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Predictive Value of Preoperative Left Ventricular Ejection Fraction on Left Atrial Reverse Remodeling After Mitral Valve Replacement

Medical Science

KEYWORDS : Mitral valve insufficiency, Mitral valve surgery, Left atrial remodeling, Left atrial volume index

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ABSTRACT

Background: *Left atrium enlargement is commonly seen in patients with mitral regurgitation (MR). Left atrium reverse remodeling (LARR) occurs after surgical correction (repair or replacement of mitral valve) of MR. Preoperative left ventricle ejection fraction (LVEF), as a predictor of this phenomenon is not well known.*

Methods: *We retrospectively studied 200 consecutive patients who underwent mitral valve replacement (MVR) for MR in whom preoperative echocardiography report was available. The preoperative echocardiography parameters were compared. Follow up echocardiography was done during the study. LARR was defined as a reduction in left atrium volume index (LAVi)≥ 15%.*

Results: *LARR occurred in 163 patients (81.5%), with the mean LAVi decreasing from 43.6 mL/m2 to 29.7 mL/m2 (p <0.001). These patients had a higher left ventricular ejection fraction (LVEF) (p =0.027). LVEF was identified as the preoperative predictor of LARR (odds ratio, 1.09; 95% confidence interval, 1.008–1.12). A LVEF cutoff value of 53.6% identified patients with LARR of ≥15% with a sensitivity of 86.8% and a specificity of 74.3%.*

Conclusion: *LARR occurs frequently after mitral valve surgery and is associated with preoperative LVEF higher than 53.6%.*

Introduction

Patients with severe chronic mitral valve disease undergo alterations in the size of the left atrium, a process known as left atrial remodeling [1]. Left atrial remodeling includes left atrial dilatation, left atrial dysfunction, and left atrial failure [6,7]. Both left atrial enlargement and remodeling are compensatory mechanisms in patients with chronic severe mitral regurgitation (MR). These changes allow the left atrium to accommodate the regurgitant volume without increased pressure [2-4]. Left atrial remodeling can be caused by pressure overload in association with mitral stenosis or volume overload in association with mitral regurgitation [5]. Left atrial enlargement is a known marker of major cardiovascular events such as atrial fibrillation, stroke, and death in patients with cardiac disease [6-10]. In patients with chronic severe MR, left atrial size seems to be an important predictor of outcome, either during conservative management or after mitral valve surgery [4,11-13]. Since mitral valve surgery can correct anti-physiological conditions in the mitral valve, it can also cause left atrial reverse remodeling.

In this study, we aimed to identify left ventricular ejection fraction as a predictor of midterm left atrial reverse remodeling after mitral valve surgery.

Different definitions of LARR after mitral valve surgery have been used, of which the most frequently followed is any reduction of LAVi by 15% or more [14- 19]. The objective of our study were to assess the changes in left atrial size after surgery for MR and to verify the preoperative LVEF that may be associated with or predictive of a reduction in left atrial volume index (LAVi) of at least 15%.

Methods

We retrospectively studied 200 consecutive patients at out-patient follow up, whohad undergone mitral valve replacement (MVR) for chronic severe MR at LokmanyaTilakMuncipal Medical College Hospital, Mumbai. Patients were excluded if they had undergone MVR for isolated mitral stenosis or concomitant mitral stenosis along with MR or associate with coronary artery disease, congenital heart disease, infective endocarditis, acute rheumatic fever, stage 2 or 3 systemic hypertension, or a past history of mitral-valve surgery. Assessment included the patients' clinical history, preoperative echocardiography report and a review echocardiography at the out-patient follow up.

Echocardiography

All patients who had undergone MVR carry a detailed preoperative transthoracic echocardiogram with a 2–4 MHz multi-frequential transducer. Echocardiography was repeated at the follow-up. Mean follow up period was 33.6 months (5 months to 64 months) after surgery. Patient position, echocardiographic imaging planes, and measures were performed as recommended by the American Society of Echocardiography [20]. The left ventricular ejection fraction (LVEF) was obtained using the biplane Simpson method. The left atrial volume was estimated using the biplane area-length method and expressed in milliliters (mL). LAVI was determined by dividing left atrial volume (mL) by body surface area (m2). LARR was defined as a reduction of ≥15% in LAVi on postoperative echocardiography.

Statistical analysis

Continuous variables are presented as mean values ± standard deviation, and categorical variables as absolute numbers and percentages. The normal distribution of continuous variables was analyzed using the Kolmogorov-Smirnov test. The association between categorical variables was assessed using either Pearson's chi-square or Fisher's exact test. To compare preoperative and postoperative variables, the paired Student's t-test or the Wilcoxon test, were used. Comparison between groups with and without LARR was done using either Student's t-test or the Mann–Whitney test. The Yolden criteria were used to identify the cutoff value of LVEF that predicted LARR ≥15% [22,27]. Intra- and inter-observer variability was assessed by means of percentual difference between measurements, the paired t-test, and the Pearson correlation coefficient. The significance level of all tests was set at 5%.

Results

The baseline characteristics of the patients are given in

Table 1.All Two hundred patients (100%) underwent mitral valve replacement 149 mechanical prostheses and 51 biological valves. Surgical atrial reduction was not performed in any patients included in the study. In the postoperative evaluation, 169patients were in sinus rhythm, and 31 in atrial fibrillation. 119 (59.5%) patients had a preoperative LAVI ≥40 mL/m2. The LAVI decreased from a preoperative mean of 43.6 mL/m2 to a postoperative mean of 29.7 mL/m2 (p <0.001); the mean reduction was 28%. LARR was observed in 163 (81.5%) patients.

Categorical variables such as sex, age, cardiac rhythm and type of vale (mechanical or biological) II or III/IV, type of surgery performed (repair or replacement), postoperative mean diastolic gradient and preoperative cardiac rhythm (sinus or atrial fibrillation) were not significantly associated with LARR, with p-values ranging from 0.24 to 0.79. Patients with LARR had higher LVEF value (p =0.027). Other preoperative variables were not significantly different between patients with or without LARR (Table 3).

Table 1 Baseline patient characteristics

Variables	n (%)
Female sex	56.0
Age (yrs) ; mean ± SD	38.7 ± 12.9
Body surface area (m^2); mean ± SD	1.41 ± 0.15
Rhythm: Sinus	77.5
Atrial fibrillation	22.5

LVEF was found to be the significant preoperative variable associated with LARR (odds ratio, 1.09; 95% confidence interval, 1.008-1.12). A cutoff value of 53.6% for preoperative LVEF identified patients with LARR ≥15% after surgery, with a sensitivity of 86.8% and a specificity of 74.3%.

Table 2 Echocardiographic variables

Variables	Preoperative	Postoperative	P value
LAVI (mL/m^2)	43.6 ±13.8	29.7 ± 8.2	< 0.001
LVEF (%)	58.6 ± 8.1	51.9 ± 6.7	< 0.001

Table 3 Comparison of age and preoperative echocardiographic variables of patients with or without postoperative left atrium reverse remodeling

Variable	LAVi reduction <15% (n=37)	LAVi reduction ≥ 15% (n=163)	P value
Age (yrs)	39.2 ± 12.3	38.3 ± 13.2	0.54
Sex : Female	20	92	0.42
Male	17	71	0.48
LAVi (mL/m2)	40.1 ± 12.9	45.9 ± 10.7	0.24
LVEF	53.1 ± 7.8	58.9± 6.3	0.027
Cardiac rhythm : Sinus	26	129	0.76
AF	11	34	1.13
Valve type : Mechanical	28	141	0.38
Biological	6	22	0.80

Discussion

Our study revealed that LARR occurs frequently after surgery for chronic severe MR and that preoperative LVEF is a significant variable associated with a postoperative LAVi reduction of at least 15%. Many factors have been reported as determinants of LARR after mitral regurgitation surgery. These include MR etiology, patient age, preoperative LAVI, cardiac rhythm, mitral valve double dysfunction with predominant MR, systemic arterial pressure, diastolic mitral pressure gradient, postoperative reduction in left ventricle diastolic volume, and residual mitral regurgitation after surgery [15- 19].The percentage of patients in our study with LARR after mitral valve replacement is better than other study populations previously described [14-19,27]. Further, a preoperative LVEF of 53.6% or higher identified those patients with at least 15% LARR. While most studies define LAVi at 15%, some of the prior studies differed from ours regarding a higher LAVi value of 25 % taken, while others did not define a cutoff value [14-19]. In our study, a preoperative LVEF of 53.6% or higher identified those patients with at least 15% LARR.

Left atrial size in patients with chronic mitral regurgitation increases with the severity of the regurgitant volume and with duration and progression of the disease [2-4]. Also influencing left atrial dilatation, LVEF is known to deteriorate in patients with advanced MR, and diastolic dysfunction may occur[3,4]. As long as left atrial dilatation persists or progresses, interstitial wall fibrosis and hypertrophy may develop and make reversal remodeling after surgery less likely [22-24] This may be a reason for the observed association of better preoperative LVEF with postoperative LARR in our study. After successful mitral-valve surgery with reduction in left ventricular volume, a decline in left ventricular filling pressure may have occurred, facilitating left atrium emptying and reverse remodeling[27].

Considering the known association between increased left atrial size and cardiac events in patients with MR [12,13] and the fact that early surgery may avoid excess left atrial dilation, it seems reasonable to point out that LARR after MR surgery may be beneficial. A recent large multicenter study using propensity-score matching found that early surgery in patients with MR due to flail leaflets was associated with less heart failure and lower mortality than medical management. However, there was no difference in atrial fibrillation, which is usually associated with a large left atrium [25]. In our study, preoperative atrial fibrillation was not associated with postoperative LARR; of 45 patients with preoperative atrial fibrillation, 14 recovered sinus rhythm after surgery. Another retrospective study did not find association between LARR and reduction of cardiovascular events, mortality and atrial fibrillation [26]. Further studies are needed to verify the prognostic benefits of LARR after mitral-valve surgery in patients with MR.

In conclusion, LARR occurs frequently after mitral valve replacement in patients with primary chronic severe MR, and is associated with the preoperative LVEF higher than 53.6%.

Study limitations

The results of this study may not be applicable to patients with MR from causes other than rheumatic in origin. 3-dimensional echocardiography was not used in our study, although it seems to be slightly more precise for determining LA volume compared with 2-dimensional echocardiography, and facilitates functional analysis. Mitral valve repair surgery has not been included because mitral repair surgery is not routinely done in our institute.

Disclosure :

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