications for coronary artery bypass grafting (CABG) or history of coronary artery disease were excluded from the study.

Results: Significant (at least moderate) TVR was found in 60% of the patients. All patients with rheumatic tricuspid valve had significant TVR. After excluding the patients with significant pulmonary hypertension, there was no difference in the prevalence of significant TR, between the patients with tricuspid valve repair and those without any intervention on tricuspid valve (P=0.178). Furthermore, no difference was observed between the patients with/without any intervention on tricuspid valve considering RV size and function.

Conclusion: In patients with left valve surgery concomitant with TR, tricuspid valve repair and replacement could preserve RV size and function, for a long time. During the correction of the left-side valvulopathy, it seems rational to adopt more interventional consideration for patients with tricuspid valve regurgitation, especially those with rheumatic tricuspid valve involvement.

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Introduction

Tricuspid valve regurgitation (TVR) after successful mitral valve surgery may progress and lead to right-sided heart failure, thereby exerting a great impact on patient mortality and morbidity (1, 2) This entity was ignored for a long time. All cases of secondary TVR do not regress after a successful implementation of mitral valve replacement (MVR), and others may even progress in more than half of the patients over time. Conservative approach to tricuspid valve

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(TV) during mitral valve surgery displays a more significant TVR than expected (3, 2, 4).

The secondary form of TVR, related to the dilation of the TV annulus and tethering of the leaflets secondary to right ventricular dysfunction, is the most common cause of this condition. In addition to assessing TVR severity, TV annular dilatation should be noticed in all mitral valve procedures (5).

Prevalence of secondary TVR has been reported to be 25-30% in patients undergoing MVR (3, 6, 7, 8). The incidence of late TVR is more commonly associated with mitral valve diseases, especially those with rheumatic etiology, as compared to aortic valve problems (8-67%) (3, 6, 7). Additionally, TV repair seems to be a lower-risk procedure. Furthermore, re-operation on the TV has a high mortality rate ranging from 50% in the past to 10% in the recent period. Therefore, for patients who had undergone surgery for a left-sided valve disease, more interventional approaches for TV are now recommended (3, 9). The main aim of this study was to evaluate the frequency of significant TVR, as well as assessing the RV size and function in patients, who had MVR with TV repair or without any intervention on TV.

Materials and Methods

Study group

This cross-sectional study was conducted on all (222) patients who underwent successful MVR for rheumatic disease and were referred to our Echocardiography Lab in Ghaem Hospital, Mashhad, Iran, within 2013-2018. The patients with concomitant indications for coronary artery bypass grafting (CABG) or history of coronary artery disease were excluded from the study (n=11). All patients were subjected to a comprehensive 2-dimensional (2D) Doppler echocardiography. In this series of patients, subgroups were defined according to the concomitant types of TV interventions.

The subjects of the study were assigned into four groups of MVR. Patients without concomitant TV intervention (Group 1), with concomitant TV repair (Group 2), MVR associated with biological TV replacement (Group 3) and concomitant mechanical TV replacement (Group 4).

Echocardiography evaluation

Transthoracic echocardiography was performed with the available ultrasound equipment. The images were obtained with a 3.5 MHz transducer. The RV dimension was measured from four chambers. In addition, the RV focused view and RV function were evaluated by lateral TV annular systolic velocity, tricuspid annular plane systolic excursion, and fractional area change. The valves were quantified by 2D Doppler study. Moreover, pulmonary artery pressure, as well as left ventricular size and function, was evaluated.

Statistical analysis

The data were presented as absolute number (percentage). Differences between groups were analyzed using the Chi-square test for the categorical variables. The t-test was used to compare the quantitative variables between the two groups. The Spearman's correlation test was also used for relevant variables. The study population was divided based the implementation or non-implementation of intervention on TV. A p-value less than 0.05 was considered statistically significant. The collected data were analyzed in SPSS software (version 23.0; SPSS, Inc., Chicago, IL, USA).

Results

Baseline characteristics

Baseline clinical and echocardiographic characteristics of patients are shown in Table 1 and Figure 1. The mean age of the patients was 55±13 years, and 71% of them were female. With regard to heart rhythm, 58 (46%) cases had atrial fibrillation (AF).Considering 211 patients undergoing MVR, 11, 5, and 6 patients underwent simultaneous TV repair, TV replacement with biologic type, and mechanical TV replacement, respectively. Significant TVR, which is defined by at least moderate regurgitation, was found in 62% of the cases. Among 189 patients receiving no intervention on TV, 12 cases had TV with rheumatism involvement with 100% significant TR.

Table 1. Baseline clinical and echocardiographic characteristics of patients (n=211)

Characteristic	Value
Age (years)	55±13
Male Gender, n (%)	61 (29)
Atrial fibrillation, n(%)	58/124 (46)
PAH, n (%)	47 (22.3)
Without any intervention on tricuspid valve, n (%)	189 (89)
Tricuspid valve repair, n(%)	11 (5.2)
Mechanical TVR, n(%)	6 (2.8)
Biological TVR, n(%)	5 (2.4)
Significant TR, n(%)	126 (62)
Rheumatism tricuspid valve involvement, n(%)	12/189 (6.3)
Significant TR in rheumatism tricuspid valve, n(%)	12 (100)

PAH: pulmonary arterial hypertension, TVR: tricuspid valve replacement;
TR: Tricuspid valve regurgitation.
Data are presented as mean±SD or number (percent).

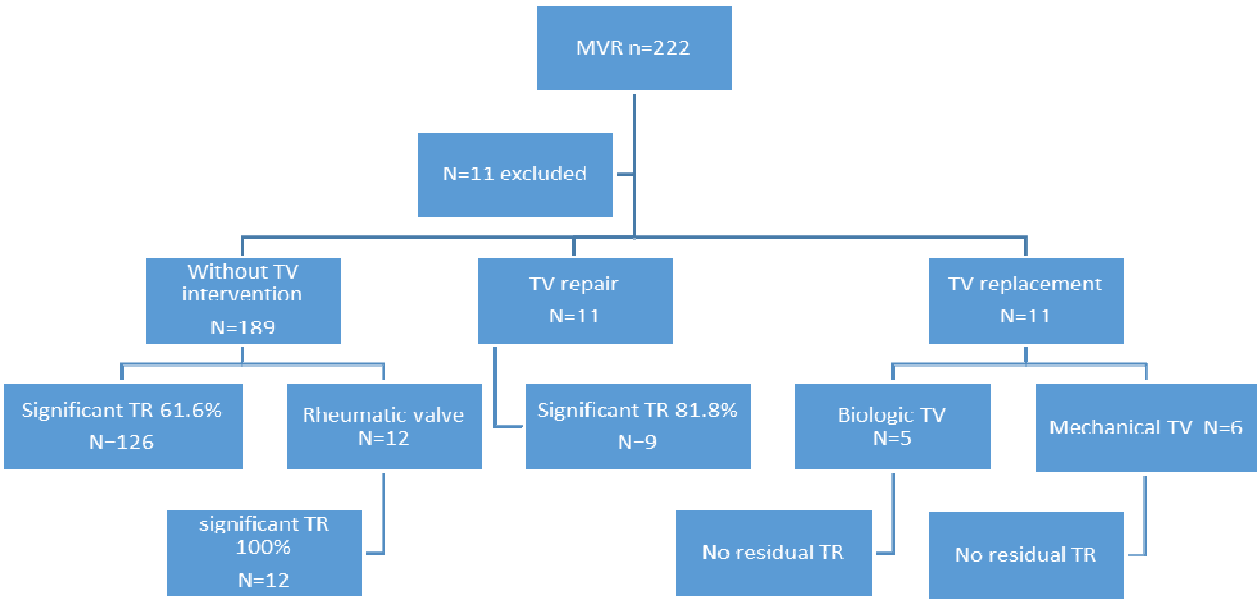

Figure 1. Study algorithm.

Comparison of Changes in Echocardiographic Parameters after MVR

Comparison of changes in echocardiographic parameters after MVR is shown in Table 2. The

TVR was more significant in female patients than in male subjects (68% vs. 50%; P=0.015). In addition, 22.3% of patients had moderately severe pulmonary hypertension. There was a direct moderate correlation between pulmonary artery pressure (PAP) and TVR severity (r=0.47; P<0.001). By increase in TVR severity, the patients had more RV enlargement and RV dysfunction (P<0.001, r=0.48 and P<0.001, r=0.43, respectively).

Severe TVR was more prevalent in patients with AF rhythm than in those with normal rhythm (72% and 28%, respectively, P=0.002). Among 6 patients with TV mechanical replacement, 2 cases had valve malfunction. Furthermore, significant TVR (P=0.720).

was noted in 9 (81.8%) patients with TV repair. After the exclusion of patients with significant pulmonary hypertension (>45 mmHg), there was no difference between patients with TV repair and without any intervention on TV regarding the prevalence of significant TVR (81.8% vs. 62%, P=0.178).

The patients with TV replacement did not show any significant TVR. Furthermore, no significant difference was observed between the patients with/without any intervention on TV in the terms of RV size and function. In this regard, 22% of patients receiving an intervention on TV had moderately severe RV enlargement; however, this rate was reported as 12% for the patients undergoing no such intervention (P=0.362). Additionally, 11% of patients with an intervention on TV and 15.6% without any intervention were found to have moderately severe RV dysfunction

Table 2. Comparison of changes in echocardiographic parameters after mitral valve replacement [a]

Variable		**Descriptive Index**		**P-value**
		Significant TR	Non-significant TR	
Gender **n (%)**	Female	100 (68)	47 (32)	P=0.015*
	Male	30 (50)	30 (50)	
Significant RVe	Yes	37 (28)	1(1.3)	P<0.001*
n (%)	No	93 (72)	76 (98.7)	
Significant RVd	Yes	38 (29)	7(9.1)	P<0.001*
n (%)	No	92(71)	70 (90.9)	
Variable		Intervention on TV		**P-value**
		with	without	
Significant RVe[b]	yes	2/9 (22)	16/135 (12)	P=0.362*
n (%)	no	7/9 (78)	119/135 (88)	
Significant RVd[b]	yes	1/9 (11)	21/135 (15.6)	P=0.720*
n (%)	no	8/9 (89)	114/135 (84.4)	
Variable		Intervention on TV		**P-value**
		Repair	Without any intervention	
Significant TR[b]	Yes	9/11 (81.8)	109/177 (62)	P=0.178*
n (%)	No	2/11(18)	68/177(38)	

Abbreviations: TR, tricuspid valve regurgitation, AF: atrial fibrillation, TVr: tricuspid valve repair, RVe: right ventricular enlargement, RVd: right ventricular dysfunction

A. Data are presented as numbers. B. After excluding patients with significant pulmonary hypertension.

Discussion

Despite supporting current recommendations and successful MVRs, post-operative significant TVR and even clinically overt heart failure may still occur (1). As observed in a significant number of cases, secondary TVR is not a truly functional entity and contains intrinsic anatomical abnormalities of the valve apparatus. Regarding this, TVR does not regress or even may progress after the appropriate correction of the left-side valvulopathy (3, 2). In the current study, 60% of the patients had significant TVR with similar result compared to Porter A study (60% vs. 67%) (7).

Prevalence of significant TV regurgitation in conjunction with MVR was found to be higher in our study than other studies which patients with aortic valve involvement also were included (60% vs. 35%). This finding is partly supported by more prevalence of TR in conjunction with mitral valve disease than aortic valve involvement and in rheumatic valve involvement than degenerative valves (3).

The reason for obtaining a higher TVR prevalence rate for female patients (68%) can be due to the larger number of female patients in our study. A high prevalence (60%) of TVR in patients without any intervention on the TV may occur after the correction of left valve pathology. The TVR does not regress or even progresses during the time. In the same vein, Q Tri et al. showed that 11% of patients progressed to severe TVR over a one-year follow-up after MVR by rheumatic etiology (2).

According to our clinical data, all patients with rheumatic TV progressed to develop significant TVR. This supports the fact that intrinsic the anatomical abnormalities of the valve apparatus are essentially the etiology of significant TVR in a number of patients and is not a truly functional entity (3, 10). In cases without pulmonary hypertension, the progression of TVR along the time may be illustrated by milder involvement of the apparatus which cannot be seen clearly by means of 2D echocardiography. In a study, Shiran et al. suggested that in patients undergoing MVR, tricuspid annular cut-off size for TV repair in echocardiography, regardless of TVR severity, might be lower for rheumatic ones (11).

The results of the present study revealed a direct correlation between PAP and any increase in TVR severity. Therefore, after adjustment for significant pulmonary hypertension, there was no difference between patients with and without TV repair regarding the prevalence of significant TVR, as well as RV size and function. Accordingly, despite the high prevalence of significant TVR after TV repair, valve repair could preserve RV size and function at a similar rate observed in patients without any intervention on TV (12). Therefore, concomitant TV repair should be used more often in the presence of TVR, and this procedure may be delayed redo correction of tricuspid regurgitation (13).

In patients with TV replacement, there was no sign of significant TVR, and RV function could be well-preserved; however, 30% of mechanical valves had malfunction. Given the high rate of mechanical TV malfunction reported in the related literature, mechanical prosthetic valves are less likely to be implanted in the right side of the heart (14).

Based on the obtained results, TV intervention could preserve RV function and secondary TVR is not truly functional. Consequently, the indicators for surgery on TV during left-sided valve surgery should move towards a more interventional attitude, especially in patients with rheumatic tricuspid even without significant TVR or annular dilatation.

Study limitations

The main limitation of this study was its relatively small sample size.

Conclusion

The results of this study indicated that in patients with left valve surgery concomitant with TVR, TV repair and replacement could preserve RV size and function. Significant TVR after the correction of the left-side valvulopathy is prevalent and does not regress or even progress. Therefore, more interventional attitude should be adopted, especially for patients with rheumatic TV involvement even when they have no significant TVR or annular dilatation.

Conflicts of interest

No potential conflict of interest related to this article was reported.

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